California Sea Grant College Funded Projects 2013

The research funded is selected on the basis of competitive, peer-reviewed proposals and addresses a wide range of problems and opportunities. Summaries of the 2013 projects and other program information are grouped as follows:

California Sea Grant College Funded Projects 2013

Healthy Coastal and Marine Ecosystems

Healthy coastal and marine West Coast ecosystems have intrinsic ecological and aesthetic value and are essential for sustaining the diversity that draws people to the coast and supports many coastal communities. California Sea Grant focuses on supporting research and providing information to conserve, restore and manage these ecosystems; helping to prevent the introduction and spread of invasive, non-native plants and animals, and management and eradication of established populations; and seeking ways to reduce water and sediment contamination in the coastal and marine environment. The funded projects in this focus area for 2013 are listed below.

Modeling Interannual Krill Availability (MIKA) in the Central-Northern California Current, 1990–2009

R/ENV-220 Feb. 2012–Jan. 2014

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Krill are a main food for many marine species and, because of this, krill shortages can have a profound effect on certain fishes and seabird chick populations. In this project, researchers are seeking to link krill distributions to fish recruitment and survivorship using physical oceanographic data and direct measurements of nutrients, plankton and zooplankton concentrations in the central-northern California Current ecosystem. Output from the model is now being analyzed and compared to acoustically derived estimates of krill availability and to direct observations of predator recruitment and survival (for species such as salmon, sardine and rockfish). The modeling work has also included a 20-year hindcast of ocean conditions vis-à-vis an existing “oceanographic-ecosystem-krill” model adapted and calibrated with field observations from 1990 to 2009. The hypothesis is that 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 and to explaining boom-bust cycles in salmon numbers and seabird reproductive success.

Sustainability and Fine-Scale Management of a California Sea Urchin Fishery and the Ecology of Exploitation
R/FISH-209 Feb. 2010–Jan. 2014
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A small group of commercial urchin divers has long expressed interest in developing community-based, co-management of the red sea urchin fishery. 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 collaborative fisheries research project is gathering spatially explicit data on sea urchin movement patterns and mortality rates within the Point Loma kelp bed off San Diego to both further fishermens' 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. A new kind of tag has been developed for tracking urchin movements, and researchers are in the process of developing three underwater time-lapse camera systems to observe small-scale urchin movements and behaviors, including "urchin feeding lines." In the coming year, they will analyze fishing data provided by fishermen to evaluate fishing effort and catch volumes at fine spatial scales. The group continues to collaborate with local educational organizations such as Ocean Discovery Institute, Science Education Foundation and San Diego Oceans Foundation to facilitate public outreach and participation in the project.

Adaptive Management of Marine Protected Areas: Predicting Responses to MPA Implementation for Comparison to Monitoring Data
R/FISH-211 Feb. 2010–Jan. 2014
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In this project, scientists are developing computer models to help interpret monitoring data from the Central Coast MPA study region. The focus is on how to interpret estimates of fish abundances, sizes and biomasses for key species such as blue rockfish, black rockfish, lingcod and cabezon. The spatial population models are incorporating 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 how to interpret the monitoring data that has been gathered, and continues to be gathered, for the region. Such information is critical for adaptively managing the state's network of MPAs and meeting their intended conservation goals. In work to date, scientists have reported the effects of larval dispersal distances, adult home-range sizes, and exploitation intensities on optimal monitoring protocols (i.e., when and where to sample). They have also outlined species dispersal distances and species home range sizes that are expected to be protected by the Central Coast MPAs (based on the reserves' sizes and locations). Another manuscript describes the expected transient responses of populations to the MPAs, and their dependences on fishing mortality rates, ages of maturity, natural mortality rates and larval connectivity. In ongoing work, they are collaborating with MPA Baselining Monitoring researchers and California Sea Grant Extension on an analysis of their monitoring data, and have been invited by the Ocean Science Trust to present findings to date at the State of the Central California Coast meeting in February 2013.

Molecular Identification of Fish Eggs and Larvae: Enhancing the Value of Icthyoplankton Surveys in Monitoring and Management
R/FISH-216 Feb. 2012–Jan. 2014
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Many species of fish eggs are spherical, transparent, about the same size and hence visually ("morphologically") difficult, if not impossible, to correctly identify. This project is making use of advances in molecular genetics and sequencing technologies to explore new methods for efficient identification of fish eggs in environmental samples. The scientists have demonstrated the ability to use a PCR-based fluorescent probe array (developed in an earlier Sea Grant project) to identify fish eggs and larvae in archived ichthyoplankton samples collected during CalCOFI cruises. This work has shown that fish eggs are often misidentified. Pacific halibut, sand dabs and other flatfish are examples of a group of fish eggs that are easily confused. The scientists are currently collecting fish eggs at the Scripps pier to identify the group of fishes that are reproducing in the local marine protected area. When this is done, they will decide whether to develop a "tuned" probe array or employ alternate approaches (which will also be based on DNA barcoding principles). The ultimate goal is to be able to monitor fish reproduction more rapidly, accurately and cost effectively. Surveys of fish eggs and larvae are conducted to help estimate spawning fish biomass, from which harvesting guidelines are in part set. A better understanding of fish reproductive success, as well more information on the timing and location of spawning, would be of great value in fisheries management and in explaining natural variation in fish population sizes, as well as assessing the impacts of environmental change.

Match-Mismatch in the Timing of Hatchery Chinook Salmon Releases and Favorable Ocean Conditions
R/FISH-217 Feb. 2012–Jan. 2014
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California's commercial salmon fishery is in trouble and what remains of the fishery is sustained by hatchery-born Chinook salmon from the Sacramento-San Joaquin River system. Several of the hatcheries that produce these fish now truck juveniles directly to the San Francisco Estuary so the fish don't have to outmigrate through the Central Valley's rivers and the Sacramento-San Joaquin Delta. The scientists involved in this project are asking the question: Is it possible to stagger hatchery releases over a longer period of time to increase the odds that at least some fish will enter the sea when there is enough food (krill) for them? The hypothesis is that these fish are currently released in large pulses (over a narrow window of time) and that this practice subjects fish to a sort of lottery in which there may or may not be enough food, exacerbating boom-bust cycles in salmon numbers. To test these ideas, researchers are examining hatchery reports of when and where fish are released to compute average release times, variabilities in release times, and recovery rates of different release groups. These statistics are being used to explore relationships between recovery rate and release timing in relation to ecosystem dynamics. 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
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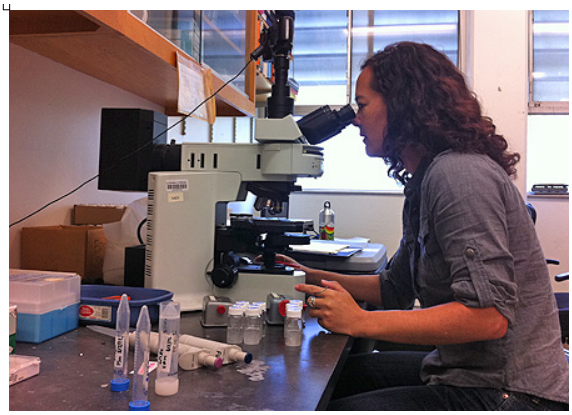
Many species of marine crustacean larvae are able to migrate vertically in the water column to avoid surface flows that may carry them away from their preferred developmental or settlement habitats. Because of this, maps of surface currents do not explain larval distribution patterns and hence cannot be used to identify adult populations that are most likely to replenish local populations or seed distant ones. This fact has been observed by the researchers leading this project in strong upwelling centers off California for 45 species of crustaceans. From the literature and their own research, they have identified six primary modes of behavior by which larvae exert control over their position offshore—by exploiting vertical shears in horizontal flows. These vertical migrations may be triggered, for example, by a certain developmental stage or by tidal cycles, heat or hydrostatic pressure, among other things. The main objective of this project is to incorporate these six larval behaviors into a Lagrangian particle transport module within a Regional Ocean Modeling System for the California Current to

study larval transport and connectivity of populations along the coast and within the new MPAs. For each of the six behaviors, thousands of virtual larvae are being released into the surface layer (depths less than 30 meters) from 1 kilometer to 10 kilometers from shore every other day, transported by modeled ocean currents and tracked for 180 days. Maps of habitat type have been incorporated into the "settlement" component of the model. Settlement is assumed to occur if larvae return to shore at the end of their pelagic larval stage, either 30 days or 60 days depending on the model "run." Results from the project's first year further underscore the importance of vertical migrations to settlement success. Along the Central California coast, larvae that were assumed to descend beneath the surface layer were 500 times more likely to be retained at the coast 30 days after release than those larvae that remained with the surface boundary layer. Settlement success rates were 145 times greater for larvae that avoided surface flows. Among the final outputs from this project will be the construction of 1.5 kilometer-resolution circulation model from Baja California, Mexico to the US-Canadian border that will include climatological estimates and interannual variability in connectivity statistics from larval trajectory output.



Is C/N Decoupling Caused by Harmful Algal Blooms in Santa Monica Bay?

R/CONT-209 Feb. 2010–Jan. 2014
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Even when nitrate levels are very low in the surface mixed layer, Santa Monica Bay can still experience algal blooms. This might seem impossible since algae require nitrate for growth, but blooms do happen, and almost always they are blooms of dinoflagellates, algae that can forage for nutrients. This project explores whether these blooms leave a "footprint" in seawater chemistry—in particular whether dissolved inorganic carbon levels within the mixed layer can be observed to be declining in concert with nitrate concentrations below the mixed layer. This decoupling of carbon and nitrogen would further support the idea that huge numbers of dinoflagellates are migrating below the mixed layer at night to get nitrate and reascending by day to sunlit waters to photosynthesize, which lowers dissolved inorganic carbon levels. In the summer of 2012, scientists

sampled waters in Santa Monica Bay during conditions that seemed ripe for a bloom, as the water column was highly stratified and surface nitrate levels were depleted. However, no bloom formed, and the project has been extended a year so that the researchers may have another summer of fieldwork to gather the necessary data.

Submarine Groundwater Discharge in North Monterey Bay—The Fuel Sustaining the Algal Incubator

R/CONT-218 May 2012–Apr. 2014

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The northeastern portion of Monterey Bay is a hotspot of harmful bloom activity, particularly in late summer and early fall when upwelling is weak and surface waters are highly stratified and hence favorable to dinoflagellates. Though what fuels these blooms during these conditions is not well documented, the region's inner shelf circulation is believed to contribute to bloom formation by creating "retention zones" within which nutrients and algae are accumulated. This retention circulation, however, is not consistent with some field observations and cannot, for example, explain the persistence of dinoflagellate blooms during periods when winds have changed, upwelling has become relatively intense, and shelf currents are no longer in a retention mode. There must be other major processes at play in sustaining the northeaster incubator during these periods. This project explores whether submarine groundwater discharges might offer a partial explanation to the persistence of these "red tides" by providing a continuous source of nutrients, metals, and dissolved organic carbon. The scientists have preliminary data consistent with the idea, and in this project will build on this preliminary work to more rigorously measure groundwater fluxes (using the geochemical tracers radium and radon) at six locations in the bay, two within the incubator zone and four "controls" outside it. A mass balance model for excess radium and radon will be used to quantify fresh groundwater and recirculated seawater inputs and constituent loads associated with this discharge to the bay. In addition, bioassay incubations with groundwater will be performed using in-situ "incubator" water and resident plankton species to identify nutrients, metal or other constituents that may be key to sustaining dinoflagellate growth.

