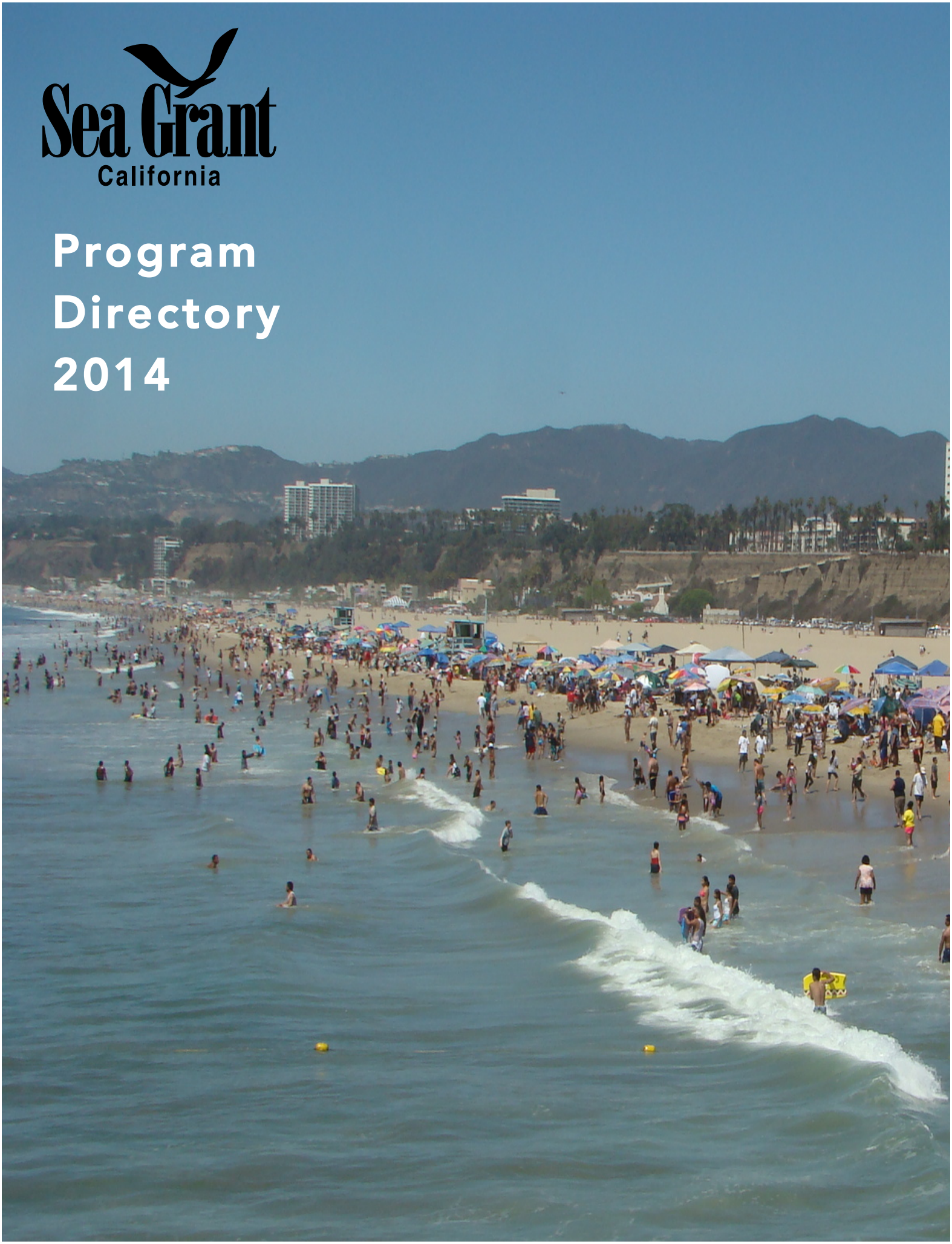
Sea Grant
California

Program Directory 2014

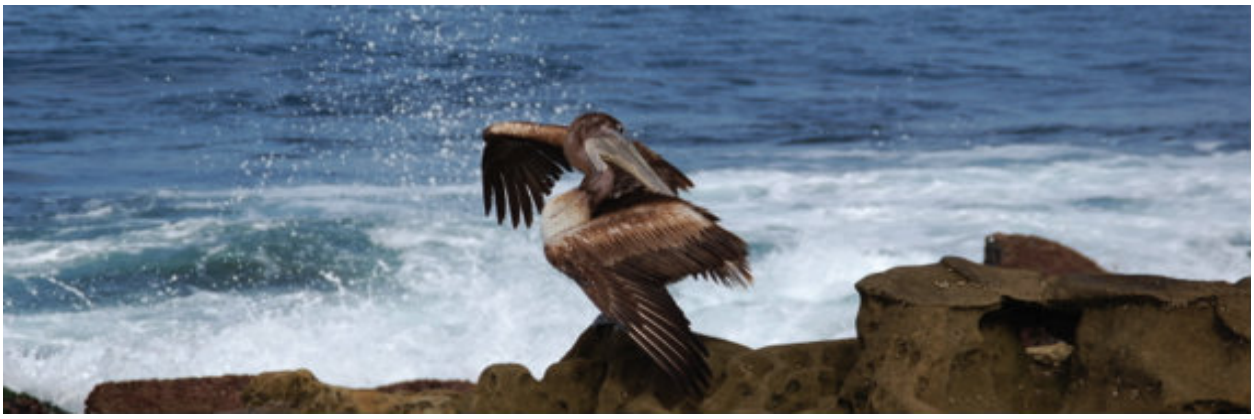


2014 California Sea Grant College Program Funded Projects

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 2014 projects and other program information are grouped as follows**:**

Healthy Coastal and Marine Ecosystems

Healthy coastal and marine ecosystems are foundational to life along the West Coast. They have intrinsic ecological and aesthetic value, and are essential for sustaining the diversity of coastal and marine life that draws people to the coast and supports many coastal communities. The health of California's coastal ecosystems is under assault from multiple stressors, many of which are of anthropogenic origin, including nutrient and pollutant discharge, harmful algal blooms, changes in water turbidity and sediment transport, species invasions, and climate change (resulting in ocean acidification and hypoxia). CASG is committed to providing evidence of the driving forces and connectedness within ecosystems that define their productivity, sensitivity and health. Our goal is to be a leader in regional approaches to understanding and maintaining healthy ecosystems to identify information gaps, set research priorities, and coordinate information and technology transfer to those who need it. The funded projects in this focus area for 2014 are listed below.



Consequences of Nearshore Low Oxygen and Low pH for Coastal Resources of Southern California
R/CC-04 Feb. 2012–Aug. 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–Aug. 2014
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Though researchers generally expect terrestrial plants to grow larger with rising atmospheric carbon dioxide levels, it is more difficult to predict how marine algae, kelp, and seaweeds may respond to climate change. This project is exploring the physiological responses of coralline (calcified) algae and fleshy seaweeds (red and brown) to an ocean that is both warming and more corrosive. In work to date, research teams deployed collecting trays (i.e. sets of settlement tiles) off Carmel and La Jolla and allowed these to be colonized with natural assemblages of seaweeds and invertebrates for a year. Researchers are exposing the organisms on these settlement tiles to ocean conditions predicted for 2100 and tracking changes in growth, calcification and species composition for two to three months. The idea is to better understand how rocky reef communities may respond to climate change. Researchers will also look at whether climate change may interfere with the chemical cues that help red abalone larvae find coralline algae—their preferred settlement habitat. The scientists hypothesize that weaker, more fragile coralline algae may emit different chemical signals and that abalone larvae reared at elevated pCO2 levels may have impaired sensory abilities to detect settlement cues. Results further both state and federal goals of managing marine ecosystems in the face of climate change. In addition, scientists plan to develop K-12 classroom curricula about climate change in marine ecosystems.

Effects of Ocean Acidification on Olfactory Senses, Swimming Physiology, and Gene Expression in Juvenile Rockfish
R/CC-07 Feb. 2013–Aug. 2014
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This project examines effects of ocean acidification (as simulated by elevating pCO2 levels) on swimming physiology, behavior and gene expression patterns of early post-settlement rockfishes found in Central California's kelp forests and rocky reefs. Manipulation experiments are being conducted at the Monterey Bay Aquarium Research Institute to compare the effects of ocean acidification on rockfish species that recruit during periods of strong and weak upwelling. The hypothesis is that juveniles (2–4 centimeters in length) exposed to more acidic waters, consistent with climate-change scenarios for 2050 and 2100, will have an impaired ability to distinguish the odors of predators and, as a result, will show reduced problem-solving abilities. Researchers will also examine consequences of elevated pCO2 conditions on juvenile fishes' swimming speeds and aerobic performance (e.g., respiration rates). In the genetics component of the project, they will develop assays to characterize changes in the expression of genes involved in olfaction, acid-base regulation, cellular stress response and protein biosynthesis in fishes exposed to ambient and elevated pCO2 levels. A secondary hypothesis being explored is that species recruiting in spring may be more adapted to variable pH-conditions associated with seasonal upwelling of deeper, more acidic waters. In the past year, researchers have found that copper rockfish (which recruit in spring) are much more sensitive to more acidic conditions than blue rockfish (which also recruit in spring). In the coming year, they plan to finalize results of gene

expression assays and they will conduct experiments with additional rockfish species to better understand species-specific sensitivities to elevated pCO2. Results will be shared with federal and state fisheries agencies involved with managing groundfishes.

Is C/N Decoupling Caused by Harmful Algal Blooms in Santa Monica Bay?
R/CONT-209; Feb. 2010–Apr. 2014
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It is well known that nutrients in lawn and crop fertilizers, washed into the ocean by rivers, rain and runoff, can trigger some marine algal blooms. But somewhat paradoxically, blooms can also happen when nitrate levels at the ocean's surface are very low. This occurs because some algae, known as dinoflagellates, can propel themselves with whirling, tail-like structures and forage for nutrients. This project was originally funded in the hopes that scientists would be able to sample waters in Santa Monica Bay before, during and after a late-summer or early-fall dinoflagellate bloom. The field samples were, ideally, supposed to capture dinoflagellates in action during periods of low surface nutrient levels. That is, they hoped to observe a draw down in nitrate levels beneath the surface mixed layer, associated with dinoflagellate foraging, and a simultaneous draw down in surface dissolved organic carbon concentrations, associated with cell grown in sun-lit waters. In this way, researchers had hoped to explain an apparent decoupling of surface carbon and subsurface nitrate levels, as the chemical footprint of sub-surface dinoflagellate foraging. The ocean has not been cooperating, however, and in 2012 and 2013, late-summer blooms in Santa Monica Bay were dominated by another kind of algae, diatoms, which do not propel themselves up and down in the water column and are typically associated with spring upwelling events. Scientists have speculated that ocean acidification may be creating conditions that favor diatoms over dinoflagellates.

Noroviruses in Coastal Waters: Implications for Seafood Cultivation and Human Health
R/CONT-216 Feb. 2012–Jul. 2014
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If you've had stomach flu or food poisoning, there is a good chance you've had a norovirus infection. According to the Centers for Disease Control, 1 in 15 Americans become infected with noroviruses each year, making these highly contagious pathogens the leading cause of food-borne disease outbreaks in United States. This project seeks to determine the fate, transport and human health risk of human noroviruses (NoVs) along the Central California coast, particularly in areas where shellfish are grown commercially or recreationally harvested. To do this, the research team is testing four hypotheses: 1) NoVs are preferentially attached to particles in estuarine and marine waters; 2) NoVs accumulate in mussels; 3) the presence of NoVs is correlated with the presence of zoonotic pathogens, such as *Toxoplasma, Cryptosporidium, Giardia* and *Salmonella*, and fecal indicator bacteria; and 4) NoVs pose a significant health risk to those who consume shellfish. In work to date, scientists have conducted laboratory experiments confirming that NoVs do attach to particles in water samples and display patterns of enhanced aggregation in estuarine and marine water samples. Subsequent laboratory experiments have examined the transport characteristics of NoVs and the effects of water salinity on the accumulation of NoVs in coastal habitats. Data analyses from these experiments are ongoing but have implications for understanding the factors that determine NoVs concentrations in waters where shellfish are present. In the field component of their project, researchers have collected water samples from Tomales and Monterey bays and have determined that hollow fiber

ultrafiltration is the best technique for collecting NoVs from environmental samples. Mussels have also been collected during the dry season and after rainfall events in the Carmel and Cambria regions. Testing of these samples has documented the presence of *Toxoplasma gondii, Giardia* and *Salmonella* in these bivalves. In future work, reverse transcription PCR techniques will be applied to mussel and water samples to quantify NoVs gene expression levels. Results from these analyses will provide the basis for evaluating whether NoVs pose a significant risk to shellfish consumers.

Submarine Groundwater Discharge in North Monterey Bay—The Fuel Sustaining the Algal Incubator
R/CONT-218; May 2012–Apr. 2015
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Certain kinds of harmful algal blooms in the northeastern portion of Monterey Bay form 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 is not well documented, the region's inner shelf circulation is believed to create retention zones within which nutrients and algae are accumulated. This theory, however, does not explain the persistence of dinoflagellate blooms during periods of intense upwelling, when shelf currents are not in a retention mode. The scientists leading this project theorize that submarine groundwater discharges may sustain these blooms during these periods 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.

Impact of 4-nonylphenol on Immunocompetence and Disease Susceptibility in Pacific Oysters, Crassostrea gigas
R/CONT-220 Feb. 2013–Aug. 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 hemocytes 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.

Modeling Interannual Krill Availability (MIKA) in the Central-Northern California Current, 1990–2009
R/ENV-220; Feb. 2012–Aug. 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 hind cast 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.

Scale Insects: Emergent Threats to Salt Marsh Restoration
R/ENV-221; Feb. 2013–Aug. 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, 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 YouTube music videos.

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–Aug. 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.

Sustainability and Fine-Scale Management of a California Sea Urchin Fishery and the Ecology of Exploitation
R/FISH-209; Feb. 2010–Aug. 2014
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Is San Diego's red sea urchin fishery sustainable? The question is challenging to answer because of a lack of basic biological information on the species and because urchin populations are open populations, meaning that the animals' larvae (offspring) drift for days or even weeks, seeding both nearby and remote habitats. This project builds on earlier collaborations among fishermen, scientists and processors to gather spatially explicit data needed to reliably evaluate the fishery's status. In the project's first two years, biologists acoustically mapped bottom elevations in a local kelp forest at horizontal resolutions of 10 to 15 meters and have developed a new kind of tag for tracking urchin movements among reefs and within feeding lines. They have also developed underwater time-lapse camera systems to observe small-scale urchin movements and behaviors. They are in the process of working with ever-larger groups of fishermen, who may collect data needed to estimate local urchin movements, growth, and mortality within harvested areas. It is hoped that this information can be used to develop a spatially explicit population model. The approaches under development in this project may be applied to other small, artisanal fisheries.

Molecular Identification of Fish Eggs and Larvae: Enhancing the Value of Icthyoplankton Surveys in Monitoring and Management
R/FISH-216 Feb. 2012–Aug. 2014
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This project seeks to advance scientists' ability to monitor the spawning activity of fish communities for both fisheries management and marine conservation purposes. In work to date, the researcher has developed and tested a variety of molecular approaches for identifying species of fish eggs (e.g., bead arrays) and is currently using a combination of species-specific PCR primers and direct sequencing to analyze sorted fish egg samples collected during the 2002-05 winter CalCOFI cruises. It is hoped that this analysis, a collaboration with NOAA Southwest Fisheries Science Center researchers, will shed light on the relationship between fish community structure and environmental parameters, both biotic and abiotic, in coastal waters. To better understand in-shore fish spawning activity that is not surveyed during CalCOFI cruises, the researcher and his students have initiated a twice-weekly sampling of fish eggs from the Scripps Pier in La Jolla. So far, 15,000 eggs have been collected; 6,000 of these analyzed, and 35 different fish species identified, including the shortfin corvina, which is not commonly thought to spawn in Southern California, and the speckled sanddab and the señorita, the most abundant species to date. The shore-based sampling has also revealed noticeable seasonal patterns in spawning: for example, anchovy are winter spawners, corbina, spring and summer spawners, while others spawn year-round. In the coming months, the research team hopes to perform near real-time identifications of fish eggs collected from the pier and post results on a public website, such as the Southern California Coastal Ocean Observing System's.

Realistic Behavioral-Physical Models of Connectivity for a Network of Marine Protected Areas
R/FISH-218 Feb. 2012–Aug. 2014
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Using a particle transport module within a Regional Ocean Modeling System, scientists are exploring the effects of documented differences in larval behavior of crustaceans on dispersion and settlement off California. In work to date, researchers have found that larvae that consistently swim below the surface mixed layer are 500 times more likely to be retained along the Central California coast than larvae that remain at the surface. For species with 30- to 60-day pelagic larval periods, larvae that avoided surface currents were also 145 times more likely to settle back to the coast. Higher settlement rates were most pronounced from Pt. Conception to Pt. Arena and notably less pronounced north of Cape Mendocino. Modeling has also been used to study the effects of upwelling (winds) on when and where larval settlement occurs along the coast, and scientists are in the process of developing a higher-resolution circulation model that will be used to refine the representation of nearshore processes. Results from this project will further what is known about patterns of crustacean larval dispersal and population connectivity in California.

Climate and the Santa Barbara Basin Fish Assemblage in the Last Two Millennia: Management Implications
R/HCME-01 Feb. 2014 - Jan. 2016
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Marine fish population sizes may vary over periods of months to decades in response to natural ocean cycles, which inevitably favor some species over others. Superimposed on these natural cycles are a host of man-made stressors, such as fishing and anthropogenic climate change, which may also cause further swings in fish population sizes. This project seeks to reconstruct patterns of fish abundances in the Santa Barbara Channel over a 2,000 year period predating modern human activity to tease apart the processes most affecting fish populations currently. The raw material for this reconstruction will be layered sequences of otoliths (ear-bone-like structures) in sediment cores extracted from the seafloor below the Santa Barbara Basin. The shape, size, and elemental composition of these otoliths, along with assumptions about their deposition rates, will be used to estimate fish biomasses over time and in relation to ocean climate. Data collected from this study will be shared with fishery managers and policy makers. Researchers will also produce an online key for identifying the region's marine fishes from their otoliths.

The Importance of Estuarine Acidification (EA) for Commercial Oyster Production and Native Oyster Restoration
R/HCME-02 Feb. 2014 - Jan. 2016
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Though the ocean is expected to become more acidic on average over the next several decades, it is not clear whether climate change will have the same effect on California's estuaries, since these waterways are highly influenced by local freshwater in-flows and upwelling dynamics. In this project, Tomales Bay will be used as a test bed for studying the relative importance of pH, salinity, plants and mixing on oyster populations. This will be achieved through targeted water sampling of key environments in the bay and through outplanting and resampling of young oysters to document rates of shell calcification, growth and survival. Sampling will be conducted on daily cycles to document the effects of plants on water characteristics and on seasonal cycles to document the effects of the region's Mediterranean climate. There will also be episodic sampling during major events such as large ocean storms or heavy rains. The data that will be collected during the project will allow scientists to explain whether pH or other factors are more important in explaining patterns observed in the field. Findings will be shared with native oyster restoration groups and local shellfish producers at annual stakeholder meetings to be convened by the researchers, and through outreach materials, to be produced through the cooperative extension program of UC Agriculture and Natural Resources.

Context and Scale of Seagrass Effects on Estuarine Acidification: An Academic-Industry Partnership to Explore Mitigation Potential
R/HCME-03 Feb. 2014 - Jan. 2016
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Could seagrass meadows be a natural, local remedy for ocean acidification? This project explores the idea by documenting pH, alkalinity and other properties of seawater at seagrass meadows and control sites in Tomales Bay, a major shellfish-growing center in the state. Three major questions will be addressed: 1) To what extent does carbonate chemistry within the bay vary because of geomorphology and hydrology? 2) To what degree do seagrasses, by up-taking and releasing carbon dioxide, alter local carbonate chemistry? And, 3) Do results support the idea of using expanded seagrasses to locally buffer carbonate chemistry and hence offset ocean acidification? Results from this project will be shared with stakeholder groups at yearly workshops, convened by the project's lead investigator, and may provide crucial information to help protect the region's shellfish farms from climate change. The project is a collaboration with the Hog Island Oyster Company.

Ocean Forcing of San Francisco Bay: Intrusion of Upwelled Water
R/HCME-04 Feb. 2014 – Dec. 2015
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This project examines the degree to which the intrusion of deep, upwelled water into San Francisco Bay affects the bay's nitrate, oxygen and pH levels and thus contributes to eutrophication, hypoxia and acidification. The research, which will combine new and existing field data, will address basic questions about when and why upwelled water is sometimes but not always delivered into the bay; the origins of this dense water; its reach into the bay and the processes (e.g. tidal flows) that enhance or minimize mixing of water masses. Findings will be shared with state and local agencies involved with reducing nutrient pollution into the bay and understanding and preparing for climate change.

Geochemistry, Physics, and Ecology of an Intermittent Estuary on the California Coast: A Multi-Disciplinary Investigation into an Annual Organism Die-off
R/HCME-05 Feb. 2014 – Jan. 2016
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Almost every year since 1995, Pescadero Estuary in San Mateo County has experienced mysterious die-offs of fish, including federally protected steelhead trout. These fish kills always occur after the sandbar across the lagoon mouth has been breached (due to the build-up of freshwater behind it) and the lagoon becomes opened to tidal flushing. Why would tidal flushing kill fish? It is speculated that the initial outflow of stagnant freshwater stirs up sulfur-containing sediments on the bottom, which, by changing the water's sulfur chemistry, cause a potentially lethal drop in the water's dissolved oxygen content. This project seeks to test these ideas by quantifying sulfur cycling in the estuary, as it opens and closes and its marshlands are flooded and drained. The scientists will also characterize the physical dynamics of the estuary during open and closed states and during transitions from each. The project's third objective is to characterize how changes in geochemical and physical water conditions influence fish movement patterns, especially how fish attempt to escape anoxic (suffocating) conditions. For this

component of the project, fish will be acoustically tagged and tracked with an existing array of receivers. Findings, which will be shared at two workshops for decision-makers, may help identify restoration activities that could reduce fish kills in the estuary and protect habitat quality for the commercially important Dungeness crab fishery. The project is a partnership with NOAA Fisheries and state and federal agencies participating in the Pescadero Estuary Science Panel.