In-situ Detection of Indicator Organisms by Digitization and Concentration in Microfluidic Picoliter Droplets

R/CONT-219 Feb. 2013–Jan. 2014

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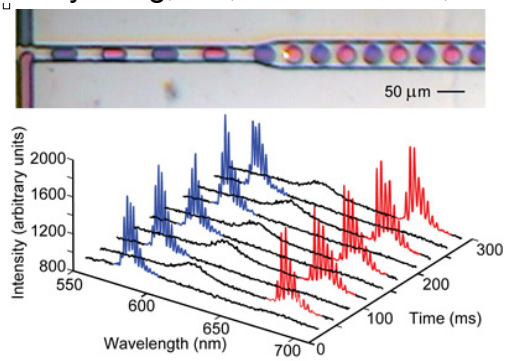

The researcher has designed but not fully tested an intensely high-tech approach for monitoring low concentrations of pathogenic bacteria in water samples. In the method, water samples are mixed with probes that enzymes in bacteria convert to a fluorescent-colored product. Picoliter (trillionth-of-a-liter) droplets are formed from this mixture and the brightly colored drops are then counted to estimate bacterial concentrations. The key step in the approach is the ability to form the droplets, within which a single cell will have a very high effective concentration, on the order of 10^9 cfu/mL. Besides amplifying the pathogenic signal, the approach also reduces the assay time for detecting bacteria, which is critical for protecting public health. The main objective of this proof-of-concept project is to demonstrate the ability to form the droplets and count cells for the fecal indicator bacteria *Escherichia coli and* Enterococcus sp. The method's accuracy will be verified for samples with known cell counts. The scientist will also characterize the rate at which color intensity builds in "incubating" droplets, as a function of droplet size, to identify an optimal drop size and assay time for the bacteria. The enzyme-substrate probe technology to be employed in this project has been approved and is expected to become adopted by the EPA. Outcomes from this project will further efforts to quantitatively measure low concentrations of water-borne pathogens through a technique that "packages" the EPA method in picoliter containers.

Forecasting River Runoff Effects on Domoic Acid Production in Coastal California

R/CONT-221 Feb. 2013–Jan. 2014

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In Monterey Bay, harmful blooms of microalgae of the genus Pseudo-nitzschia are often associated with spring and early summer upwelling of macro-nutrients to the surface from depth. Though less frequent, highly toxic blooms have also been observed following “first flush” storms, which occur in fall at the beginning of the rainy season. The trigger for these harmful events has been linked to discharge from the Pajaro and Salinas rivers, which can, among other things, decrease silicon and increase nitrogen concentrations. In this project, scientists will use field data collected before and after first heavy rain events, as well as other environmental and monitoring data, to parameterize a simple numerical model for the rate of domoic acid production. The model assumes that the rate of domoic acid production is proportional to the biomass of domoic-acid-producing algae, multiplied by their growth rate. The proportionality constant is a “domoic acid production factor” that assumes a primary nutrient limiting process (i.e., silicon limitation or nitrate limitation) and is a function of three “tunable”parameters. The main goal of this project is to back-solve (or optimize) the parameters using existing data, and to then check the “fit” using other existing (or new) data. When this is done, the scientists will have a "zero-dimensional" model for domoic acid production that they can continue to develop and ultimately “couple” to 3D circulation models. Domoic acid is a potent neurotoxin that has caused marine mammal and seabird die-offs in Central California and can accumulate in seafood, causing “amnesic shellfish poisoning.” New research suggests that chronic low-level exposure to the toxin may pose a health threat to vertebrates. Results from this project will further efforts to understand what causes these harmful algal blooms and to forecast their occurrence.

Scale Insects: Emergent Threats to Salt Marsh Restoration
R/ENV-221 Feb. 2013–Jan. 2014
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Who is eating the marsh grass? A group of insect parasites known as scales that inject a long needle-like mouthpart into plants may literally be sucking the life out of wetland restoration efforts in San Diego County, especially because there are types of scales that specifically target salt marsh cordgrasses. This is of concern as cordgrasses are some of the only vegetation that grow in tidal salt marshes, providing habitat for lots of wildlife including the light-footed clapper rail. In this project, scientists will compare scale damage at a constructed salt marsh in San Dieguito Lagoon in Del Mar and at a natural marsh at the Sweetwater Marsh National Wildlife Refuge in Chula Vista to test theories about the comparative vulnerabilities to pests at constructed and natural marshes. At the constructed marsh, they will also study the distances over which scales travel to get ballpark numbers on the ability to spread and infest other areas. Because there is some evidence that some strains of cordgrass are resistant to scales, samples of cordgrasses will be collected from scale-infested and scale-free marshes and grown in a garden experiment to test their susceptibility to infection. As part of the outreach components of the project, scientists will recruit and train volunteers to help carry out the cordgrass experiments. Scientists will also produce an interpretative display for the visitor center at the Tijuana River National Estuarine Research Reserve, and students will “rap about their science” and produce science music videos for YouTube.

Determination of Boreal and Subtropical Zooplankton Energetic Quality in the Northern California Current and Its Implications for Higher Trophic Level Feeding Dynamics
R/ENV-222 Feb. 2013–Jan. 2014
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Within the Northern California Current, a transition occurs in the zooplankton community structure, as subtropical zooplankton species common off California are replaced by boreal ones typical to Oregon and Washington’s much colder waters. In this project, scientists will collect zooplankton samples (copepod and euphausiid species) every month for a year along an established transect off Trinidad Head in Humboldt County (latitude 41°). Some sampling will also be conducted in a transect three degrees north in Newport, Oregon. Both transect lines are surveyed regularly as part of the Pacific Coast Ocean Observing System, which was established, in large part, to collect environmental data for salmon fisheries management. The dominant zooplankton species collected during the cruises will be analyzed for their lipid and protein content to assess food quality for juvenile salmon and other animals. The hypothesis is that boreal

zooplankton will have a higher energy content than that of the subtropical species and that this will translate into higher survival rates for juvenile salmon feeding in boreal-zooplankton-dominated waters. A year-long time series of prey energy content will be constructed for the Trinidad Head survey line, and there will be analyses of seasonal changes in energy content and its potential relationship to wintertime upwelling, which for salmon may be critical for early at-sea survival. Results will be used to help assess the applicability of a "Northern Copepod Index" (used successfully to forecast salmon returns one to two years in the future in Oregon and Washington) to salmon fisheries in Northern California.

Impact of 4-nonylphenol on Immunocompetence and Disease Susceptibility in Pacific Oysters, *Crassostrea gigas*

R/CONT-220 Feb. 2013–Jan. 2014
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Nonlyphenol ethoxylates are industrial compounds (often surfactants) used as detergents, emulsifiers and foaming agents in a long list of household products including toilet paper, plastics, pest sprays and personal care products. In the aquatic environment, they degrade into compounds that include 4-nonylphenol (4-NP), an endocrine disruptor that has been detected at elevated levels in marine organisms in California estuaries. The scientists leading this project suspect that septic tanks and toilet paper are a main source of 4-NP in the coastal environment and in this project will examine the consequences of the compound on the Pacific oyster, focusing on how (or if) the chemical alters the shellfish's immune system. In experiments, oysters will be injected with the bacterium *Vibrio campbellii (*nonpathogenic in oysters) and *V. harveyi* (pathogenic in oysters). Scientists will then monitor the animals' immune response vis-à-vis total hemocyte counts, superoxide anion production levels and hemocyte lysozyme activity. Changes in protein production in gonadal tissues and hemocyctes will be examined, and there will be an effort to detect changes in the transcription profiles (number of copies of mRNA from a specific segment of DNA) for genes involved with antimicrobial defense. Results will be shared with the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment, which has identified a critical need for targeted studies of 4-NP toxicity on marine organisms.

California Sea Grant College Funded Projects 2013

Safe and Sustainable Seafood Supply

Fish and shellfish are an important source of protein, and the state of California is well positioned to help supply the growing demand for seafood through commercial fisheries and aquaculture. California's advantageous location on the Pacific Rim also makes it an excellent candidate for developing marine aquaculture techniques, enhancing marine fish stocks and exchanging scientific information with other nations. Many of the commercially important fisheries within the California Current have been sustainably harvested and thus remain at low levels of exploitation. Others, such as groundfish and salmon, have sustained commercial fishing closures in recent years. With the advice from both fisheries and aquaculture experts, California Sea Grant provides information to ensure the sustainable use of living coastal and marine resources and associated communities, support a sustainable California aquaculture industry to help meet the growing demand for seafood and minimize socio-economic and environmental impacts. The funded projects in this focus area for 2013 are listed below.

Development of Sustainable Tuna Aquaculture in the United States Using Yellowfin Tuna as a Model

R/AQ-133 Feb. 2012–Jan. 2015
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Dan Margulies, Inter-American Tropical Tuna Commission, 858.546.7120, dmargulies@iattc.org

This project seeks to resolve what scientists say is a major bottleneck to developing a viable domestic tuna-ranching industry in Southern California: the high mortality rates of eggs and larvae airfreighted from Inter-American Tropical Tuna Commission's facility at Achotines Laboratory in Panama to Hubbs-SeaWorld Research Institute in San Diego, a regional center of aquaculture research. The goal of this project is to determine causes of larval mortality and, if feasible, to resolve them. Preliminary experiments during the project's first year suggest that something in the bagging and packaging larvae for transit may be in

itself lethal, as high mortality rates were observed in treatments that were airfreighted to San Diego and in controls kept on the ground in Panama. Ongoing trials are examining whether larvae that are not packaged for airfreight but stocked directly into a culturing tank will experience similar mortalities.

Maximizing the Values of Offshore Aquaculture Development in the Context of Multiple Ocean Uses
R/AQ-134 Sep. 2012–Aug. 2014
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Offshore aquaculture is being explored in California, as a new industry for coastal communities and a source of fish for local consumers. The Southern California Bight is particularly well suited for offshore fish growing because of the region's mild weather, weak prevailing winds and proximity to major markets in Los Angeles and San Diego. In the next couple years, the state of California will establish a management framework for permitting and regulating offshore facilities in state waters. One of the anticipated challenges will be in deciding where to locate offshore farms, as there may be conflicts with other sectors of the marine economy, such as fishing, shipping or energy production. To assist in the planning process, this project seeks to model and evaluate economic and environmental tradeoffs of offshore aquaculture and other existing or planned marine uses in the bight. The project is based on a similar one, led by the UC Santa Barbara's Sustainable Fisheries Group, in which the impacts of offshore energy were analyzed. This model, like the one used previously, will be "dynamic" in that it will incorporate ocean currents and "human-response patterns" as factors that can influence interactions, benefits, opportunities and points of conflict among stakeholders. The scientists believe that strategic marine spatial planning can significantly reduce conflict over and impacts from fish farming and thereby increase its value and compatibility with other ocean uses.

Social Constraints and Solutions for Progressive Development of the Nation's Offshore Aquaculture Industry
R/AQ-135 Sep. 2012–Aug. 2014
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Edward W. Glazier, Impact Assessment, 858.459.0142, isia@san.rr.com

This project will identify and analyze existing social constraints to developing a domestic offshore aquaculture industry, and seek to identify solutions to socioeconomic and policy hurdles. Objectives include: (1) identifying the range of social, economic, environmental, cultural and ocean space-use challenges observed by participants in the emerging offshore aquaculture industry; (2) validate this information with people "directly involved in, formally overseeing, indirectly observing, and potentially working and recreating in areas adjacent to

the industry," and (3) identify options for mitigating or precluding the range of constraints and challenges. Well-tested social science research methods will be employed, including archival research, "purposive social network-based sampling," in-depth interviews and follow-up interviews, participatory mapping, and in-depth focus group research. Findings will assist formal policy deliberations on the future of the industry.

Understanding Roles of Competing Bacterial Endosymbionts in Abalone Health, Management and Restoration

R/FISH-208 Feb. 2010–Jan. 2014

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Several years ago, a new rickettsia-like organism (RLO) was observed in farmed abalone. Since then, transmission electron microscopy has shown that the "new" parasite is likely the original withering syndrome rickettsia-like organism infected with a phage hyperparasite. In work to date, scientists have identified a set of potential phage genes and are in the process of testing PCR primers that will allow them to characterize the organism and document its geographic distribution in both wild and farmed animals, and in seawater. Testing in abalone, to date, suggests that the phage is present in some mainland but not island locales. Withering syndrome is a lethal, contagious water-borne abalone disease, triggered by El Niño, or El Niño-like coastal warming. Withering syndrome outbreaks have become less frequent and severe in recent years, and it is not known whether this is due to cooler water temperatures or to the presence of the phage parasite, which could confer disease protection. As part of this project, scientists will test the RLO's protective value, and its link to water temperatures. Researchers continue to monitor black abalone populations and report a dramatic increase in the number of animals counted at nine survey sites along

the periphery of San Nicolas Island—from 195 in 2001 (a record low) to 1,430 in 2012. 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.

Noroviruses in Coastal Waters: Implications for Seafood Cultivation and Human Health
R/CONT-216 Feb. 2012–Jan. 2014
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This project explores an emerging group of sewage-related viruses—noroviruses—that cause "stomach flu" in millions of Americans each year. The focus is on determining whether these viruses are present in coastal waters and sediments, persistent in the environment and accumulating in shellfish. Many pathogens are not routinely monitored, including noroviruses, as well as Cryptosporidium, Giardia and Salmonella. Yet another goal of this project is to look for associations between fecal coliform counts (which are routinely monitored) and other pathogens. A close link might suggest that standard water quality testing is a reasonable proxy for viral or zoonotic pathogen testing, at least under some circumstances. Computer models will be "run" to provide insights on the human health risks of consuming local shellfish, using field data collected during this project. The Centers for Disease Control estimates that norovirus infections kill about 800 people in the United States annually and are the nation's leading cause of food-borne gastrointestinal disease. The anticipated outcomes of the project are an improved assessment of the presence, or absence, of noroviruses along the Central California coast, and a first estimate of the level of risk these pathogens pose to those who consume raw shellfish grown or harvested locally.

Fishing Sustainability Labeling at the Point of Purchase, Consumption for Seafood, and Policy Simulations
R/RCC-02 Feb. 2013–Jan. 2014
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Do consumers really care about the health of the ocean and are they willing to pay more for seafood that carries the Monterey Bay Aquarium's "green" best choices label? Will they avoid "red" choices when presented with that information, and most importantly, could consumer demand for certain seafood products incentivize more sustainable fishing practices globally? To address these questions, resource economists will be analyzing retail seafood sales data for a

chain of grocery stores in the San Francisco Bay Area that transitioned to a FishWise sustainable seafood labeling program, based largely on the Monterey Bay Aquarium's Seafood Watch, over a period of several months. During this time, some of the stores sold products with the color-coded red, yellow and green labeling. Some did not. The same items were sold at the same prices across all ten of the chain's stores. That is, consumers were not asked to pay a premium for items with the "green" label. This project will look at purchasing patterns at these stores before, during and after the transition to the labeling program. The hypothesis is that consumers will buy more of the green-labeled products and less of the red-labeled products when given ratings information. If this is true, green product sales volume should be higher and red product sales volume lower, relative to nonlabeled products at the other stores. If such a pattern is observed, and statistically significant, scientists will begin asking questions such as, what are the concomitant changes in product prices that could account for the patterns of sales data observed? If red products were removed from stores, what products would consumers choose instead? If regulations forced red products to meet yellow standards, would consumers buy the yellow products? The scientist leading this project hopes to take what is learned and apply it, perhaps in modified form, to markets beyond the Bay Area.

California Sea Grant College Funded Projects 2013

Effective Response to Climate Change

The wide-reaching effects of climate change (including ocean acidification) on people, property and living organisms in the coastal and marine environment are being increasingly recognized at national, regional and local scales. California Sea Grant is supporting research to understand the impacts of climate change and ocean acidification on coastal and marine species and environments, and working with communities and partners to plan for and adapt to the effects of climate change and ocean acidification. The funded research projects for 2013 are listed below.

Consequences of Nearshore Low Oxygen and Low pH for Coastal Resources of Southern California

R/CC-04 Feb. 2012–Jan. 2014
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In this project, researchers are investigating the combined effects of low-oxygen, low-pH conditions on marine organisms living at depths between 20 meters and 300 meters off San Diego. Specific goals include mapping dissolved oxygen concentrations and water acidity to characterize the frequency, duration, extent and intensity of these conditions on seasonal and, if possible, weekly time scales. Maps of oxygen concentrations will be superimposed on squid egg-bed habitat maps to identify areas where the species may be susceptible to low-oxygen stress, particularly during its early life history stages. Through laboratory experiments and field collecting, researchers will estimate critical lethal and sublethal oxygen and pH thresholds for the market squid. These thresholds will be used, in conjunction with monitoring data, to identify areas where squid embryos may experience higher than normal mortalities. This work will address the hypothesis that market squid migrate or shift spawning grounds in response to dissolved oxygen concentrations. Results will provide valuable insights into the potential consequences of the shoaling of the oxygen minimum zone in the Southern California Bight on key marine resources with the California Current large marine ecosystem.

Response of Calcified and Fleshy Macroalgae to Warming and Ocean Acidification: From Single Species to Community Interactions

R/CC-05 Feb. 2012–Jan. 2014
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Land plants are generally expected to grow larger as CO_2 levels rise, but the responses of marine algae, kelp and seaweeds are more difficult to predict, since the ocean will become more acidic as it absorbs more of the gas from the atmosphere. The project tests the responses of coralline (calcified) algae and fleshy seaweeds (red and brown) to an ocean that is both warming and more corrosive. The research teams have recently deployed collecting trays off Carmel and La Jolla to gather natural assemblages of bottom species. These trays will later be placed in tanks pumped with extra carbon

dioxide (CO_2), which makes the water more acidic. The researchers will also look at whether climate change may interfere with how algae and red abalone communicate via chemical cues (not really understood yet). What scientists do know is that abalone larvae preferentially descend and settle down on coralline algae—their preferred habitat in the transition from free-swimming larvae to miniature versions of their adult selves. The scientists hypothesize that weaker, more fragile coralline algae may not emit the same chemical cues to young abalone. Results further both state and federal goals of managing marine ecosystems in the face of climate change.

Effects of Ocean Acidification on Olfactory Senses, Swimming Physiology, and Gene Expression in Juvenile Rockfish
R/CC-07 Feb. 2013–Jan. 2014
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This project will examine effects of ocean acidification (as simulated by elevating pCO_2 levels) on developmental physiology, behavior and olfactory gene expression patterns of early post-settlement rockfishes found in Central California's kelp forests and rocky reefs. Manipulation experiments will be conducted at the Monterey Bay Aquarium Research Institute on rockfish species that recruit during spring upwelling (e.g., blue and black rockfishes) and on those species that recruit in summer and fall (e.g., gopher and kelp rockfishes) when upwelling is weak. The hypothesis is that juveniles (2–4 centimeters in length) exposed to elevated pCO_2 conditions, consistent with climate-change scenarios for 2050 and 2100, will have an impaired ability to distinguish the odors of predators, such as boccaccio and lingcod, from nonpredators, such as surfperches and senorita, and that this may be detected in standard two-channel flume "choice experiments," in which subjects can choose to swim in water from one of two different sources, scented by predators or nonpredators. A secondary hypothesis is that fish recruitment in spring may be more adapted to variable pH-conditions associated with upwelling of deeper, more acidic waters. Researchers will examine consequences of elevated pCO_2 conditions on juvenile fishes' swimming speeds and aerobic conditioning (e.g., respiration rates). In the genetics component of the project, they will begin to develop assays to characterize changes in olfactory-related gene expression patterns in fishes exposed to ambient and elevated pCO_2 levels. Results will be shared with federal and state fisheries agencies involved with managing groundfishes.

California Sea Grant College Funded Project 2013

Resilient Coastal Communities

Coastal communities today face a multitude of opportunities and risks, and California is no exception. From its rural towns, to working harbor communities, to mega-cities, predicting sea-level rise, managing population growth, resolving competing uses for natural resources, maintaining infrastructure, managing shortages of fresh water, and developing local responses to regional issues are among the state's needs. California Sea Grant focuses effort and work with strategic partners toward the sustainable use and effective management of coastal and marine resources; works with communities to improve coastal environmental quality; and assists communities in reducing vulnerability to coastal hazards. The funded project in this focus area for 2013 is listed below.

Beach Evolution on Scales from Storms to Years

R/RCC-01 Feb. 2012–Jan. 2014

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In 2012, eight beaches in San Diego County were nourished with sand dredged from offshore, as part of a regional beach sand project. Researchers are now monitoring several of these same beaches to study the mechanisms by which waves, tides and storms scour and sculpt sand. At one of the beaches—Cardiff State Beach in northern San Diego County— laser imaging technology is being used for the first time in the region to measure changes in beach sand levels at very high resolution. The instrument, known as LiDAR, has been mounted on a 30-foot scaffold at the back of the beach and from this perspective is able to map beach-sand levels along a 600-meter sector every 30 minutes.

The data gathered during winter storms of 2012-2013 will allow researchers to refine an existing beach equilibrium model that has successfully predicted shoreline position at the adjacent southern beach—Seaside Reef—during "average" storm years, but not during El Niño events when sea levels may rise 20-plus centimeters and storms are more intense. Scientists believe that the problem in the model is due to the omission of the cobble layer beneath the sand at these beaches. These potato-sized cobbles resist erosion, and a model that assumes a purely sandy beach will over-estimate beach sand loss. The near-term goal of this project is to incorporate an erosion-resistant layer into the existing model and to truth check its output with the data now being collected. This project is a collaboration with the US Army Corps of Engineers. Findings will be shared with stakeholder groups, including the San Diego Association of Governments, which oversees regional sand projects and is interested in cost-effective beach nourishment strategies.

California Sea Grant College Funded Projects 2013

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 listed below have 2013 funding.