The Effect of Sea Otter Re-establishment in Southern California on the Remnant Populations and Recovery of Black Abalone, An Endangered Species
R/HCME-06 Feb. 2014 – Jan. 2016
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The black abalone is a long-lived intertidal marine snail listed as endangered under the federal Endangered Species Act. The southern sea otter is a voracious marine mammal that adores abalone, is also federally protected and, with the termination of the "otter-free" management zone, is now allowed to expand its range naturally into Southern California. Broadly, this project seeks to evaluate the potential impact of the otter's free-ranging status on black abalone populations at the four northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa and San Miguel). These offshore islands are within the otter's new foraging territory and are believed to be home to more than half of all abalone in Southern California. In the project's first year, biologists will begin conducting field surveys to map the locations and sizes of black abalone, as well as the numbers of animals residing within deep, rocky crevices beyond arms reach of otters. The quality of black abalone habitat will also be evaluated and mapped. In the project's final stages, researchers will assess the proportion and location of abalone populations vulnerable to otter predation. Results will be rendered into GIS-compatible formats essential to developing mitigation and management strategies for two recovering, protected species.

The Spread and Ecological Consequences of the Invasive Seaweed *Sargassum horneri*
R/HCME-07 Feb. 2014 – Jan. 2016
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Sargassum horneri is a large, annual, brown alga native to shallow reefs of Japan and Korea that was first discovered in the eastern Pacific Ocean in Long Beach Harbor in 2003. Since then, the alga has become invasive in shallow rocky reef habitats from Santa Cruz Island in the Channel Islands archipelago to Isla Natividad in Baja California, Mexico. Though not yet rigorously documented, some biologists have expressed concerns that the algae may be displacing giant kelp, the keystone species for California's kelp forests, in some areas. To better evaluate it's potential threat to these ecosystems, scientists will lead dive surveys and conduct experiments around the Channel Islands to identify the physical and biological characteristics of nearshore habitats that encourage the invader's proliferation. They will also attempt to document what, if any, effects the non-native seaweed has on native kelp communities' structure and diversity. Marine protected areas around the Channel Islands may slow the invader's spread. Yet another goal of this project is to examine if this is true and, if so, the mechanisms by which this biotic resistance is conferred. Results from the project will be shared with NOAA Fisheries, which has funded research on eradicating the alga, and the Channel Islands National Marine Sanctuary, which has identified *S. horneri* as an invasive species of great concern. To educate the broader public, researchers will help create exhibits for the Outreach Center for Teaching Ocean Science at UC Santa Barbara, and the Channel Islands Boating Center.

Safe and Sustainable Fisheries and Seafood Supply

Fish and shellfish provide an important source of protein to many citizens, 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. California's long coastline and rich coastal waters produce a wide variety of seafood. Some of the commercially important fisheries within the California Current have been sustainably harvested and thus remain at low levels of exploitation. Many others, however, such as groundfish and salmon, have suffered commercial fishing closures in recent years. CASG has key roles to play in advancing public understanding of the nature of problems and opportunities related to fisheries sustainability and aquaculture. Through the use of its research, extension, and education capacities, CASG will provide information to support the kind of informed public and private decision making that will lead to a sustainable supply of safe seafood long into the future. The funded projects in this focus area for 2014 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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Rearing fish during their larval stage is often the most difficult part of developing a new species for culture; however, for yellowfin tuna, this common difficulty is further complicated by the absence of a domestic population of breeding fish. Instead of setting up breeding tanks locally, which is expensive and logistically complex, researchers have been airfreighting tuna eggs and larvae from the Inter-American Tropical Tuna Commission's facility at the Achotines Laboratory in Panama (one of the few research facilities in the world designed specifically to study the early-life history of tropical tunas) to their aquaculture facility at Hubbs-SeaWorld Research Institute in San Diego. The survivorship of these animals, though, has been so low that it has been basically impossible to carry out the necessary research on their early life history

requirements (e.g., nutritional requirements). The first main goal of this project is to identify what is causing low survivorship among airfreighted fish and to fix the sources of harm, if feasible. Preliminary experiments during the project's first year suggest that packing larvae for airfreight may itself be a problem, as low survivorship was observed in both larvae airfreighted to San Diego and in controls kept on the ground in Panama. In correspondence with scientists in August of 2013, Sea Grant was informed that all aspects of the project were delayed for the last 14 months because the captive tuna stopped spawning. According to the research team in Panama, this was due largely to a smaller-than-normal number of breeding adults and an inability to replenish the brood stock with new fish, because of unusually poor fishing conditions. The scientists report that fishing has improved recently, and the population now stands at 24 with a target of 40 adults. They plan to resume their research in 2014.

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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The state of California is in the process of establishing a management framework for permitting and regulating open-ocean aquaculture. To assist in the planning process, this project seeks to model and evaluate the industry's economic and environmental tradeoffs. The emphasis of the work, to date, has been to decide on how to focus the modeling effort on specific species and culturing methods that together might broadly represent the full range of likely farming operations. After much research, the team has decided to model and evaluate these three scenarios: 1) finfish in net pen cages, based on white seabass, 2) shellfish on longlines, based on Mediterranean mussels, and 3) kelp on longlines, based on Laminaria. The model will examine the effects of these on: 1) the California halibut fishery, 2) water quality and the bottom environment, and 3) visual impact from operations that may be visible from the coast. In the coming months, the team will be running the finfish scenario in Aquamodel, a proprietary software model developed by colleagues at USC, and will be exploring how to model disease dynamics so as to be able to evaluate the risk of disease transmission to wild fish. Other modeling work will looks at patterns of larval dispersal and connectivity, and possibly pollutant dispersal. 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. The hoped for outcome of this project, scientists say, is to 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, edward.glazier@gmail.com

This project seeks to identify and analyze the social obstacles (constraints) to developing a domestic offshore aquaculture industry. The hope is that this type of information might lead to solutions that could help move the industry forward. 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. The team has, to date, completed its first phase of work in Hawaii, California and along the U.S. East Coast and is in the process of preparing a report on the "human context in which the offshore aquaculture industry is situated." Once this is done, their investigations will focus on a second round of interviews, focus groups and data analyzes that they hope will identify strategies for resolving concerns, constraints and objections to the industry's growth. Findings will assist formal policy deliberations on the future of the industry.

Determining the Genetic and Molecular Bases of Oyster Resistance to an Oyster-killing virus, Ostreid herpesvirus 1
R/SSFS-01 Feb. 2014 - Jan. 2016
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Pacific oysters worldwide have suffered mass mortalities from the oyster herpes virus (Ostreid herpes virus 1). In Tomales Bay in Northern California, a major shellfish growing center in the state, the virus has doubled summertime mortality rates of oysters over their 18-month culture cycle. As a waterborne pathogen activated by warmer water temperatures, all the state's shellfish growing areas are potentially at risk should the virus spread from its current location in Tomales Bay and Drake's Estero. The goal of this project is to protect and improve Pacific oyster farming in Tomales Bay and other parts of the state by providing a detailed understanding of the genetic, cellular and physiological mechanisms of heritable resistance to the herpes virus infection. In the project's first year, the scientists will conduct field trials to identify oyster families with differential susceptibility to the oyster-virus infection. A second set of experiments will then examine the heritability of disease resistance from these families and whether it translates into higher survivorship and yield in the field. Assuming that it does, the researcher will employ gene-mapping and gene-expression profiling techniques to localize and identify genes and biomarkers for disease resistance. Maps of these genes will then be compared to genetic profiles of oyster families that have previously produced offspring with high rates of survivorship in Tomales Bay. Ideally, findings will advance the seed industry's ability to selectively breed high-yield oysters with genetic resistance to the virus. This project is a collaboration with the University of Washington in Seattle, Hog Island Oyster Company, Taylor Shellfish Farms and California Department of Fish and Wildlife.

Resilient Coastal Communities

Coastal communities throughout California today face a multitude of opportunities and risks. 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. CASG will help acquire and provide the best available science-based knowledge to engage a diverse and growing coastal population. It will use its capabilities to support the development of resilient coastal communities that are economically and socially inclusive, are supported by diverse and vibrant economies, mitigate and respond effectively to natural and technological hazards, and function within the carrying capacity of their ecosystems.

Beach Evolution on Scales from Storms to Years
R/RCC-01 Feb. 2012–Aug. 2014
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The physical oceanographers leading this project have been monitoring sand movement at three beaches in San Diego County that received beach nourishment in 2012 through a $28-million regional beach sand project. This monitoring has highlighted the dramatic variability in how beaches may respond to wintertime waves: Sand at Cardiff State Beach and Solona Beach, for example, was transported to offshore waters (depths of 4-12 meters) during the 2012-13 winter season, while at Imperial Beach, much of the added sand remained above mean sea level and was transported several kilometers south, reaching the Tijuana River mouth 8 months later. The scientists have extended their Sea Grant project in order to continue monitoring beach sand movement, and they are also developing numerical models for sand transport. The ultimate goal of the project is to better understand how our sandy beaches respond to waves over time scale ranging from individual storms to decades-long storm patterns. The project is a collaboration with the U.S. Army Corps of Engineers and the California Department of Parks and Recreation.

Spatial Redistribution of Fishing Effort: Identifying Drivers and Testing Model Predictions for Informing Expectations in Marine Spatial Planning
R/RCC-03 Feb. 2014 – Jan. 2016
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Do marine reserves reduce fishermen's catches or simply displace where fish are caught? Is "spill-over" real and can it be documented from catch records? This project seeks to identify, test and quantify factors that have redistributed fishing effort (where fishing is occurring and how intensely) around the Northern Channel Islands since the region's marine protected areas (MPAs) went into effect in 2003. In the project's first year, researchers will mine data from existing socio-economic reports, developed by the environmental consulting firm Ecotrust, based on extensive interviews with local fishermen. This analysis will be used to formulate hypotheses about fishermen's responses to the MPAs. Examples of the types of hypotheses that will be considered include: MPAs remove rather than redistribute fishing effort and MPAs induce fishermen to "fish the line" to take advantage of "spill-over" from no-fishing areas. In the second year, researchers will compile empirical data to test the hypotheses developed in the project's first stage. This empirical data will be drawn from multiple datasets, including aerial monitoring of fishing vessel type and location, fish biodiversity, benthic habitat and kelp forest cover, weather conditions and other relevant spatial information across the islands, before and after the MPAs' establishment. Findings will be used to develop models for forecasting potential impacts of other MPAs in redistributing fishing effort and/or changing the amount or quality of fish caught by fishermen. The team will share their results with marine scientists and managers at two local meetings, and their findings will also be presented at the five-year review of the North Central coast's MPAs in 2015. Ecotrust, a partner on the project, will communicate the results with California fishermen.