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–Mar. 2014
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This project explores ocean acidification, as observed through field measurements at an upwelling center off California and through laboratory experiments designed to simulate low-oxygen, corrosive conditions that may be experienced during periods of upwelling. In work to date, scientists have deployed a moored infrared detector 10 kilometers off Trinidad Head in Humboldt County that continuously measures surface-ocean and atmospheric carbon-dioxide concentrations (from which the partial pressure of carbon dioxide is calculated). Sensors at the mooring are also recording water temperatures, salinity and oxygen concentrations, and water samples are being collected from R/V *Coral Sea* about 15 times a year at the mooring, and along a transect west of it to ground-truth the sensor data and document a broader view of when, where and how long corrosive, low-oxygen waters persist in the region. With partial support from the National Science Foundation, scientists have designed and are now operating a temperature controlled, flow-through gas equilibrium tank system for conducting manipulation experiments on shell-building organisms (abalone, oysters and sea urchins) that may be most vulnerable to changes in seawater carbonate chemistry. In the project's final year, scientists will study the effects of low-oxygen, low-pH conditions on the gene expression patterns of red sea urchin to more fully understand the consequence of upwelled water on urchins. Results will be shared with resource managers, abalone farmers, sea urchin fishermen and other interested parties.

The Future of the California Chinook Salmon Fishery: Roles of Climate Variation, Habitat Restoration, Hatchery Practices and Biocomplexity
R/OPCFISH-10 Feb. 2010–Feb. 2014
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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–Mar. 2014
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This project seeks to advance the ability to credibly forecast harmful algal blooms off California, with a focus on the algae *Pseudo-nitzschia* and its toxin domoic acid, the causative agent of amnesic shellfish poisoning (ASP). Two existing harmful algal bloom models—one for Santa Barbara Channel and the other for Monterey Bay —are being validated, expanded to other regions and further tested using new monitoring and remote sensing data. The refined models are being tested with numerical model fields (ROMS and NCOM) as inputs to enable the models' expansion to the entire California coast. A similar but much simplified modeling effort is underway for *Alexandrium catenella*, which produces the toxin that causes paralytic shellfish poisoning. In the coming year, researchers will be focused on understanding "drivers" of blooms and toxin production (e.g., surface seawater temperatures, surface salinities, micronutrient concentrations, and their ratios, ocean color, freshwater inputs and upwelling indices). Broadly speaking,

they would like to know what variables are critical in each of the two models, and under what conditions and why. Such information will also be used to determine the number of regional models that need to be "stitched" together to accurately predict blooms for all of California. Data for hindcast studies and model validation come from multiple sources including the California Department of Public Health and the California Program for Regional Enhanced Monitoring of PhycoToxins. In addition to the modeling work, OPC funding provides support for continued collection of field data and for the development of several outreach tools, including various web portals to aggregate all of California's harmful algal bloom projects, present bloom forecasts to managers and health officials, and to help implement a coordinated response network.

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
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Rick Starr, CASGEP, 831.771.4442, RickStarr@ucsd.edu

This project explores the ability to use MPA monitoring data, collected by volunteer anglers, for improving fisheries management, particularly for fisheries that are "data poor" (i.e,. have limited data). OPC funding provides support to continue angler research surveys for an additional two years, after which time there will be a seven-year record of catch data (e.g., fish abundances and sizes, among other things) within four Central Coast MPAs and associated reference sites. With these data, researchers will assess effects of the MPAs on key nearshore species, in terms of fish sizes, abundance, species composition and, in some cases, fish growth and movements. In addition to these MPA monitoring objectives, researchers will use the fishery-independent dataset to populate ("run") five new fishery models for setting catch limits. Output from these models will be analyzed and compared to catch limits calculated through traditional stock assessment models. "A management strategy evaluation" will examine the

models' performances through time and under various control rules, including bio-economic modeling to forecast long-term costs and benefits of different management actions. There will also be an effort to begin to resolve the "mismatch" in spatial scales at which stocks are assessed and fishing pressure applied. When such a disconnect occurs, it can lead to local depletions or under-utilizations of stocks. The highly localized angler survey data may shed light on how to manage stocks at the community level and/or most relevant spatial scales. Results and recommendations will be shared with state resource managers and the public.

California Sea Grant College Funded Projects 2013

New Technologies and Products

Exploiting Marine Actinomycete Diversity for Natural Product Discovery

R/NMP-100 Feb. 2010–Sep. 2013

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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 most recently during two research cruises. Scientists have also described the biosynthesis of hybrid isoprenoids (including the promising anti-inflammatory compound cyclomarin) 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.

California Sea Grant Funded Projects 2013

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 Wildlife, 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–Dec. 2013

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Gerry McChesney, USFWS, 510.792.0222, ext. 222, gerry_mcchesney@fws.gov

In the first two years of this project, researchers refined protocols for monitoring six species of seabirds that are expected to benefit from the creation of North Central Coast MPAs—the Pigeon Guillemot, Pelagic Cormorant, Brandt's Cormorant, Common Murre, Western Gull, and Black Oystercatcher. 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 decreasing human-caused disturbance to breeding sites.

Baseline Characterization of Newly Established Marine Protected Areas within North Central Coast Study Region—LiMPETS Intertidal Citizen Science

R/MPA-7 Mar. 2010–Dec. 2013

Amy Dean, Farallones Marine Sanctuary Association, 415.561.6625, ext. 303, adean@farallones.org

Through the LiMPETS (short for Long-term Monitoring Program and Experiential Training for Students)program, students, educators and volunteers are taught how to monitor Pacific mole crabs at sandy beaches within the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries, and they learn to identify 33 species associated with rocky intertidal habitats. Survey data are entered online and archived for long-term studies. This project expands the existing LiMPETS program beyond the sanctuaries' boundaries to contribute to baseline monitoring of the North Central Coast MPAs. Researchers will also analyze historical data from the LiMPETS program to help identify long-term ecological trends. This work will further efforts to document MPA effects from natural variability. LiMPETS 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–Dec. 2013

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Dirk Rosen, Marine Applied Research & Exploration, 510.232.1541, dirk@maregroup.org

Researchers have completed ROV surveys of deep-water habitats along the North Central Coast, collecting more than 20,000 still photographs and nearly 300 hours of video at ten MPAs and adjacent reference sites. Sampling was conducted off Point Arena, Bodega Head, Point Reyes, Southeast Farallon Islands and Pillar Point. From these images, researchers are identifying (and

counting) fishes and large invertebrates and associating these organisms with seafloor features (such as bottom slope, relief and substrate type). By early 2013, they plan to be done with the biotic analyses and habitat maps, which were the key deliverables of the project as originally conceived. They will spend the remainder of 2013 pursuing a suite of synthetic products with analyses across the region and with other baseline monitoring projects. These may include maps of fish densities along the North Central Coast and predictions of where certain fish species (e.g., canary and vermillion rockfishes) might be expected to live based on seafloor features. In addition, scientists will evaluate and offer recommendations on the draft plan for long-term MPA 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–Dec. 2013
Kirsten Lindquist, Farallones Marine Sanctuary Association, 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 highly trained volunteers who regularly survey an assigned beach within the Gulf of the Farallones and Monterey Bay National Marine sanctuaries. Volunteers gather data on live and dead birds and marine mammals, collect oil samples, and document human use patterns and violations. The goal of this project is to compile Beach Watch data to produce a picture of bird and marine mammal life, both within and outside MPAs, before and around the time of their implementation. Researchers are also analyzing the "historical" data reaching back to 1993 to identify 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–Dec. 2013
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This project is characterizing rocky intertidal habitats along the North Central Coast, following biodiversity and target-species survey methods developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and Multi-Agency Rocky Intertidal Network (MARINe), for long-term monitoring of the West Coast's intertidal habitats. Surveys were conducted inside and outside the new MPAs, and many of these survey sites have been part of the ongoing PISCO and MARINe monitoring program, which predate the MPAs. The now completed survey work has led to the discovery of several previously unknown pockets of black abalone, an endangered, intertidal species. 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 (see project description for R/MPA-17 below) to help it ground-truth its multi-spectral, aerial images of substrate and nearshore communities with field observations. Details on the protocols for the biodiversity and target-species surveys are available at the SWAT Coastal Biodiversity Survey webpage and MARINe webpage, respectively. The focus of research in 2013 will be to complete analyses of the survey data.

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–Dec. 2013
Mark Carr, UCSC, 831.459.3958, carr@biology.ucsc.edu

In this project, diver surveys were conducted in kelp forests of six North Central Coast MPAs and associated reference sites to construct a baseline snapshot of the region's kelp forest ecology. The six MPAs where these surveys were completed are Salt Point State Marine Park, Stewart's Point State Marine Reserve (SMR), Del Mar Landing SMR, Saunders Reef State Marine Conservation Area (SMCA), Point Arena SMR and Sea Lion Cove SMCA. At each of the 35 sites surveyed during the summer of 2011 and the year prior, diver protocols replicated those for the Central Coast baseline monitoring program, based on widely recognized standards developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). Among the metrics being calculated from the transect data are estimates of fish, kelp and benthic invertebrate densities, fish-size distributions and percent seafloor cover of small invertebrates and algae. Substrate type (e.g., sand, cobble, bedrock and boulder) and vertical relief is also being documented to assemble a picture of species-habitat relationships. All the data collected during the diver surveys have been

transcribed from the field datasheets into a database with requisite metadata. A highlight of the project was the opportunity to survey areas during an intense algal bloom that wiped out red abalone populations along Sonoma County. Divers adapted their surveys to characterize the geographic distribution of the die-off and counted abalone shells, from which mortality rates were estimated. These results were shared with the Fish and Game Commission, which voted to close the sport fishery in Sonoma County for the remainder of the 2011 season, and has since established a Fort Ross Red Abalone Closure Area in the county. 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–Dec. 2013
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Jan Freiwald, Reef Check Foundation, 831.345.8167, jfreiwald@reefcheck.org

Reef Check California's network of volunteer divers has been monitoring reefs along the North Central Coast for seven years, spanning a period both before and after the North Central Coast MPAs went into effect. This project expands on this existing program by enlisting its trained volunteer divers to survey rocky reef and kelp forest ecosystems inside and outside the new MPAs for the purposes of baseline monitoring. In 2012, Reef Check volunteers completed eight surveys at six of the program's long-term monitoring sites, and it forged new partnerships with UC Santa Cruz and California State University, Monterey Bay's scientific diving programs to train yet more diver volunteers. This will further build the expertise and public interest for continued monitoring in the region, including areas that are somewhat remote and challenging to survey. This coming year the focus will be to analyze and synthesize the diver data from the region, in collaboration with its many baseline monitoring partners. Reef Check is dedicated to building the human capital and scientifically rigorous protocols for long-term, citizen-science monitoring of habitats and marine reserves in California and globally.

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–Dec. 2013

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This project is establishing a benchmark of sandy-beach ecology along the North Central Coast around the time that the new MPAs went into effect through surveys of sand crabs, shorebirds, human activities, wrack and wrack-associated macro-invertebrates at five sites within the new MPAs, five reference sites and seven "extra" beaches also outside of the MPAs. The macro-invertebrate monitoring includes diversity surveys of sand-associated macro-invertebrates eaten by shorebirds and surfzone fishes. Researchers have collaborated with student citizen-scientists and NOAA National Marine Sanctuaries staff from the LiMPETS program (see R/MPA-7) to refine a regional sand crab monitoring program to continue beyond the life of this project and have developed citizen-science protocols for monitoring surf-zone fishes through a volunteer angler program. This year investigators will analyze survey data, with the full MPA baseline monitoring program team, to develop "a synthetic understanding of the baseline status of marine ecosystems inside and outside of MPAs in the North-Central Coast region."