Statewide High-Resolution Assessment of California Coastal Cliff Erosion and Retreat
R/RCC-04 Feb. 2014 – Jan. 2016
Adam Young, UC San Diego/Scripps Institution of Oceanography, 858.822.3378, adyoung@ucsd.edu

In this project, the scientist will lead an effort to measure and map recent coastal cliff erosion and retreat along most of the California coast, using aerial laser survey data collected in 1998, 2002 and 2010. Recent hot spots of erosion will be identified and examined for any spatial erosion patterns relating to bluff composition, coastal settings and other factors such as coastal armoring and wave exposure. The scientist will assess whether there have been changes in erosion rates over time by comparing laser-based contemporary cliff retreat rates to published long-term historical ones. Results will provide a baseline for future coastal erosion studies and may shed light on the future of, and processes shaping, California's coastline.

California Ocean Protection Council

The California Ocean Protection Council (OPC) was created in 2004 to ensure California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. The Governor-appointed council is charged with providing leadership and coordinating the activities of ocean-related state agencies to better manage ocean resources. Since 2006, CASG has worked with the OPC as one of its state partners and has administered dedicated OPC funds to assist the state in implementing a coordinated program of applied interdisciplinary research and training, linked to manager needs and uses. The projects below have 2014 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. 2016
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This project explores the effects of ocean acidification on shell-building organisms such as abalone and sea urchins, 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 estimates of surface ocean pH can be calculated. Sensors at the mooring are also recording water temperatures, salinity and oxygen concentrations. Water samples are being collected from the 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 the 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 species that may be most vulnerable to changes in seawater carbonate chemistry. In soon-to-be published experiments, scientists have documented changes in shell thickness and growth rates in young abalone exposed to acidic and then normal water conditions, mimicking the conditions experienced by organisms during upwelling, when nutrient-rich, low-oxygen, acidic waters are brought from depth to the surface. 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 urchins to more fully understand the consequence of upwelled water on these commercially important species. 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–Jan. 2015
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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 published work to date, scientists have shown that bigger salmon out-migrating to sea for the first time are more likely to survive hostile ocean conditions than smaller fish of about the same age. This size advantage, however, occurs only when krill is scarce. Young salmon of all sizes are equally likely to survive when food resources (krill) are readily available. Based on their work, scientists have developed a model that forecasts adult salmon returns two to three years in advance, based on ocean water temperatures and krill abundances. NOAA's Integrated Ecosystem Assessment program shares these predictions with the Pacific Fisheries Management Council, which manages the salmon fishery. NOAA Fisheries' Salmon Assessment Team also uses the model output to help it evaluate the consequences of salmon fishing on endangered Sacramento River winter-run Chinook salmon.

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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In coastal waters around the globe, harmful algal blooms are becoming more intense and more frequent, endangering both human health and wildlife. In California, one of the most problematic harmful marine algal toxins is domoic acid, which has caused mass deaths of sea lions and seabirds and is commonly detected in fish caught by anglers. This project focuses on more fully understanding how certain kinds of harmful algal blooms form and spread off California, the goal being to forecast these potentially serious public health threats. The major effort to date has been to combine and expand existing domoic-acid forecasting models for the Santa Barbara Channel and Monterrey Bay, using new monitoring and NASA remote sensing data, as well as numerical model fields. A similar but much simplified modeling effort is underway for *Alexandrium catenella*, which produces the toxin that causes paralytic shellfish poisoning. In 2013, researchers sought to identify the relative importance's of surface seawater temperatures, surface salinities, micronutrient concentrations and their ratios, ocean color, freshwater inputs and upwelling indices in "driving" bloom formation and toxin production. This information will be used to determine the number of regional models that need to be "stitched" together to accurately predict blooms off all of California. The California Department of Public Health and the California Program for Regional Enhanced Monitoring of PhycoToxins are providing data needed to develop and validate the model. 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. 2015
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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.

North Coast MPA Baseline Program

California Sea Grant helps administer the North Coast MPA Baseline Program collaboratively with the MPA Monitoring Enterprise (a program of the California Ocean Science Trust), the California Department of Fish and Wildlife, and the California Ocean Protection Council (which provides funding for the projects). Below are summaries of the new projects with their lead investigators. This initial set of projects will begin in February 2014 and end in February 2017. These grants will support the collection of ecological and socioeconomic information on beaches, reefs and other nearshore ecosystems along the state's North Coast, which stretches from Alder Creek in Mendocino County north to the Oregon border. A broad collaboration of scientists, fishermen, tribal governments and citizen-science groups from 31 organizations will help gather the data.

Characterization and Indicators of Oceanographic Conditions
R/MPA-31; Feb. 2014 – Jan. 2017
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Brian Tissot, Humboldt State University
John Largier, Bodega Marine Laboratory, UC Davis
William Sydeman, Farallon Institute for Advanced Ecosystem Research
Marisol Garcia-Reyes, Farallon Institute for Advanced Ecosystem Research

Spatial patterns and temporal variability in water temperatures, currents and other oceanographic conditions play an important role in the dynamics and structure of marine populations and ecosystems. This project seeks to assemble and synthesize a variety of in-situ and remote-sensing ocean and atmospheric data to depict ocean conditions along the North Coast relevant to understanding the processes that drive the region's biological variability. The resulting data products will characterize ocean conditions for the 20-year period leading up to the implementation of the MPAs and will be updated as baseline field studies are conducted. Results from this work will provide context for comprehensive analyses of baseline and future MPA monitoring and are critically important for helping researchers determine whether observed biological patterns are due to differences in fishing pressure or natural variability in fish populations.

Baseline Characterization of Nearshore Rocky Reefs and Kelp Forests
R/MPA-32; Feb. 2014- Jan. 2017
Sean Craig, Humboldt State University, sean.craig@humboldt.edu
Ryan Jenkinson, Humboldt State University
Adam Wagschal, H.T. Harvey & Associates

This project will use data collected by professional research divers to describe and assess ecological conditions within the region's nearshore rocky reefs and kelp forests. Key metrics for assessing ecological status include documenting the density of macroinvertebrates, macroalgae, and benthic fishes; the size structure and density of red abalone and red sea urchins; the percent cover of sessile and colonial invertebrates and algae, and substrate type and reef structure. Except for the abalone and urchin focused surveys, the design and protocols for sampling and collecting data follow those established by the Partnership for Interdisciplinary Studies of Coastal Oceans for long-term MPA monitoring of kelp forests. The eight sites that will be surveyed during the project include four MPAs (Pyramid Point State Marine Conservation Area (SMCA), Double Cone SMCA, Ten Mile State Marine Reserve (SMR) and Pt. Cabrillo SMR) and four reference sites. This project is a collaboration with commercial urchin divers.

Baseline Characterization of Rocky Intertidal Ecosystems
R/MPA-33; Feb. 2014 – Jan. 2017
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Andrew Kinziger, Humboldt State University
Joe Tyburczy, California Sea Grant Extension, Eureka, CA
Ivano Aiello, Moss Landing Marine Laboratories, San Jose State University Research Foundation
Peter Raimondi, UC Santa Cruz
Rosa Laucci, Smith River Rancheria

The main objective of this project is to produce a quantitative baseline characterization of the region's rocky intertidal invertebrates and algae, 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). Researchers will also provide quantitative comparisons between rocky intertidal ecosystems within four MPAs (Pyramid Point State Marine Conservation Area (SMCA), Double Cone SMCA, Ten Mile State Marine Reserve and MacKerricher SMCA) and associated reference sites. According to scientists, about 25-30 fish species (notably, marine sculpins) inhabit tide-pools in the northeast Pacific. Researchers will explore this unique ecological attribute of the North Coast by documenting fish biodiversities in these habitats. In the project's final year, scientists plan to integrate their baseline assessments of rocky intertidal ecosystems with other components of the baseline monitoring program to help inform the role and design of future MPA monitoring and evaluation. They will also analyze the newly collected data in conjunction with existing PISCO data to look for species that could be used as indicators of rocky intertidal ecosystem health. This project is a collaboration among academic scientists and North Coast tribes.

Baseline Characterization of Rocky Reefs and Kelp Forests by Reef Check California
R/MPA-34; Feb. 2014 – Jan. 2017
Jan Freiwald, Reef Check California, jfreiwald@reefcheck.org
Gregor Hodgson, Reef Check Foundation

Reef Check is a non-profit, citizen-science conservation organization that teaches and certifies experienced divers to survey species found in rocky reefs and kelp forests along California. Its volunteers have been helping with baseline monitoring of MPAs in other parts of the state and have been monitoring rocky reefs at four sites along the North Coast for six years. Recently, its survey protocols have been modified to better assist the state in cost-effectively evaluating MPA performance over time. The main goal of this project is expand and grow the existing Reef Check California program along the North Coast to enhance baseline characterizations of rocky reef and kelp forest ecosystems. Closely related to this goal is the emphasis on engaging and educating the public about the value of and need for science-based marine management. For this project, volunteers led by Reef Check California scientists will survey multiple sites inside and outside the new MPAs, documenting abundances of about 70 rocky reef indicator species. Reefs will be surveyed for two years, and in the project's third year, the data will be analyzed to characterize reef ecosystems in the study region and document any initial changes inside the MPAs. Scientists will also combine the new and existing Reef Check survey data with data from the other baseline monitoring projects to produce a more complete assessment of the status of the region's rocky reef and kelp forest ecosystems. The lead scientist also hopes to provide recommendations for improving long-term monitoring of marine ecosystems in California.

Baseline Characterization of Seabirds
R/MPA-35; Feb. 2014 – Jan. 2017
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Daniel Barton, Humboldt State University
Phil Capitolo, Institute of Marine Sciences, UC Santa Cruz
W. Breck Tyler, Institute of Marine Sciences, UC Santa Cruz
Craig Strong, Crescent Coastal Research
Daniel Robinette, Point Blue Conservation Science
Jaime Jahnke, Point Blue Conservation Science

Seabirds are the focus of this project. Scientists will quantify their numbers and locations along the North Coast, as well as their reproductive rates, diet and related interannual variance at select colonies to identify how these important marine predators are being affected by the new MPAs, human disturbance and ever-changing ocean conditions. Species of interest include the common murre, Brandt's cormorant, double-crested cormorant, pelagic cormorant, Western gull and pigeon guillemot. The project's four main objectives are to: 1) provide a region-wide census of seabird breeding populations through aerial surveys of their breeding colonies; 2) document trends in seabird breeding population sizes at two sites using existing photographs of birds taken from 1996-2013; 3) assess seabird diets and reproductive success at Castle Rock, the largest seabird colony in the region; and 4) document foraging and roosting of key seabird species, as well as incidences of breeding and roosting seabirds being disturbed by human activities. The resulting baseline characterization will serve as a foundation for assessing initial and long-term responses of seabirds to their environment and the new MPAs. The project is a collaboration among academic scientists, federal wildlife officials, citizen scientists, a private research center and an environmental consulting company.