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–Dec. 2013

William Sydeman, Farallon Institute for Advanced Ecosystem Research, 707.478.1381, wsydeman@comcast.net

During the first two years of the project, the scientist developed multivariate indicators of ocean-climate processes affecting fish, invertebrates and other

wildlife in the North Central Coast study region from 1990 to 2010. These indicators were derived from a compilation and analysis of 16 atmospheric and oceanographic "drivers" of ecosystem function, including those originating in the tropics (e.g., El Niño and La Niño cycles) and extra-tropics (e.g., Pacific Decadal Oscillation), as well as regional-local variables such as wind stress, sea surface temperature, salinity and surface flow (as inferred from high-frequency radar). Results support the hypothesis that enhanced sub-Arctic influences and intensified upwelling are contributing to greater lower, but not upper, trophic level productivity. In 2013, the scientist will work with other researchers monitoring biotic changes in the study region to help distinguish basin-scale and regional climatic trends from changes attributable to the MPAs (i.e., to changes in human activities).

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–Dec. 2013
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The final deliverable of this project will be a baseline snapshot of key consumptive and nonconsumptive activities along the North Central Coast. The focus is to characterize the MPA's effects on three sectors of the coastal economy: (1) coastal recreation (i.e., snorkeling, surfing, spear fishing); (2) commercial fishing, and (3) commercial charter boating (i.e., sportfishing and whale watching). In the first two years of the project, scientists conducted interviews with recreational abalone divers, commercial fishermen and charter boat captains, and completed 2,500 surveys of coastal recreation. In the coming year, scientists will analyze the data and review and interpret them with stakeholders. This input will be integrated into the final report on the MPA's economic impacts.

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–Dec. 2013
Jan Svejkovsky, Ocean Imaging, 858.792.8529, jan@oceani.com

In this project, scientists collected nearshore multi-spectral images for the North Central Coast and have now processed almost all of this data into a set of GIS-compatible habitat maps, as well as fully calibrated and assembled raw-data image files. These maps depict bottom substrates and vegetation in subtidal, intertidal and estuarine ecosystems, including kelp canopy coverage, at 1-meter, or better, spatial resolution. Besides mapping habitats, scientists have completed

time-series analyses to estimate persistent (average) and variable components of kelp, eelgrass, surf grass and pickleweed distributions. Substrate and habitat classifications were validated in the field (see R/MPA-11) and the high degree of accuracy between the methods has further confirmed the value of remote sensing-based estimates of habitats. Final products produced during this project are currently being uploaded onto the MPA Monitoring Enterprise's servers, where they will become part of the public domain.

California Sea Grant College Funded Projects 2013

South Coast MPA Baseline Data Collection Project

The South Coast MPA Baseline Program is a collaboration among the State Coastal Conservancy, California Sea Grant, Ocean Protection Council, California Department of Fish and Wildlife, 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. The funded projects for 2013 are listed below.

Citizen-Scientist Monitoring of Rocky Reefs and Kelp Forests: Creating a Baseline for the South Coast MPAs

R/MPA-21 Sep. 2011–Jun. 2014

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Volunteer divers who have been trained and certified through the nonprofit Reef Check California program are surveying rocky reefs and kelp forests along the South Coast. Surveys consist of eighteen 30-meter transects along which divers count and estimate lengths of key fishes (35 species), invertebrates (32 species) and algae (9 species). Reef Check's volunteers began monitoring the region in 2006 and have during this project already completed more than 50 surveys inside and outside the new MPAs. While the new data will be used to help create a snapshot of conditions inside and outside the reserves around the time of their implementation, the old data is being analyzed to, among other things, explore potential indicator species of ecosystem status. Among the many benefits of the volunteer diver program is the establishment of "human capital" for cost-effective, long-term MPA monitoring. The program is also vital in helping educate the public in the need for science-based coastal management and conservation.

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

R/MPA-22 Sep. 2011–Jun. 2014

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Researchers are characterizing rocky-intertidal habitats inside and outside the South Coast MPAs. There are two main components of this characterization. One is to survey invertebrate and algal biodiversity, replicating protocols developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) for its West Coast program. The other is to conduct target-species sampling to, among other things, search for species that might be appropriate for longer-term monitoring objectives. That is, serve as indicator species of ecosystem status. In the project's first year, scientists completed baseline biodiversity surveys and targeted species sampling at 22 sites. Target-species sampling will continue at these sites during year 2. Details on the protocols for the biodiversity and target-species surveys are available at the SWAT Coastal Biodiversity Survey webpage and MARINe webpage, 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

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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
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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 are also being documented, and scientists are partnering with citizen-science nonprofits to develop and test protocols for training volunteers in the collection of long-term beach monitoring information. In addition to the survey work, researchers will be studying the ecological importance of beaches to 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
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In this project, researchers are estimating spiny lobster densities within six South Coast MPAs and adjacent reference sites and will relate these estimates to bottom features, such as rocky crevices and understory algae. Commercial lobster fishermen are helping to tag and recapture lobsters to study “spillover” from closed to open areas, lobster movements and home ranges. Spatially explicit landings data (catch records by location) are also being compiled to calculate catch-per-unit effort inside and outside the MPAs before and after they

went into effect. The six MPAs and adjacent reference sites are: (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 support a popular recreational and valuable commercial fishery, are a key part of the southern California kelp forest ecosystem, and are a priority species for state managers. Results from this project will help assess the fishery's stability to current harvesting practices and may be included in the spiny lobster fishery management plan now under development.

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
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Researchers are using a remotely operated vehicle to capture video and still images of life in deep-water habitats (including canyons). From the images, the numbers and kinds of fishes and larger invertebrates and their association with bottom features will be documented. In the project's first year the following sites were surveyed: (1) Point Vicente SMCA and Abalone Cove State Marine Reserve (SMR) off Palos Verdes; (2) the two Farnsworth Bank SMCAs off Catalina Island; and (3) San Diego-Scripps Coastal SMCA and Matlahuayl SMR. With additional support from private donors, the ROV was also "flown" (about a half-meter above the seabed) through four other marine protected areas near Laguna Beach and Newport Beach in Orange County. In 2012–2013, the original three sites will be resurveyed along with three new sites off San Clemente Island, with support from the US Navy. 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
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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 through a series of standardized diver surveys of kelp forests and reference sites. The data is being used to estimate fish, kelp and benthic invertebrate densities, fish-size distributions and percent cover of smaller invertebrates and algae. Divers are also documenting substrate type (e.g., sand, cobble, bedrock and boulder) and vertical relief to establish species-habitat

relationships. From these, a variety of population level (e.g., density, percent cover and biomass) and community-level (e.g., species composition and trophic-guild biomass) metrics will be calculated and 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

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In this project, ornithologists are evaluating whether the new MPAs are adequately protecting seabirds, specifically pelagic cormorants, Brandt's cormorants, Western gulls, black oyster-catchers, pigeon guillemots, California least terns and California brown pelicans, and if not, why. To do this, they are compiling and analyzing existing records of seabird populations prior to the establishment of the South Coast MPAs and also conducting new bird surveys at key sites. Last year, scientists monitored seabird breeding colonies, rooting sites and foraging rates on Santa Cruz Island, in La Jolla (where there is also a Brandt's cormorant colony), at Cabrillo National Monument on Point Loma in San Diego and along the Palos Verdes peninsula in Los Angeles. The MPAs and special closures were established, in part, to protect roosting and breeding seabirds from passing ships, fishing lines and other human activities. As part of this project, scientists will be looking for evidence that the new regulations are reducing seabird behaviors, such as nest abandonment, that indicate disturbance. During the 2012 field surveys, researchers observed low numbers of chicks at all of the least tern colonies monitored. Fecal samples were collected to study whether their poor reproductive status might be due to diet. Findings from this project will be used to enhance and encourage science-based approaches to seabird conservation.

Establishing Consumptive and Nonconsumptive Human Use Baseline Indicators for MPAs in the South Coast of California

R/MPA-29 May 2012–Jun. 2014

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This social science project is depicting beach and coastal activities along the South Coast region—to document what people are doing at the coast, where and how often, and how much they are spending. In other parts of the world, particularly the tropics, marine protected areas have created jobs and business

opportunities through ecotourism—think dive trips to coral reefs or kayaking through mangroves. Are these types of benefits happening here, too? Will fishing thrive? This project is answering these questions for three sectors of the ocean economy: (1) private recreation, which can include a range of activities such clamming, beach walking, diving, photography, surfing and birding; (2) commercial fishing, and (3) commercial passenger charter vessels (aka "party boats") that may take people fishing or whale watching, among other things. The core outcome of the project will be a series of standardized, fully documented, and quantitative socioeconomic data sets and maps that will be used to assess initial effects of the MPAs in terms of how people are using beaches and coastal waters. 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 cause-and-effect relationships 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
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San Diego-based Ocean Imaging Corp. is mapping intertidal and subtidal bottom habitats in Southern California with a new aerial imaging system that allows scientists to classify surf-grass meadows, kelp canopy, algae-covered rock and bare-rock habitats at 30-centimeter resolutions. The interpreted aerial imagery will be validated with field data. Raw image data files (calibrated and mosaicked) and GIS-compatible substrate classification files, among other metadata packages, will eventually be available through the MPA Monitoring Enterprise's data server and on DVD.

California Sea Grant College Funded Projects 2013

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 address social science issues. The 2013 funded projects are listed below.

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
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This project examines whether the new West Coast groundfish "catch shares" program might be incentivizing solutions to the weak-stock, bycatch problem of mixed-stocked fisheries vis-à-vis the creation of risk pools. Risk pools are a form of risk management, in which fishery participants pool their weak-stock quotas to protect against potentially ruinous bad hauls. As with other forms of insurance, coverage against losses may be contingent upon certain criteria, such as fishing with only highly selective gear or avoiding bycatch hotspots. A main purpose of this project is to explore whether these contingencies are advancing conservation goals voluntarily while allowing fishermen to catch full quotas of healthy groundfish species. As part of this, scientists will study the pros and cons of short-term social and economic consequences of the new management system, and model longer-term consequences on total landings, bycatch, fleet consolidation, ex-vessel prices and voluntary spatial closures. They hope to eventually develop computer models to predict conditions under which fishermen are most likely to cooperate to avoid bycatch in mixed-stock fisheries such as the West Coast groundfish fishery.

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

R/SOC-02 Feb. 2012–Jan. 2014

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The "locavore" movement is helping America's farmers. Could it also help our fishermen? Social scientists, in collaboration with marine scientists, commercial fishermen and the West Coast Sea Grant programs, are exploring whether and how direct marketing might benefit West Coast fishermen and fishing communities. In the project's first phase, researchers have been studying 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, as well as the social and economic implications of direct marketing arrangements to fishery participants and consumers. What is 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 local catches and consumer preferences. The toolkit will be tested in West Coast fishing communities struggling to organize or develop broadly successful direct marketing 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

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The vast majority of seafood consumed by Americans is imported, and over time more of it is coming from fish or shellfish farms. Yet, West Coast fishermen, by and large, still export most of what they catch. For the Pacific sardine, about 75 percent of the state's landings are exported overseas, as far as Australia, for bait, fish feed and pet food. The sardine fishery is what is known as a high-volume, low-value fishery. But what if some, or more, of California's sardines were sold whole to local restaurants or seafood markets? Besides the conservation benefits, a higher-value product might help fishermen offset rising fuel costs or lost fishing opportunities due to marine protected areas. This project explores strategies for

adding value to fish and shellfish landed in California, either through the development of new markets or through the development of new product lines, using four fisheries at different stages in developing high-value products and markets as case studies: trap spot prawn, live nearshore fin-fish, Dungeness crab and Pacific sardine. Researchers are working closely with industry to identify marketing approaches and product forms that have been successful (or unsuccessful) at adding value to West Coast fisheries. Findings from the project will be presented at workshops and townhall meetings and developed into a set of recommendations to be shared with coastal communities and managers.

California Sea Grant College Funded Projects 2013

Collaborative Fisheries Research

The following projects are being funded by Collaborative Fisheries Research West, a nonprofit organization dedicated to developing research partnerships between fishermen, managers and scientists, and the California Ocean Protection Council.

An Assessment of the Responses of Rockfish Populations to Rockfish Conservation Area Closures in the Cordell Bank and Gulf of the Farallones National Marine Sanctuaries

R/OPCCFRW-1 Jul. 2012–Jun. 2014

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In 2002, fishery managers closed large swaths of the seafloor off California (and elsewhere on the US West Coast) to fishing for bottom fishes—to rebuild several overfished stocks, including bocaccio, canary rockfish, cowcod and dark-blotched rockfish. This project will assess how fish populations within the Rockfish Conservation Areas (RCAs) off Central California have responded since the closures went into effect. Teams of volunteer anglers are key to the project, as during the next two years, they will go out on chartered sportfishing vessels to conduct repeat hook-and-line surveys of four sites—two within the RCAs and two outside them. On these carefully designed "fishing trips," fish are being caught, measured, tagged and released (for a recapture study later). To the extent possible, the sampling methods and subsequent data analysis will replicate a similar angler survey program led by the California Department of Fish and Game from 1987 to 1998. The primary goals of the project are to compare catch rates, species composition and fish sizes inside and outside the RCAs before and after the closures, as well as patterns that may be more likely attributable to shifts in ocean climate. These climatic factors could favor one

species over another irrespective of fishing pressure. In addition to the angler surveys, scientists will collect female rockfishes (from six species) during the winter spawning season to document relationships between female rockfish fecundity and body size, age, liver weight and lipid stores. This component of the project is a collaboration with NOAA's Cooperative Research Program. (Read more about this project.)

Integrating Collaborative Data Collection with Management: A Lobster Fishery Test Case R/OPCCFRW-2 Jul. 2012–Jun. 2014
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Could commercial lobster-trap fishermen help gather data for fisheries managers and help interpret that data? This project asks these questions with an emphasis on the fishery's long-term management. The project's lead scientists have previously developed a pilot at-sea sampling program for the Southern California commercial rock crab fishery, also a trap fishery. The new study will serve as a framework for establishing a Southern California Bight-wide network of commercial fishermen to help collect scientifically rigorous data for the lobster fishery, which has many more participants and is a much higher value fishery than the rock crab, in terms of the ex-vessel dollar value of catches. Among the project's goals are to identify sampling schemes (i.e., the number of traps and their placement) that will result in statistically defensible estimates of total catches while also providing useful data on lobster sizes and sex ratios and how these vary geographically. As part of the project, fishermen will be trained in scientific protocols, and there will be ongoing discussions to help fishermen identify ways to collect scientific data with minimal interruption to fishing operations. Fishermen and scientists will also discuss ideas for storing and sharing the data collected and how to continue the program into the future. Ultimately, the group will hold a workshop to share results and evaluate the program's viability.

Mortality and Population Abundance of Three Species of Paralabrax off San Diego, California
R/OPCCFRW-3 Jul. 2012–Jun. 2014
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Anglers are helping researchers study marine bass in Southern California by catching, tagging and releasing fish on chartered sportfishing trips to select sites inside and outside the new South Coast marine protected areas (MPAs), as well as during catch-and-release sportfishing tournaments. Besides tagging fish, anglers also record fish size, the gear used to catch the fish and whether the fish was suffering from pressure-induced injuries (barotrauma), among other things. Some of the bass are being put into pens to document mortality rates from catch-

and-release practices. Meanwhile, private boat owners will help researchers catch, tag and release the one species that resides in bays—spotted bay bass. The other two species of interest, the calico bass and barred sand bass, are coastal. In addition to the angler data, about 50 barred sand bass will be caught at a spawning aggregation in the new South La Jolla Marine Reserve, surgically implanted with acoustic tags, and tracked via a deployed listening array for up to a year. Data gathered from this study will be used to study fish movement patterns, including "spill over" from MPAs and to estimate spawning biomasses and mortality rates from predation, fishing and catch-and-release. Because ultimately the success of this project hinges on the ability to educate and motivate anglers to report found tags, a major focus of the project is to broadly engage recreational fishers on why the research is needed, valuable and will ultimately benefit the sport fishery by ensuring its long-term sustainability. (Read more about this project.)

Targeting Swordfish Deep During the Day to Reduce Bycatch
R/OPCCFRW-4 Oct. 2012–Sep. 2014
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In this collaborative fisheries research project, scientists are tagging and tracking swordfish to learn more about the billfish's movement patterns in relation to sea turtle habitat. The team is also collaborating with the fishing industry to test two innovative gear modifications for reducing bycatch in the commercial swordfish fishery off California. The key idea behind the gear modifications is to set hooks at depths that will efficiently target (catch) swordfish but not sea turtles and marine mammals closer to the sea's surface. One experimental gear modifies a deep-set buoy configuration currently used by small-boat swordfish fishermen off Florida. The other is a deep-set long-line for larger fishing vessels. Both were pilot tested successfully by the lead investigators in 2011 who are now continuing this earlier effort. (Read more about this project.)

Is Barotrauma Keeping You Up? Try Getting Down with Recompression!
R/OPCCFRW-6MG Aug. 2012–Jul. 2013
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John Hyde NOAA/SWFSC, 858.546.7086, john.hyde@noaa.gov

This project seeks to disseminate information to recreational fishermen, through a short video on proper techniques for releasing rockfish to reduce their chances of injury from barotrauma (pressure-induced trauma). The five-minute film will include footage of "best fishing practices," as developed at the 2012 Pacific FishSmart Barotrauma Workshop. Computer animation will show what happens to a fish as it is brought up from depth. A significant portion of the film will focus on teaching fishers to use three simple devices for "getting fish back down"—a

weighted cage, barbless weighted hooks and weighted grippers. The video will be narrated by a rockfish puppet that will describe what is happening and make entertaining comments. A well-known fish artist from Alaska will produce a soundtrack, and a fisherman who was one of the early proponents of re-descending rockfish (using a weighted milk crate) will also contribute to the video. The final product will be posted online at multiple sites, shared through social media and presented at fishing events, such as sportfishing tournaments. This project was funded through the small grants program of Collaborative Fisheries Research West. **Update**: see the video here.

Collaborative Fisheries Research to Build Socioeconomic Essential Fishery Information: A Test Case

R/OPCCFRW-7MG Apr. 2013–Mar. 2014

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A California Sea Grant Coastal Specialist is leading a one-year socioeconomic study of the commercial California halibut fishery, in partnership with the commercial fishing community and state fisheries managers. The project's focus is on the human system—the players, places and processes that interact with the ecological system. The team will review trends in commercial catches of the species by port, where the fish are landed, and by the gear used to catch the fish. The scientists will then work with fishermen to interpret the trends and explain why they are occurring. The goal is to develop a collaborative process and template for documenting, evaluating and predicting change in the fishery's human system, which can be adapted for use in other fisheries. The work will be iterative, and will include vetting and refining the initial results with a larger group of commercial California halibut fishery participants before the final results are made public. A final summary report will be posted on the California Sea Grant and California Department of Fish and Wildlife websites.

California Sea Grant College Funded Projects 2013

Delta Science Fellows Program

With funding from 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. The funded projects for 2013 are listed below.

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

Could endocrine-disrupting compounds in treated wastewater effluent and runoff be contributing to the region's declines in pelagic organisms? This project investigates evidence of endocrine disruption in resident fishes in the Sacramento-San Joaquin Delta. The model species for this research is the inland silverside, *Menidia beryllina*—an introduced, now ubiquitous species with a similar life history to the delta smelt, a species of intense management interest. In the project's first year, the Delta Science Fellow examined endocrine-related gene expression and protein synthesis patterns in male silverside collected throughout the Delta, and from this work showed that males were expressing genes and producing egg-related proteins that are usually associated with female biology. Abnormal schooling of fish during the spawning season was also observed, suggesting that endocrine-disrupting compounds may alter fish behaviors, too. In "outplanting" experiments, scientists were able to detect hormone-related changes in transplanted fish after only two weeks of exposure to conditions in the Delta. Ongoing experiments seek to document the population-level effects of contamination.

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

Native fishes in the San Francisco Bay-Delta are in trouble—the reality is that several species could go extinct. As a conservation measure, refugial populations (captive brood stock) and captive breeding program (hatcheries) have been established or proposed for seven of the most vulnerable species: longfin smelt; Sacramento splittail; Sacramento perch; green sturgeon; delta smelt; Chinook salmon; steelhead trout. The idea is to spawn fish and release their offspring in the wild to supplement, or if needed re-introduce, the species. This project seeks to identify optimal hatchery practices for preserving the genetic integrity of wild populations that are being supplemented. The approach employs computer modeling to simulate effects of hatchery protocols on the genetics of supplemented populations for each of the seven species. In the model, fish are assumed to produce offspring through one of five spawning strategies (e.g., random mating or kinship selection). Genetic inbreeding and other genetic metrics are then tracked in time to estimate the genetic consequences to supplemented wild populations (e.g., loss of genetic diversity). The model incorporates life history characteristics of each species—estimates of fecundity, fitness, age of maturity—as well as a variety of tools for genetically informed breeding (such as microsatellites, single-nucleotide polymorphisms, pedigree reconstruction and relatedness estimation). Findings will assist 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 cumulative consequences of high-saline waters and pesticide toxicity on juvenile steelhead salmon reproductive physiology through a concentration-and-response study with environmentally relevant concentrations of bifenthrin. Bifenthrin is the active ingredient in residential ant and termite control products, which is highly toxic to fish. The EPA lists this pyrethroid insecticide as a “possible human carcinogen” and its use is banned in the European Union. The hypothesis of this project is that high-saline conditions may exacerbate pesticide toxicity and hence their endocrine-disrupting effects. As a result, the reproductive health of young steelhead migrating through the Bay-Delta may be compromised. First- and second-year experiments to test these ideas showed that juvenile females but not males were obviously harmed by chronic exposure to bifenthrin under high-saline conditions. In particular, their ovaries were severely damaged—a somewhat unexpected response, as

bifenthrin is an estrogen mimic. Subsequent ovarian tissue-culture experiments verified the more predicted response—that bifenthrin stimulates ovarian follicle growth. The Delta Science Fellow is currently investigating gene expression patterns in juvenile steelhead exposed to bifenthrin. Among the topics she would like to explore include: understanding why females but not males were affected by the insecticide, and why the ovarian tissue-culture experiments yielded such vastly different results from the whole body experiments. Yet another question is whether a female salmon's ovaries can self-repair at sea, where presumably toxin exposure is much lower. If not, bifenthrin has the potential to impair salmon fecundity.