Baseline Characterization of Human Uses and the Socioeconomic Dimensions of MPAs
R/MPA-36; Feb. 2014 – Jan. 2017
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Laurie Richmond, Humboldt State University
Cheryl Chen, Point 97
Charles Steinback, Point 97

How have commercial fishermen been affected by the new MPAs? How have the no-fishing zones shifted their fishing effort? Have their catches gone up or down and can recent trends in species targeted and their landings be attributed to the new regulations? These are among the types of questions that will be addressed in this socioeconomic study, a collaboration with local fishermen and the California Department of Fish and Wildlife. The project's main goals are to 1) establish a baseline characterization of commercial fishing patterns (where fishing is occurring) and related socioeconomic descriptions, and 2) assess where fishermen were fishing before and after the MPAs went into effect in 2012 and related socioeconomic implications of these shifts in fishing effort and resulting catches. The data for this analysis will come from logbook and landings records, as well as from responses of fishermen interviewed for the study. Among the outcomes from this project will be "heat maps" showing coastal areas of high importance to commercial fishermen before and after the MPAs' implementation. The lead scientist and fishermen will also look to develop recommendations for long-term socioeconomic monitoring. Results of this study will provide a better understanding of the status of the region's fishing communities against which future MPA impacts and benefits can be measured.

Baseline Characterization of Nearshore Fish Communities Associated with Rocky Reef Habitats
R/MPA-37; Feb. 2014 – Jan. 2017
Timothy Mulligan, Humboldt State University, tjm2@humboldt.edu
Dave Hankin, Humboldt State University
Joe Tyburczy, California Sea Grant Extension
Drew Barrett, Humboldt State University

In this collaborative fisheries research project, scientists will partner with charter boat fishing captains and volunteer anglers to characterize the baseline status of nearshore rocky reef fish assemblages in four of the region's MPAs (Pyramid Point State Marine Conservation Area, South Cape Mendocino State Marine Reserve (SMR), Sea Lion Gulch SMR and Ten Mile SMR) and reference sites. This quantitative baseline data will describe the diversity, abundance, size structure and movement patterns of rocky reef fishes caught inside and outside of MPAs. The project will geographically expand upon an existing 2-year (2010-2011) data set on North Coast rocky reef fishes, enabling comparisons of fish communities before and after the MPAs went into effect in 2012. Unlike the earlier volunteer angler fish surveys, fish that are caught will be tagged and released at depth to enable studies of fish movement patterns across MPA boundaries. Researchers hope that by engaging local fishing communities in the research, they may establish a foundation for long-term collaborative monitoring and community involvement in marine resource management. Data from this project will complement other datasets collected by the other baseline monitoring projects to help evaluate placement, monitoring and overall effectiveness of the region's MPAs.

Baseline Characterization of Sandy Beach and Surf-Zone Ecosystems
R/MPA-38 Feb. 2014- Jan. 2017
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Timothy Mulligan, Humboldt State University
Jenifer Dugan, Marine Science Institute, UC Santa Cruz
Rosa Laucci, Smith River Rancheria

The goal of this project is to provide the first comprehensive baseline characterization of the region's sandy beach and adjacent surf-zone ecosystems. This characterization will be based on multiple surveys of sites within and outside of the newly established MPAs. Beach surveys will focus on documenting the biological diversity of intertidal invertebrates, including sand crabs and talitrid amphipods (sandhoppers) that are eaten by shorebirds and surf-zone fishes. Scientists will count numbers and kinds of birds and document the presence of wrack (piles of seaweed that wash up on the shore, providing food and habitat for many beach invertebrates). Human activities will also be recorded at the study beaches. The surf-zone surveys will focus on estimating abundances of surf-zone fishes, including night smelt and surfperch, both of which are important for recreational and commercial beach fishermen and for tribal traditional and subsistence activities. A limited number of fishes caught at the reference sites will be dissected to document their reproductive condition and stomach contents, from which diet is inferred. In the last year of the project, researchers will perform data analyses to identify key trophic links among beach and surf-zone organisms within the context of the North Coast's physical setting. This will provide the foundation for an evaluation of the baseline ecological status and functioning of the region's sandy-beach and surf-zone ecosystems. They also hope to identify candidate "indicator" species that could be used for long-term monitoring of sandy beach and surf-zone ecosystem health. This project is a collaboration among academic scientists, North Coast tribes, commercial and recreational fishermen and citizen scientists.

Traditional Ecological Knowledge of Keystone Marine Species and Ecosystems
R/MPA-39; Feb. 2014 – Jan. 2017
Megan Rocha, Smith River Rancheria, megan.m.rocha@gmail.com
Hawk Rosales, InterTribal Sinkyone Wilderness Council
Rachel Sundberg, Cher-Ae Heights Indian Community of the Trinidad Rancheria
Thomas Torma, Wiyot Tribe

Traditional ecological knowledge (TEK) can be defined as the cumulative body of scientific knowledge, passed through cultural transmission by indigenous people over many generations. TEK is what informs customary management of natural resources by indigenous people, and it can be a highly credible means of understanding ecological features and species, and identifying areas of concern and related threats. The main goal of this project is to draw on tribal knowledge to enhance the baseline characterizations of six species that are both ecologically and culturally important within the beach, intertidal, kelp and mid-depth rock ecosystems. To acquire this information, the lead scientist will review archival ethnographies and interview members of participating tribes who are culturally knowledgeable and/or active harvesters. Interviewees will be queried about their perceptions and knowledge of ecosystems and keystone species (such as sea lettuce, clams, abalone and mussels) that may be indicators of MPA performance. They will also be asked about their perceptions of the new "tribal take" state regulations. Interviews will include short, map-based interviews with focus groups and long, oral history interviews. Data collection will occur during the first two years of the project. In the project's final year, the team will collaborate with marine consultants at Point 97 in Portland, Ore. to develop a data survey tool and perform data analyses. This project's approach seeks to recognize and support the

political and cultural sovereignty of each participating tribe and its community's intellectual property, while maintaining consistency in the research methodology and data collection across the region. This project is being led by Smith River Rancheria in partnership with the Intertribal Sinkyone Wilderness Council, a consortium of ten federally recognized tribes, the Cher-Ae Heights Indian Community of the Trinidad Rancheria and the Wiyot Tribe.

Baseline Characterization of Estuarine Ecosystems
R/MPA-40; Feb. 2014 – Jan. 2017
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Timothy Mulligan, Humboldt State University
John Largier, Bodega Marine Laboratory, UC Davis
Adam Wagschal, H.T. Harvey & Associates
Stephen Kullmann, Wiyot Tribe

The North Coast has 16 major estuaries that support a wide diversity of plant and animal life, including salmon and other commercially important species. The focus of this project is to describe and evaluate the ecological status of representative and under-studied estuaries in the region by surveying plants, invertebrates and fishes in tidal mudflats and eelgrass beds of four estuaries – three within MPAs (Humboldt Bay, Big River and Ten Mile River) and the Mad River Estuary. Field surveys will be conducted multiple times a year for two years to better document seasonal and interannual variability in species abundances and diversity, as well as changes in the sizes of focal species, such as bivalves, eelgrass, and black rockfish, among others. Estuarine ecosystems are largely driven by a complex set of interacting physical variables, including freshwater flows, seasonal closures of lagoon mouths and ocean water properties related to winds and upwelling. Information about these "abiotic" variables will be distilled to describe the "contextual conditions" in each estuary. During the analysis phase of their project, scientists will identify baseline and contextual metrics that might allow for future evaluation of MPA performance. This project is a collaboration among academic scientists, North Coast tribes, and ecological consultants.

Baseline Characterization and Monitoring of the MPAs along the North Coast: ROV Surveys of the Subtidal
R/MPA-41; Feb. 2014 – Jan. 2017
Andrew Lauermann, Marine Applied Research & Exploration, andy@maregroup.org
Richard Starr, Moss Landing Marine Laboratories
Dirk Rosen, Marine Applied Research & Exploration

Researchers will use a remotely operated vehicle (ROV) to capture video and still images of seafloor communities from 20- to 500-meters depth along the North Coast, with an emphasis on characterizing species and habitat features within mid-depth rock, soft-bottom subtidal and deep ecosystems. These ecosystems sustain some of the state's vibrant commercial and recreational fisheries. The images collected along these "visual strip transects" will be used to identify and count fishes and macroinvertebrates and document physical features of the seafloor. They will also provide a permanent archival record of sea floor communities that can be used for a variety of purposes, in addition to baseline analyses, such as public education or future reanalysis using refined techniques. Follow this project on Twitter!

South Coast MPA Baseline Program

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 2014 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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Gregor Hodgson, Reef Check Foundation, 310.230.2371, ghodgson@reefcheck.org

Volunteers are core to this project, but these are not just any volunteers. All are skilled divers who have been trained and certified through the non-profit Reef Check program to conduct scientific surveys of rocky reef and kelp forest ecosystems. This unusual citizen-science monitoring program has been collecting data in California since 2006, and for the baseline monitoring project is being tailored to document and compare ecosystems inside and outside the new MPAs. In the project's first two years, divers completed 105 surveys in the study region and are on track to complete all proposed surveys. Each survey consists 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 scientists have also trained or re-certified more than 250 divers each year state-wide, creating invaluable human capital for continued MPA monitoring and support for marine conservation. In August of 2013, Reef Check released a report documenting dramatic declines in fish populations along the California coast since the 1970s. The report indicates "several species have started to recover in California's marine reserves such as Lover's Point State Marine Reserve in Monterey Bay. At other sites, the recovery is still in progress." (Click here to download a complete copy of the "Status of Rocky Reef Ecosystems in California 2006-2011.") Reef Check's monitoring data for the South Coast study region is available online through Reef Check's public Nearshore Ecosystem Database and is also being converted into a format consist with other monitoring data collected through the MPA Baseline Monitoring Program.

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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Jayson Smith, Cal State University, Fullerton, 657.278.4233, jasmith@fullerton.edu
Julie Bursek, NOAA/Channel Islands National Marine Sanctuary, 805.382.6141, julie.bursek@noaa.gov

Tide pools and other rocky-intertidal habitats are the focus of this project. These habitats are being described and compared inside and outside the South Coast MPAs based on invertebrate and algal biodiversity surveys and counts of target species. The survey methods replicate those developed for the West Coast by scientists with the Multi-agency Rocky Intertidal Network (MARINe). In the project's first year, scientists completed baseline biodiversity surveys and target-species sampling at 22 sites. Target-species sampling was continued at these sites during the project's second year. In the project's final year, researchers will analyze, document and describe the patterns, statuses and trends of rocky intertidal ecosystems and species along the South Coast. Additionally, researchers will co-host a workshop with staff from the LiMPETS program to train teachers on the baseline research and revised protocols for characterizing abundances of key species over time. Details on the protocols for the biodiversity and target-species surveys are available at the Pacific Rocky Intertidal Monitoring: Trends and Synthesis website at the University of California, Santa Cruz.

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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Carol Blanchette, UC Santa Barbara, 805.893.5144, blanchette@msi.ucsb.edu

The purpose of this project is to coordinate the compilation of data from the nine other South Coast baseline projects into a standardized format that can be easily shared with other researchers for integrated ecosystem studies. The researchers are also administering the other monitoring projects to help coordinate field activities (for example, by co-locating field sites) and encourage collaborations when practical. Administrative duties have included organizing and hosting two data analysis workshops for the other investigators. Since many of the baseline monitoring projects are still in the data-collection phase, the researchers won't likely begin their data compilation and analyses until 2014.