Current and Past Trophic Relationships Among Dominant Zooplankton Species in the San Francisco Estuary Determined Using Stable Isotope Analysis

R/SF-47 May 2011–Sep. 2013

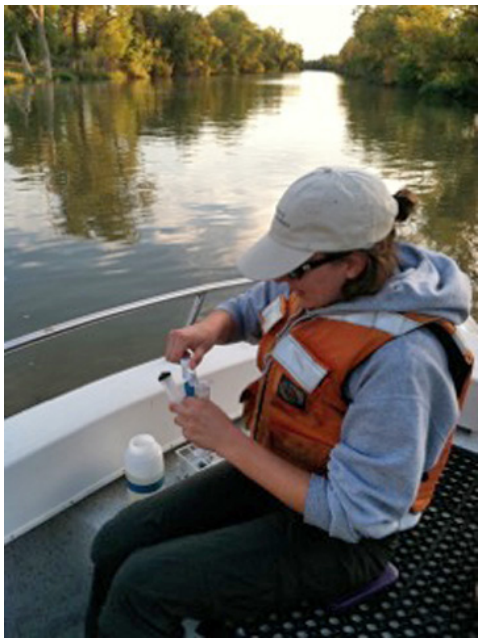
Julien Modéran, SFSU, 415.435.7113, jmoderan@sfsu.edu

This project seeks to reconstruct trends in food resources for dominant zooplankton species in the San Francisco Estuary over the last few decades, as a means of exploring potential contributing factors to declines of many fish species. In the project's first year, the Delta Science Fellow tested the effects of formalin, used to preserve zooplankton samples, on species' stable isotope compositions and with this work validated the ability to conduct stable isotope analyses on preserved samples. He is now using this approach to analyze a 36-year record of zooplankton samples collected in the estuary from 1976 to 2010 through the Interagency Ecology Program. The hypothesis is that there has been a shift in sources of carbon and nitrogen from local phytoplankton to freshwater or terrestrial-derived organic sources since the mid-'70s and that this shift to a longer, less energy-efficient food chain could imply that food shortages are occurring for higher level organisms, notably fishes of management concern. In preliminary analyses of freshwater zooplankton, no trends in carbon or nitrogen signatures were observed at the species level. (As an interesting aside, anthropogenic nitrogen was detected in zooplankton.) In the coming year, the fellow will analyze low-salinity samples and, with estimates of zooplankton biomass, investigate community-level trends in both freshwater and low-salinity samples. Statistical approaches will be used to investigate relationships between zooplankton trophic ecology and environmental factors. In the ongoing field component of the project, the fellow is collecting monthly zooplankton and organic matter samples at eight stations along the estuary's salinity gradient. These samples are also being analyzed for their stable isotopic composition to identify present day sources of organic matter and to infer trophic relationships among currently abundant zooplankton species, among other things.

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 the larger phytoplankton (primarily diatoms) by inhibiting nitrate (NO^{3-}) uptake. The primary objectives of this project are to use stable isotope analyses to track ammonium vs. nitrate uptake in phytoplankton collected in the Sacramento River and identify the sources of these nutrients (i.e., effluent from a nearby sewage treatment plant, dissolved organic matter, runoff, 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. In the project's first year, the fellow developed and validated a method for isolating algae from detrital matter prior to isotopic analysis. In the coming year, field collection will begin in the Sacramento River. Findings will have implications for determining food resources available for pelagic fishes and for regulating 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–Jun. 2013

Erin Bray, UCSB, 805.893.4886, ebray@bren.ucsb.edu

The US Bureau of Reclamation is releasing water from Millerton Lake over the Friant Dam spillway on an interim, experimental basis to explore restoration options for the San Joaquin River. To help inform this process, this project is examining spatial patterns of temperature (heat) and groundwater exchange in the river under different flow regimes. In particular, the Delta Science Fellow is examining how different dam releases—their frequency, timing and duration—might affect Chinook salmon habitat quality at length scales relevant to their life history. Of particular interest are the scales at which spawning occurs (about 150 meters) and migrating salmon travel (about 260 kilometers). In work to date, the fellow reports that "our field measurements document the effects of flow releases on groundwater-surface water exchange and temperature using fiber optic distributed temperature sensing (DTS), measurements of temperature in the riverbed, and streambed hydraulic conductivity (Ksat) over the length of three

river meander bends (2 kilometers). Measured channel bed elevation, flow depth, velocity, and bed-material grain size are currently being used to develop a model of the groundwater exchanges at the smaller scale (150 meters) and the interactions of flow and temperature at the larger scale (260 kilometers). Some of the findings from this project were incorporated into a technical 2012 report for the Bureau, titled "Controls on hyporheic water quality and salmonid egg survival in the San Joaquin River."

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

Is low-level, chronic pesticide contamination in the Sacramento-San Joaquin Delta contributing to declines in zooplankton populations? Might certain pesticides be more toxic to some species than others, and might these differences in part explain broad-scale changes in food resources for larval fishes and other zooplankton consumers? This project explores these ideas. In lab experiments conducted in the project's first year, the Delta Science Fellow estimated the lethal concentrations (LC50s after 96 hours) of five pesticides on two calanoid copepod species, *Eurytemora affinis* and *Pseudodiaptomus forbesi*. These baseline toxicity values are now being compared to pesticide concentrations in the Delta. The copepods are also being exposed to water samples collected from the Delta before and after rainfall to directly observe the toxicity of ambient surface waters and whether this toxicity is increased by runoff. Among the early findings: the pyrethroid insecticide bifenthrin was the most toxic of the five pesticides studied, and its concentrations in the Delta have been observed to exceed the lethal concentrations documented in the lab experiments. Ambient surface waters have been observed to be acutely toxic (i.e., lethal) to both copepod species; however, *P. forbes*i shows a higher tolerance to the Delta's "toxic soup" than *E. affinis*. This result is intriguing, as both species have experienced significant population declines in the last decade, particularly *E. affinis*. Future research will explore whether trends in zooplankton populations can be attributed to differences in the species' toxin tolerances. Yet another topic to be explored is the extent to which the heat content of water and suspended sediment concentrations may reduce acute pesticide toxicities. Results will help refine and update regulations on pesticide use in the Sacramento-San Joaquin Delta to protect zooplankton, ecosystem and ultimately, human health.

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,
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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 the project's first year, the fellow conducted a pilot study on fall-run Chinook smolts in the Sacramento River to test a new miniaturized acoustic technology for tracking fish on their outmigration to sea. He also used shipboard acoustic data, along with juvenile salmon survey data, to explore the degree to which young salmon and krill are generally found in the same spots. This analysis provides information on how much juvenile salmon rely on krill as a food resource. Such information can provide insights into the number of adult salmon that might be expected to return to spawn two years later. In the coming year, the fellow will begin implanting the new 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.

Modeling Wetland Plant Cover to Assess Ecosystems and Bird Habitats
R/SF-52 Oct. 2012–Sep. 2014
Iryna Dronova, UCB, 734.272.3876, irynadronova@berkeley.edu

In this project, the Delta Science Fellow will develop a method for calculating vegetative cover ("leaf area index") from NASA's Landsat remote-sensing data in key wetlands of the Delta. The primary objective is to reconstruct vegetative cover and density over a 30-year period. This reconstruction will facilitate "upscaled" (extrapolated) estimates of carbon fluxes, measured in other studies, from single sites to whole areas. It can also be used to assess trends in wetland bird habitat quality, as well as to assess and compare recovery trajectories for different habitat restoration projects. Findings will complement an ongoing NASA-funded study to quantify net carbon fluxes in wetlands in the Sacramento-San Joaquin River Delta.

Modeling Liquefaction and Levee Failure in the Delta
R/SF-53 Oct. 2012–Sep. 2014
Emma Gatti, SU, 0044.7898270930, eg322@cam.ac.uk

How would the Delta's levees respond to a strong earthquake? In this project, the Delta Science Fellow is developing a seismic hazard map for identifying levees at high risk of failure from intense shaking. The focus is on mapping the locations of underlying sediments—young river channel sands, soft clays and flood basin deposits—that are most likely to liquefy, fail or deform in response to seismic activity. Earthquakes are arguably the greatest natural threat to the Delta's aging collection of levees that contain and channel drinking and irrigation water. Results from this project will contribute to ongoing efforts to maintain water supplies in the event of a massive quake.

The Loss of Marshes in the Delta, Has It Changed the Base of the Food Web?
R/SF-54 Mar. 2013–Mar. 2015
Emily Howe, UW, 206.384.2059, ehowe2@uw.edu

Has the loss of marshes in the Delta changed the base of the food web? Most studies identify phytoplankton (algae) as the base of the food chain; however, the Delta's once marsh-dominated landscape might have supported a detritus-based food web. In this case, many native species would be expected to be adapted to utilize this food source, and the phytoplankton-based food web that is viewed as normal might actually be a symptom of ecological degradation. To investigate these ideas, the Delta Science Fellow is using stable isotope and fatty acid biomarkers to: 1) identify the origin, transport and fate of organic debris in the Delta and Suisun Bay and, 2) investigate the role of this debris in supporting key invertebrate prey organisms in tidal marshes and other shallow-water ecosystems. Ultimately, she would like to evaluate some of the implications of freshwater discharges on these processes and, more generally, to the connectivity of marsh ecosystems and aquatic food webs. Findings will be of relevance to wetland restoration planning.

Salinity Tolerances and Biomarkers of Salt Stress in Longfin and Delta Smelt
R/SF-55 Jan. 2013–Sep. 2014
Brittany Kammerer, UCD, 206.940.7537, bdkammerer@ucdavis.edu

In the first year of this project, the Delta Science Fellow is conducting laboratory experiments to identify the range of salinity conditions that are optimal and stressful for newly hatched and 45-day-old longfin and delta smelt, as inferred by differential growth rates and survival of fish exposed to different water salinities. She will also examine salinity tolerances of adult delta smelt and identify physiological biomarkers of "stress" for different life-history stages of both species. Both longfin and delta smelt are protected species on the brink of

extinction. Efforts are underway to bring longfin smelt into a captive rearing program at the UC Davis Fish Conservation and Culture Laboratory, as has been done for delta smelt, but the culturing techniques for the species are not yet fully established. Results from this project will augment what is known about the species' early life-history requirements—in particular the timing of when young fish should be transitioned from fresh to saline conditions—and in this way may further efforts to establish a refugial population of longfin smelt. In addition, the physiological biomarkers to be identified in this project will help managers and researchers assess the health of these species, particularly in the wild, as they relate to salinity exposure effects.

Understanding the Impacts of Climate Change on Delta Smelt
R/SF-56 Sep. 2012–Aug. 2014
Lisa Komoroske, UCD, 716.912.4656, lmkomoroske@ucdavis.edu

How might climate change affect sensitive species in the San Francisco Bay-Delta? This question is being addressed for the delta smelt, a flagship species in the Delta is in danger of extinction. In preliminary experiments, fish were exposed to warmer and more saline water conditions that are predicted for the Delta under realistic climate change scenarios. The Delta Science Fellow is currently developing the tools for detecting and measuring "stress effects" of these conditions on fish. Once this is accomplished, the fellow plans to integrate physiological, genomic and environmental water-quality data to model mechanisms of physiological tolerance. Results will shed light on how, or whether, climate change might alter fish habitat quality and in this way help managers prioritize conservation strategies.

Controls on the Net Carbon Emissions from Restored Wetland Ecosystems
R/SF-57 Sep. 2012–Aug. 2014
Gavin McNicol, UCB, 510.541.1145, gavinmcnicol@berkeley.edu

Are wetlands sources or sinks of greenhouse gasses? Could certain restoration strategies alter net carbon loading? This project explores emissions scenarios for two large restored wetlands in the Delta—one on Sherman Island, the other on Twitchell Island. The main goals are to quantify methane releases and, using isotopic methods, to investigate the effects of marshland plants on methane flux dynamics. (Methane is 25 times more effective at trapping heat than carbon dioxide on a century time scale, and thus is a central focus of this study.) The fellow will also study the rates at which carbon degrades to carbon dioxide and methane in wetland soils and how these vary with soil and substrate characteristics.

Understanding Food Webs in Shallow Nearshore Waters of the Delta
R/SF-58 Oct. 2012–Sep. 2014
Matthew Young, UCD, 559.936.7242, mjyoung@ucdavis.edu

This project explores the role of non-native species' invasions in contributing to declines of some resident fish populations in the Delta vis-à-vis changes to food availability and predation. Resident fishes are those that live year-round in the Delta. They typically inhabit waters close to shore. In the first year of the project, the fellow will document trends in fish populations—for species such as Sacramento blackfish and tule perch—and then seek to disentangle what might be causing these declines, beyond habitat loss and water diversions. Field studies will focus on areas targeted for habitat restoration. Major goals of the project include reconstructing local food webs and comparing where native and non-native species are in these webs. Findings will provide greater insight into the factors that are most critical to rebuilding or sustaining native resident fishes.

California Sea Grant Funded Projects 2013

National Aquaculture Research Program

Genomically Enabled Crossbreeding to Improve Yields of Farmed Pacific Oysters

R/AQ132-NSI Oct. 2010–Feb. 2014
Dennis Hedgecock, USC, 213.821.2091, dhedge@usc.edu
Donal Manahan, USC, 313.740.5793, manahan@usc.edu
Paul Olin, CASGEP, 707.565.3449, polin@ucsd.edu

This project seeks to develop tools and knowledge for developing a high-yield Pacific oyster for commercial culture. In work to date, scientists have been crossing oyster lines and studying how different oyster genotypes affect various physiological, metabolic and proteomic processes. The basic premise is that genes are responsible for hybrid vigor (high growth rates) and that this superior growth will be reflected in other biological processes, such as protein metabolism. A main goal of this project is to identify, from the millions of possibilities, genes, proteins or metabolites that might serve as biomarkers for detecting desired characteristics during an oyster's larval stage. Such a tool would enable researchers to screen oyster genotypes rapidly, without having to wait for shellfish to mature to adult size to show their traits. In parallel with laboratory experiments, California Sea Grant Extension has led and now completed field tests of an experimental "double cross hybrid" Pacific oyster seed produced by Taylor Shellfish Farms, the project's industry collaborator. This experimental seed was raised alongside seed, selectively bred for growth and high survivorship, at Hog Island Oyster Company in Tomales Bay, Grassy Bar Oyster Company in Morro Bay and Carlsbad Aquafarm in northern San Diego County. The double-hybrid seed was shown to increase yields by 2 percent, 6 percent and 8 percent at the three farms. Oyster culture is an $84-million-a-year industry on the West Coast, and the increased yields observed with the experimental seed could add approximately $21 million to the industry's value over a decade.

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

R/AQ-134 Sep. 2012–Aug. 2014
Sarah Lester, UCSB, 805.893.5175, lester@msi.ucsb.edu
Steven Gaines, UCSB, 805.893.7363, gaines@bren.ucsb.edu
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Offshore aquaculture is being explored in California, as a new industry for coastal communities and a source of fish for local consumers. The Southern California Bight is particularly well suited for offshore fish growing because of the region's mild weather, weak prevailing winds and proximity to major markets in Los Angeles and San Diego. In the next couple years, the state of California will

establish a management framework for permitting and regulating offshore facilities in state waters. One of the anticipated challenges will be in deciding where to locate offshore farms, as there may be conflicts with other sectors of the marine economy, such as fishing, shipping or energy production. To assist in the planning process, this project seeks to model and evaluate economic and environmental tradeoffs of offshore aquaculture and other existing or planned marine uses in the bight. The project is based on a similar one, led by the UC Santa Barbara's Sustainable Fisheries Group, in which the impacts of offshore energy were analyzed. This model, like the one used previously, will be "dynamic" in that it will incorporate ocean currents and "human-response patterns" as factors that can influence interactions, benefits, opportunities and points of conflict among stakeholders. The scientists believe that strategic marine spatial planning can significantly reduce conflict over and impacts from fish farming and thereby increase its value and compatibility with other ocean uses.

Social Constraints and Solutions for Progressive Development of the Nation's Offshore Aquaculture Industry
R/AQ-135 Sep. 2012–Aug. 2014
John S. Petterson, Impact Assessment, 858.459.0142, isia@san.rr.com
Edward W. Glazier, Impact Assessment, 858.459.0142, isia@san.rr.com

This project will identify and analyze existing social constraints to developing a domestic offshore aquaculture industry, and seek to identify solutions to socioeconomic and policy hurdles. Objectives include: (1) identifying the range of social, economic, environmental, cultural and ocean space-use challenges observed by participants in the emerging offshore aquaculture industry; (2) validate this information with people "directly involved in, formally overseeing, indirectly observing, and potentially working and recreating in areas adjacent to the industry," and (3) identify options for mitigating or precluding the range of constraints and challenges. Well-tested social science research methods will be employed, including archival research, "purposive social network-based sampling," both in-depth and follow-up interviews, participatory mapping, and in-depth focus group research. Findings will assist formal policy deliberations on the future of the industry.

California Sea Grant College Funded Projects 2013

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 of 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." The funded projects for 2013 are listed below.

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 (*Doryteuthis opalescens*) is the state's largest fishery by volume, representing more than half of the total amount of fish, across all species, landed in 2011. It is also among the state's most valuable fisheries, worth an estimated $68 million ex-vessel that same year. Despite the size and value of the fishery, there has never been a formal estimate of the amount of squid in the ocean—no estimate of its biomass. This fact, along with high harvests, has led some to question whether the removal of so much forage may be a problem for sea birds, marine mammals and other marine predators. In this project, scientists are examining methods for assessing "data poor" stocks such as the market squid. The main approach has been to compare performances of

various forecasting methods under ecologically realistic levels of “noise.” This work has shown that mechanistic models (i.e., models that incorporate assumptions about biological processes) may be less accurate than simple time-series reconstructions (i.e., using the past to predict the future) for fisheries that are relatively data poor, such as the squid. In the coming year, scientists will perform the same simulations using real data from the squid fishery. Results will be of use to managers and conservation groups interested in developing ecosystem-based management plans.

2013 NMFS—Sea Grant Fellowship Program in Marine Resource Economics Propagation of Environmental Variability Across Trophic Levels: How Biological and Ecological Factors Influence Sensitivity of Communities to Climate and Fishing
E/PD-10 Jun. 2012–May 2014
Lewis Barnett, UCD, 530.665.0019, labarnett@ucdavis.edu

This project seeks to explore the effects of climate variability on food webs and to identify management techniques that might be most effective “under a range of possible changes to timescales of environmental variability imposed by climate change.” A major goal is to determine “how the effects of environmental variability on food webs depends on the demographic process that is being influenced (e.g., larval survival) and the trophic level of the affected species.” The kelp forest communities along the Channel Islands will be used as a case study for exploring these ideas, and the analysis will make use of existing monitoring data in the region to compare consequences of temporal variability on species abundances across trophic levels inside and outside marine reserves. Results will address the degree to which observed fluctuations in populations can be explained by the inclusion of environmental variability in population dynamics models. Findings will provide insights into understanding those processes that are most influential in causing fluctuations in relative abundances of species and the management actions that may be necessary in the future to protect ecosystem function.

Controlling Marine Invasive Species: The Case of the Indo-Pacific Lionfish Invasion in the Southeast US and Caribbean
E/MRE-6 Jun. 2011–May 2013
David Kling, UCD, 530.902.7154, kling@primal.ucdavis.edu

Though entrancingly beautiful, the venomous lionfish is menacing coral reefs and other habitats in the Southeast, Gulf of Mexico and Caribbean and has become a poster-child for what can go awry when pet fish are let loose in the ocean. Besides the loss of biodiversity that these formidable predators cause, lionfish may also be taking a toll on commercially important species such as red snapper. Managers would like to control these skilled hunters before they damage pristine and protected areas, but it is not clear how to go about this seemingly impossible task on a budget. The project employs analytical techniques to address what can

be done to control the fish given limited funds. The main emphasis has been to develop mathematical models that may flesh out strategies for cost-effectively monitoring and controlling the invasion in light of gaps in what is known about local lionfish numbers. Early results highlight the value of and need for monitoring in conjunction with lionfish removal. In the coming year, the fellow will publish results from the modeling studies. One of these will be geared to policy making. Results will be of use to managers who are currently developing formal lionfish control programs.

Efficiency Costs of Restrictions in Tradable Permit Programs: Analysis of the Alaskan Halibut and Sablefish Individual Fishing Quota System
E/MRE-7 Jun. 2012–May 2014
Kailin Kroetz, UCD, 603.219.6933, kkroetz@ucdavis.edu

Nationally, 15 fisheries are currently managed under catch shares programs. One of these is the Alaskan halibut and sablefish fishery, which is managed by a particular type of catch-shares program known as an individual transferable quota (ITQ). As is common with other ITQ fisheries, the halibut and sablefish ITQ program places restrictions on who can trade with whom and own quota. For example, a certain amount of the total quota must be maintained by smaller vessels, and there are limits to corporate ownership and consolidation. This project will explore the economic consequences of these rules. Findings are relevant to fishery managers and can be used to inform the design of new catch shares programs.

During the 40 years of California Sea Grant's existence, the program has funded an estimated 900+ students through fellowships, traineeships and scholarships. To celebrate this milestone, an interactive map has been created that shows where these fellows, scholars and trainees from over the years have ended up. Click “view larger map” to get a closer view and find what alumni in your area are up to!

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.

Knauss Sea Grant Fellows 2013

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The California Sea Grant Fellows Program, modeled after the federal Knauss 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.

California Sea Grant Fellows 2013

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California Sea Grant College Funded Projects 2013

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