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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Sandy beach ecosystems are the focus of this baseline monitoring study. Metrics for assessing beach ecosystem function and health include: 1) kelp-wrack coverage and composition; 2) marine bird, pinniped and macroinvertebrate abundances and 3) population abundances, biomasses and sizes of target species, including sand crabs, Pismo clams, talitrid amphipods and wrack-associated invertebrates. Human activities at the beach are being documented, and scientists are partnering with citizen-science nonprofits to develop and test protocols for training volunteers to help collect long-term beach monitoring information. In addition to the survey work, researchers are studying the ecological importance of beaches to other coastal and nearshore ecosystems, and in 2013 published findings suggesting that two tiny burrowing crustaceans closely related to the roly poly have, in the last century, vanished from most beaches in the South Coast study region. Scientists said the trend is alarming because these animals are considered indicators of beach ecosystem health. In the project's final year, researchers will complete monthly surveys of South Coast study beaches, analyze their data and conduct a joint workshop for teachers on refining LiMPETS protocols for sandy beaches.

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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Ed Parnell, UC San Diego/Scripps Institution of Oceanography,
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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 tagged and recaptured 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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Dirk Rosen, Marine Applied Research & Exploration, 510.232.1541, dirk@maregroup.org

Researchers are using a remotely operated vehicle to capture video and still images of life in deep-water habitats, including submarine canyons. From the images, they are documenting the numbers and kinds of fishes and larger invertebrates and their association with bottom features. 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 the project's second year, the original three sites were resurveyed along with three new sites off San Clemente Island, with support from the US Navy. The final baseline characterization to be prepared in the project's final year 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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Jennifer Caselle, UC Santa Barbara, 805.893.5144, caselle@msi.ucsb.edu

The goal of this project is to produce a baseline characterization of kelp and shallow (less than 30-meters depth) ecosystems inside and outside the South Coast MPAs 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, used for baseline monitoring of the Central Coast and North Central Coast MPAs. Researchers surveyed 119 sites in 2011 and 117 sites in 2012, and are currently processing and analyzing these data.

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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Jaime Jahncke, Point Blue Conservation Science, 707.781.2555, ext. 335, jjahncke@prbo.org

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. They are compiling and analyzing existing records of seabird populations prior to the establishment of the South Coast MPAs and conducting new bird surveys at key sites. In the project's first two years,

scientists monitored seabird breeding colonies, roosting 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 a result, scientists will be looking for evidence that the new regulations are reducing seabird behaviors like nest abandonment that indicate disturbance. During the 2012 field surveys, researchers observed high mortalities of least tern chicks. Fecal samples suggest the reproductive failure was caused by a lack of 1-year-old Northern anchovy and young rockfishes near the bird's breeding colonies. The scientists report that 2013 appears to be a mixed year for least tern chicks, with some colonies doing better than others. Analyses of least tern fecal pellets and other seabird monitoring data will be conducted this fall and next year. 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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Charles S. Steinback, Ecotrust Fisheries, 503.467.0758, charles@ecotrust.org

People are the focus of this baseline-monitoring project. In particular, social scientists leading this project are documenting human behavior at the coast. They will observe what, where and how often, and how much people spend for three sectors of the ocean economy: (1) private recreation, which includes activities such clamming, beach walking, diving, photography, surfing and birding; (2) commercial fishing, and (3) commercial passenger fishing vessels (aka "party boats") that may take people out fishing or whale watching. The core outcome of the project will be a series of standardized, fully documented, and quantitative socioeconomic data sets and maps. These will be used to establish an initial snapshot of human-use "indicators" for the South Coast MPAs and to assess initial changes in how people enjoy the water and commercially fish along the coast. 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
Jan Svejkovsky, Ocean Imaging, 858.792.8529, jan@oceani.com

Scientists with San Diego-based Ocean Imaging Corp. are mapping intertidal and, to a lesser extent, subtidal habitats in the South Coast study region, using multi-spectral images collected in the red, green, blue and near infrared bands. These imaging data are being combined with bathymetric maps, produced using LiDAR data collected by Fugro EarthData for a California Coastal Conservancy-funded project. The result is the ability to map sandy beaches, surf-grass meadows, kelp canopies, algae-covered rocks and bare-rock habitats at 1-meter resolutions. In the project's final year, raw image data files (calibrated and mosaicked) and GIS-compatible substrate classification files, among other metadata packages, will be made publicly available the MPA Monitoring Enterprise's data server and on DVD.

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 2014 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-Aug. 2014
Christopher Costello, UCSB, 805.893.5802, costello@bren.ucsb.edu
Steven Gaines, UCSB, 805.893.7363, gaines@bren.ucsb.edu

In 2011, the Pacific Fisheries Management Council and NOAA Fisheries established a West Coast groundfish catch-shares program to help rebuild vulnerable stocks within the complex of groundfish species caught by trawlers. This project is examining the social and economic consequences of the new management system. In work to date, scientists have compiled an extensive database of trawl activity in the fishery. This database will be used to document changes in groundfish landings, bycatch, fleet size and ex-vessel prices of catches since 2011. A bioeconomic model has also been developed to explore the pros and cons of no-take marine reserves vs. catch shares in rebuilding depleted groundfish stocks. One of the hoped-for advantages of catch shares management is to incentivize market-based, industry-led solutions to the fishery's bycatch problem. Yet another goal of this project is to evaluate whether one such emerging solution - the formation of risk pools, in which members pool their quotas of weak-stock species - is working as intended. In particular, researchers will examine whether risk pool members are more likely to catch their full quotas of healthy stocks and less likely to have high rates of bycatch than other fishery participants. Initial findings from this project will be shared with fishermen, managers and regulators at a workshop this spring.

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

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. 2015
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Lia Protopapadakis, Santa Monica Bay Restoration, 310.216.9826, lprotopapadakis@santamonicabay.org

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.

Scaling Up Cost-Effective Community Engagement in Coastal Resource Management
R/SOC-04 Feb. 2014- Jan. 2016
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Shawn Rowe, Oregon Sea Grant, 541.867.0190, shawn.rowe@oregonstate.edu
Heidi Ballard, UC-Davis, 530.754.6255, hballard@ucdavis.edu

Citizen science offers unique opportunities to build public engagement, community capacity, and relevance for science, while addressing major environmental and resource issues in timely, cost-efficient fashion. Effective programs enhance science learning, long-term public involvement, and the knowledge needed to collect accurate data. This project will gauge the essential elements of a rigorous, successful coastal citizen science program quantitatively and qualitatively, using individual demographics, organizational, community, and regional predictors, and focus group evaluations. Its focus will be COASST, a coastal observation and seabird survey team that operates along the West Coast and into Alaska.

The Environmental and Economic Impacts of Moorage Marinas on the West Coast
R/SOC-05 Feb. 2014- Jan. 2016
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James Moore, University of Southern California, 213.740.0595, jmoore@usc.edu

Recreational marinas are growing rapidly on the West Coast but fall outside usual planning, economic, and environmental research disciplines. This interdisciplinary study will calculate the net economic impacts of moorage marinas in Southern California and Western Washington and investigate environmental externalities. It will use GIS to correlate marina locations and NOAA Mussel Watch data on pollution and other impacts back to 1986. The economic and environmental impacts will then be compared for baseline and alternative scenarios, helping regulators and coastal communities develop smart, well-informed marina policies.

Collaborative Fisheries Research West

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
Richard Starr, Moss Landing Marine Laboratories, 831.771.4442, starr@mlml.calstate.edu
Susan Sogard, UC Santa Cruz, 831.420.3932, susan.sogard@noaa.gov

Large swaths of the seafloor off the U.S. West Coast have been closed to fishing for bottom fishes —to rebuild overfished stocks, such as bocaccio, canary rockfish, cowcod and dark-blotched rockfish. This project will assess how fish populations within Rockfish Conservation Areas (RCAs) off Central California have responded since the closures went into effect in 2002. Teams of volunteer anglers are key to the project, as they are boarding charted passenger sport fishing vessels to help scientists conduct repeat hook-and-line surveys of four sites—two within the RCAs and two outside them. On these rigorously 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 Wildlife 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. The scientists will be analyzing data in the coming months and plan to have some results in early 2014.

Integrating Collaborative Data Collection with Management: A Lobster Fishery Test Case
R/OPCCFRW-2; Jul. 2012–Jun. 2014
Carolynn Culver, CA Sea Grant Extension, 805.893.4530, cculver@ucsd.edu
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Caroline Pomeroy, CA Sea Grant Extension, 831.459.4173, cpomeroy@ucsd.edu

Could commercial lobster-trap fishermen help gather and interpret data for long-term, cost-effective fisheries management? This project addresses this question, building on an at-sea sampling program for the southern rock crab fishery that was developed by the project's lead scientists. During the CFR West project's first year, fishermen, scientists and managers worked together to develop and test protocols for collecting different types of data. They are also determining how to integrate those protocols with different kinds of commercial lobster fishing operations. In August 2013, the scientists reported that they were in the process of analyzing data collected during the previous fishing season (2012-13) to identify the types of data most needed for management (i.e., data that varies among fishing locations) and an associated sampling regime for the upcoming 2013-2014 lobster season that ensures scientific rigor while minimizing impacts on the program's fishing partners. In addition, fishermen, scientists and managers involved in the project have been discussing ideas for storing and sharing data, and for continuing the program into the future. To help identify some options, the lead scientists have been gathering information on other similar fishermen-based data collection programs. Ultimately, the group will hold a workshop to share results and evaluate the program's long-term feasibility.

Mortality and Population Abundance of Three Species of *Paralabrax* off San Diego, California
R/OPCCFRW-3; Jul. 2012–Jun. 2014
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In this project, anglers are catching, tagging and releasing calico bass and barred sand bass 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, they are recording fish sizes, the gears used to catch fishes and evidence of pressure-induced injuries (barotrauma). Samples of bass are also being put in pens and observed to estimate mortality rates from catch-and-release practices. Private boat owners are helping researchers catch, tag and release spotted bay bass, which reside in bays. 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 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. As of August of 2013, volunteer anglers and researchers had tagged more than 8,500 bass from Imperial Beach north to Long Beach. The scientists also deployed the acoustic hydrophone array. Some of the project's preliminary results suggest that all three bass species are likely to survive catch-and-release and that recaptured fish have relatively small home ranges (i.e., limited movements), with some exceptions. A few barred sand bass tagged in San Diego Bay, for example, were subsequently recaptured off the Tijuana Flats, and one tagged kelp bass traveled from La Jolla to San Clemente in southern Orange County. Scientists say that the continued accumulation of tagging and tracking data will provide highly

valuable information for models of marine bass movement, mortality, and stock abundance. Some of the team's outreach activities, to date, have included hosting booths at the annual Fred Hall Fishing and Boat shows, giving talks to local fishing clubs and making themselves readily available to various media outlets.

Targeting Swordfish Deep During the Day to Reduce Bycatch
R/OPCCFRW-4; Oct. 2012–Sep. 2014
Chugey Sepulveda, Pfleger Institute of Environmental Research,
760.721.1404, chugey@pier.org
Heidi Dewar, NOAA/National Marine Fisheries Service, 858.546.7023, Heidi.Dewar@noaa.gov

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 are 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. In 2012-2013, PIER scientists tagged 10 swordfish within the Pacific Leatherback Closure Area, established to protect the critical habitat of migrating leatherback sea turtles. The tracking data is being used to characterize swordfish habitat and tailor the trial deep-set operations. The NOAA Fisheries team meanwhile has been conducting field trials of the deep-set long-lines and in 2012 made 17 deployments in waters off Central and Southern California, with hooks set at an average depth of 235 meters. With this configuration, researchers caught a range of marketable species, including one swordfish, 37 opah and two albacore tuna. Bycatch was dominated by blue sharks. There were no sea turtle or marine mammal interactions. The coming year's fieldwork will focus on figuring out why so few swordfish were caught and whether different strategies might increase swordfish catches, while still minimizing sea turtle interactions.

Collaborative Fisheries Research West Mini Grants

This program provided funding up to $25,000 for short, focused research or proof-of-concept projects. The results must be applicable to fisheries science or management.

Collaborative Fisheries Research to Build Socioeconomic Essential Fishery Information: A Test Case
R/OPCCFRW-7MG; Apr. 2013–Mar. 2014
Caroline Pomeroy, CA Sea Grant Extension, 831-459-4173, cpomeroy@ucsd.edu
Monica Galligan, Cal State University, San Marcos, 831-582-4743, mgalligan@csumb.edu
Paul Reilly, CA Department of Fish & Wildlife, 831-649-2879, preilly@dfg.ca.gov
Carolynn Culver, CA Sea Grant Extension, 805-893-4530, cculver@ucsd.edu

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.

Testing the Feasibility of Urban Coastal Direct Seafood Markets
R/OPCCFRW-8MG; Jul. 2013 – Jun. 2014
Theresa Sinicrope Talley, CA Sea Grant Extension, 858.200.6975, tstalley@ucsd.edu
Adina Batnitzky University of San Diego, abatnitzky@gmail.com

The goal of this project is to facilitate a diverse and local sustainable fishing industry by raising public awareness of the benefits and value of supporting locally caught and grown fish and shellfish. The scientists will meet this goal "using an inductive approach by leveraging San Diego's ethnic diversity and desire for healthier diets, and the Port of San Diego s collaborative plan for two direct seafood markets." The project has four main objectives: to 1) determine public demand for local product and the ability of fishers and growers to supply consumers with products they will purchase, 2) identify and address limitations to the public consuming more seafood, 3) raise public awareness of the local fishing industry and diversity of its products and 4) identify species of emerging public interest to facilitate the development of management strategies before demand increases. On September 2, 2013, the scientists and their many collaborators hosted a seafood tasting, survey and outreach event at San Diego Bay. At the highly successful event, about 200 participants voted on their likelihood of buying species they had just sampled in expertly prepared dishes and they took a 30-minute survey on their knowledge and interest in local seafood. There was also public information on seafood nutrition, and separate morning and afternoon events to better reach key audiences, namely East African American women and urban seafood consumers likely to support the locavore movement. Analyses of the survey results are ongoing. In the coming months, scientists will hold workshops aimed at San Diego's fishermen and aquaculturists and San Diego consumer groups, and will follow up with each of the groups surveyed.

Cooperative Tagging and Tracking of Yellowtail to Assess Recruitment and Residency in the Southern California Bight
R/OPCCFRW-9MG; Jul. 2013 – Dec. 2014
Stuart Sandin, UC San Diego/Scripps Institution of Oceanography, 858-534-4150, ssandin@ucsd.edu
Noah Ben-Adereta, UC San Diego/Scripps Institution of Oceanography, 858-248-0884, nbenader@ucsd.edu

Yellowtail are a highly sought after trophy fish, whose basic life history characteristics are poorly understood. To enable sustainable, long-term management of the popular sport fishery, this project seeks to gather quantitative movement pattern data on this economically important species', with an emphasis on its movements around several of the region's new marine protected areas. The tagging and tracking data that will be gathered in this project collaboratively with anglers will focus on two main questions: 1) whether there is a resident year-round "home guard" yellowtail population in San Diego, and 2) whether these fish are successfully spawning locally. The data will help researchers interpret spatial patterns of catch inferred from historical angler catch records and provide a robust dataset for future management decisions. In addition, the project's findings will set a precedent for the study of movements and interactions of highly mobile species within California's new marine reserves. Read the California Sea Grant news release here.

Developing an Index of Abundance for Pacific Sardine in California
R/OPCCFRW-10MG; Jul. 2013 – Jun. 2014
Diane Pleschner-Steele, California Wetfish Producer's Association, diane@californiawetfish.org
Kirk Lynn, California Department of Fish and Wildlife, Kirk.Lynn@wildlife.ca.gov

New aerial surveys of sardines off Southern California will address fishermen's concerns that sardine abundance estimates are effectively "missing California fish," as this project will help pay for two spotter-pilot surveys of the iconic silver fish. The first survey was flown in the summer of 2013 and the second will occur in the spring of 2014. The project's leaders hope to use digitally enhanced photos of fish schools taken during the flights to develop a scientifically rigorous method for calculating sardine abundances. If this can be done, they will ask the Pacific Fishery Management Council, which manages the Pacific sardine fishery with NOAA Fisheries, to consider including California aerial survey data into its future stock assessments, from which harvesting limits are set. In addition to the aerial surveys, Lynn and staff will be conducting some "chaser boat" sampling of fish schools spotted by plane – to verify that the species they think they have spotted has been correctly identified. Besides looking at sardines, the group has a secondary interest in documenting anchovy abundances.

Crowd Sourcing Essential Fishery Information for California halibut
R/OPCCFRW-11MG; Aug. 2013 – Sept. 2014
Lia Protopapadakis, Santa Monica Bay Restoration Foundation,
310.216.9826, LProtopapadakis@santamonicabay.org
Steve Santen and Bob Godfrey, Marina Del Rey Anglers
Kim Penttila, California Department of Fish and Wildlife

The goal of this project is to collect Essential Fishery Information from sport-caught California halibut (*Paralichthys californicus*). This data will contribute to improved sex-specific growth curves for the species and will aid in estimating sex-specific gear selectivity. The team will work directly with recreational fishermen and will charter a commercial passenger fishing vessel to gather additional data. Using a newly-developed, non-lethal method for determining the gender of a landed halibut, collaborators will also measure and weigh sub-legal fish. Legal-sized fish will also be measured and their otoliths (bone-like ear structures) will be collected to estimate their ages. Building on this work, the team plans to develop a citizen-science program using a web-based reporting platform for Santa Monica Bay and eventually throughout the species' range in California.

Setting the Stage for Community-Based, Fishermen-Led Lost Crab Fishing Gear Recovery
R/OPCCFRW-12MG; Aug. 2013 – Dec. 2013
Kirsten Gilardi, UC Davis Wildlife Health Center, 530.752.4896, kvgilardi@ucdavis.edu
Jennifer Renzullo, UC Davis Wildlife Health Center, 707.483.8480, jrrenzullo@ucdavis.edu
David Bitts, Humboldt Fishermen's Marketing Association, dbitts@suddenlink.net

Dungeness crab fishing grounds from Crescent City to Morro Bay may be littered with thousands of lost crab pots. These pots are not "derelict (abandoned) gear." Fishermen do not want to lose a $200 crab trap; however, the North Coast is a rough coastline with huge winter swells that can roll and tumble pots along the seabed. Most of these pots are in 200 to 600 feet of water, and if their rot-cords fail, they may continue to "ghostfish" for crab and other species. Pots attached to long buoy lines may entangle whales and dolphins. The California Lost Fishing Gear Recovery Project encourages people to report lost gear, and then hires experienced commercial SCUBA divers to remove it. More recently, scientists have been working with crab fishermen in Eureka to develop a local fisherman-led gear removal program. This project seeks to expand this program to the entire North Coast. The objective will be to reaffirm and grow industry support for a community-based, fishermen-led crab gear recovery effort. The team will also explore a variety of strategies for achieving financial self-sustainability for lost crab gear recovery. By the project's end, the California Lost Fishing Gear Recovery Project plans to be well-positioned to support North Coast crab fishermen in their efforts.

Collaborative Research on Night Smelt
R/OPCCFRW-13MG; Feb. 2014 – Dec. 2014
Drew Barrett, HSU, drew_bar@msn.com
Adam Wagschal, H.T. Harvey & Associates
Mike Zamboni, Commercial Fisherman

The specific objectives of this research project are to form a collaboration between commercial fishermen, resource managers, and marine fisheries ecologists, to: 1) document locations of spawning events and characterize spawning habitat, 2) gather basic life history information on the spawning population of night smelt including measurements of sex, age, length, weight, and 3) examine bycatch in the commercial night smelt fishery landings. The commercial night smelt harvest typically occurs between January and August.

Delta Science Fellows Program

Beginning in 2003, the Delta Science Fellows Program (previously known as the CALFED Science Fellows Program) has paired graduate students and postdoctoral researchers with Bay-Delta agency scientists and senior research mentors. Fellows work on collaborative data analysis and research projects applicable to the California Bay-Delta system under the mentorship of both agency and academic scientists. The program's goals are to invest in knowledge that will fundamentally advance the understanding of the complex environments and systems within the Bay-Delta system, to aid policy-makers and managers, and to train the next generation of research scientists for water issues in California. The funded projects for 2014 are listed below.

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

Imagine farmers growing crops not for food but to sequester carbon dioxide. Under the state's cap-and-trade program, such scenarios are possible, though there are many details to hash out – not the least of which is putting hard numbers to the carbon-credit value of different types of vegetation. In research that may help in this effort, the Delta Science Fellow is attempting to develop a method for calculating vegetative cover ("leaf area index") in key wetlands of the Sacramento-San Joaquin River Delta, using NASA Landsat satellite images. Her work to date has focused on collecting fish-eye images of plant communities at freshwater marshes on Twitchell Island and Sherman Island and tidal marshes at Suisun Marsh. From these photos and light-intensity readings, which are also recorded, she is able to calculate local estimates of leaf area index. In the coming year, these estimates of leaf area index will be compared to Landsat's spectral-based estimates for the same areas, to establish, or look for, a consistent relationship between the two estimation methods. If this can be done, scientists will be able to use the Landsat images to reconstruct vegetative cover and density over a 30-year period for the entire delta. This reconstruction will facilitate an ongoing NASA-funded study to quantify net carbon fluxes in wetlands in the delta. Other applications of the project include being able to better monitor trends in wetland bird habitat quality and recovery trajectories for various habitat restoration projects.

Research mentor: Peng Gong, Department of Environmental Science, Policy, and Management, UC Berkeley
Community mentor: Kristin Byrd, USGS Western Geographic Science Center

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

Has habitat loss altered the base of the food web in the Sacramento-San Joaquin River Delta? This project seeks to test the hypothesis that the primary source of carbon (energy) at the base of the food web has shifted from plant detritus to phytoplankton, as wetlands and their marsh plants have been destroyed. As a result, the food chain has become structured around pelagic food web dynamics and is yet one more symptom of ecosystem degradation. To investigate these ideas, the Delta

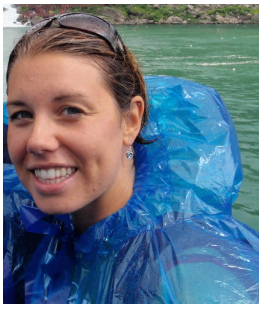
Science Fellow is using stable isotope and fatty acid biomarkers to: 1) identify the origin, transport and fate of organic debris in the delta and Suisun Bay, and 2) investigate the role of this debris in supporting key invertebrate prey organisms in tidal marshes and other shallow-water ecosystems. Ultimately, she would like to evaluate implications of freshwater discharges on these processes and investigate the connection between marsh ecosystems and aquatic food webs. Findings will be of relevance to wetland restoration planning.

Research mentor: Charles Simenstad, School of Aquatic and Fisheries Sciences, College of Ocean and Fishery Sciences, University of Washington
Community mentor: Robin Steward, USGS, Menlo Park

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

This project seeks to identify salinity tolerances of two state protected fish species – longfin smelt and delta smelt. To date, experiments have focused on newly hatched and post-45-day-old smelt. This preliminary work shows that both smelt species are able to survive and grow in salty waters. In coming months, the Delta Science Fellow will conduct experiments on adult delta smelt. These experiments will look at how changes in water salinity, associated with natural fish movement patterns in the estuary, might affect the delta smelt's physiology. Yet, another component of this project is to identify biomarkers for both species, through fluorescent staining of gill cells. These biomarkers will let scientists and managers monitor species' exposures to different water salinities. Results from this project may further what is known about the species' life history requirements, particularly the timing and speed at which smelt can transition from fresh to saline conditions.

Research mentor: Swee Teh, Department of Anatomy, Physiology, and Cell Biology, School of Veterinary Medicine, UC Davis
Community mentor: Randall Baxter, California Department of Fish & Wildlife, Stockton



Understanding the Impacts of Climate Change on Delta Smelt
R/SF-56; Sep. 2012–Aug. 2015
Lisa Komoroske, UCD, 716.912.4656, lmkomoroske@ucdavis.edu

Climate change is expected to increase both water temperatures and salinities in the delta. This project examines potential consequences of climate change to the endangered delta smelt at multiple biological scales. In the project's first year, laboratory experiments were conducted to determine the species' thermal and salinity tolerances and physiological responses to warm and salty waters. The Delta Science Fellow has developed a microarray for the delta smelt's "transcriptome," the small percent of the genome that is involved in making proteins. This lab-on-a-chip will be used to document normal levels of gene expression and how they change as water temperatures and salinities approach tolerance thresholds. 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.

Research mentor: Nann A. Fangue, Wildlife, Fish and Conservation Biology, UC Davis
Community mentor: Gonzalo Castillo, U.S. Fish & Wildlife Service

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 net sources or sinks of greenhouse gasses? Could certain restoration strategies alter carbon loading? This project explores emissions scenarios for two large restored wetlands in the San Francisco Bay-Delta—one on Sherman Island, the other on Twitchell Island. The main goals are to quantify methane releases from wetland soils and, using isotopic methods, to investigate the effects of marshland plants on methane flux dynamics. In the project's first year, scientists surveyed soil methane production at the two restored sites and at a natural wetland called Sherman Lake on Sherman Island. Rates of methane and carbon dioxide production were found to be high across all sites, suggesting that the age of a wetland does not predict methane emissions. At the scale of microbes, redox chemistry seems to partially regulate the relative amounts of carbon lost as carbon dioxide vs. methane. This suggests that wetland restoration projects could potentially be modified to reduce methane emissions. In the summer of 2013, scientists began a second phase of fieldwork. They are capturing "time-stamped" methane bubbles in Mayberry wetland. These data will enable scientists to correlate gas releases to environmental factors. In the coming year, the Delta Science Fellow will measure the radiocarbon age of methane emitted from wetlands to distinguish the relative contributions of methane from new plant material vs. methane from decomposing peat soil layers, which restoration may stabilize.

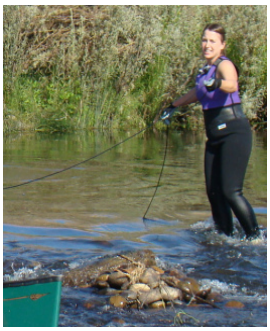
Research mentor: Whendee Silver, Department of Environmental Science, Policy and Management, UC Berkeley
Community mentor: Belinda Morris, California Director, American Carbon Registry

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

This project explores the impact of non-native species on native, resident fish populations. The emphasis is on documenting the effects of non-native species on predator-prey relationships, food availability and habitat quality. In the project's first year, the Delta Science Fellow explored trends in fish populations, for species such as Sacramento blackfish and tule perch. He is now comparing what native and non-native fishes, with presumably similar roles in the ecosystem, consume and how they utilize habitat. The goal is to better understand how native and non-native fishes might respond to various restoration options and the degree to which declines in native, resident fish species might be due to competition with invasive species for food and habitat. Findings will provide greater insight into the factors that are most critical to rebuilding or sustaining native resident fishes.

Research mentor: Peter Moyle, Wildlife, Fish and Conservation Biology, and Center for

Watershed Sciences, UC Davis
Community mentor: Fred Feyrer, Bay-Delta Office, US Bureau of Reclamation, Sacramento



How Hydrologic and Geomorphological Processes in Gravel-Bed Rivers Sustain Chinook Salmon Spawning Habitat During Managed Flow Regimes
R/SF-59; Nov. 2013 – Oct. 2015
Erin Bray, post-doctoral researcher, UC Santa Barbara and UC Berkeley, ebray@bren.ucsb.edu, 805.618.8851

Chinook salmon begin and end their lives in the gravel-bottomed upland reaches of rivers, and it is believed that suitable habitat for salmon eggs occurs along stretches of gravel with good groundwater and surface-water exchange. A main goal of this project is to figure out how to predict the locations of where this exchange occurs. To do this, the fellow will study the effects of stream-flow releases and sediment characteristics on flows between river channels and groundwater aquifers. Among the questions that will be addressed in the projects early stages are: How does the geometry of gravel bars vary between natural, flow-altered and engineered gravel bars? What are the hydrologic implications of the observed geometry of gravel bars? And, what is the form and function of bend-bar morphology in terms of infiltration and seepage patterns, as it relates to suitable salmon spawning habitat? Findings are of relevance to identifying ways to restore spawning habitat for Chinook salmon through actions, such as gravel augmentation and altered managed flows.

Research mentor: Thomas Dunne, UC Santa Barbara
Community mentor: Erin Rice, U.S. Bureau of Reclamation

Using Genomics to Explore the Physiological Effects of Elevated Water Temperature on Bay-Delta Fish
R/SF-60; Sept. 2013 - Aug. 2015
Kenneth Jeffries, post-doctoral researcher, UCDavis, kenmjeffries@gmail.com, 530.752.4680

Scientists expect that climate change will increase San Francisco Bay's water temperatures, potentially degrading habitat for species with preferences for cooler conditions. In the project's first year, the fellow plans to document the thermal tolerances of three fish species in the bay: delta smelt, longfin smelt and inland silverside. Both smelt species are native fishes experiencing dramatic population declines, while the inland silverside is an abundant, exotic species with a high tolerance for a range of environmental conditions. In the project's second stage, the fellow will attempt to identify the genes activated by thermal stress and will use these genes to develop an assay for assessing thermal stress levels in wild fish that might not have any outward signs of physiological distress (such as lower growth rates). Findings from this project will help identify species-specific biomarkers of thermal stress for long-term ecosystem management under climate change scenarios.

Research mentor: Richard Connon and Nann Fangue, UC Davis
Community mentor: Ted Sommer, Department of Water Resources, California Natural Resources Agency

Scaling of the Portfolio Effect in Central Valley Chinook Salmon: Trends and Implications
R/SF-61; Jul. 2014 – Dec. 2015
Anna Sturrock, post-doctoral researcher, UC Santa Cruz, sturrock@ucsc.edu, 510.423.2210

Is bigger always better? Recently published research suggests that bigger out-migrating young salmon are more likely to survive poor ocean conditions than smaller salmon of about the same age. But, does this size advantage hold true for all salmon populations under all freshwater conditions? The fellow will explore this question for juvenile Chinook salmon in the Central Valley. Abundance and size data from juveniles exiting their natal rivers and caught in traps will be analyzed and compared with size-at-outmigration reconstructions of adults that returned to their natal rivers to spawn, to see who really survives. The reconstructions will be based on analyses of otoliths (earbone-like structures) collected during salmon carcass surveys. Strontium isotope signatures in the otoliths will be used to determine where a fish was born, its size upon leaving its natal stream and upon entering the ocean. Scientists will compare patterns across a range of spatial and temporal scales (rivers, basins, runs, years and hydrologic regimes) to explore the importance of size-selective mortality and life-history diversity for juvenile salmon in the Central Valley. Results will be evaluated in the context of the portfolio effect, which argues that maintaining multiple and diverse salmon stocks will dampen boom-bust cycles in adult salmon returns and increase population persistence.

Research mentor: Stephanie Carlson, University of California Berkeley
Community mentor: Rachel Johnson, U.S. Bureau of Reclamation

Testing the Interactions Between Invasive Perennial Pepper Weed and Ecosystem Function in Tidal Marshes of the San Francisco Bay-Delta
R/SF-63; Sept. 2013 - Aug. 2015
Rachel Wigginton, doctoral student, UC Davis, rdwigginton@ucdavis.edu, 714.394.2792

This project will explore the ecological role and impact of a highly aggressive, non-native plant in the mustard family, known as perennial pepper weed **(***Lepidium latifolium)*. Native to Europe and Central Asia, the noxious weed has invaded sensitive tidal wetlands of the San Francisco Bay-Delta and Suisun March, elbowing out native marsh plants, including the endangered endemic soft-bird's beak. The core of the project will be a series of field-manipulation experiments, in which pepper weed and native plant densities are held constant and varied to evaluate the weed's ecological consequences at various stages of invasion. Experiments will seek to quantify the weed's impact on carbon storage, marsh plant productivity and food webs at sites with different salinity exposures. Findings may provide important insights into cost-effective control strategies for the weed and their implications for marsh restoration.

Research mentor: Ted Grosholz, UC Davis
Community mentor: Brenda Grewell, USDA

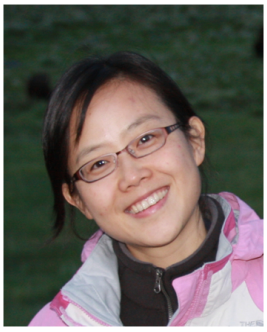
Optimizing Salt Marsh Harvest Mouse Conservation Through an Investigation of Demography, Habitat Use and Multi-Species Management

R/SF-64; Sept. 2013 – Aug. 2015
Katherine Smith, doctoral student, UC Davis,
ratsmith@ucdavis.edu, 530.400.7729

The salt marsh harvest mouse (*Reithrodontomys raviventris)* is the world's only land mammal found exclusively within coastal marshes. Amazingly adapted to coastal living, the small mammal can swim (yes, swim), drink salt water, and climb pickleweed to evade high tide. This project explores novel approaches to helping the endangered species thrive within San Francisco Bay's small, highly fragmented marshes, further threatened by sea level rise. To do this, the fellow is live-trapping, radio-collaring and monitoring the mice at six sites within Suisun Marsh monthly. Three of the study sites are managed to enhance duck hunting. The other three sites are natural tidal wetlands. A main goal of the project is to establish population sizes of the mice at the six study sites and to figure out where mice go when the managed wetlands are flooded to create duck ponds for hunters. Her work will document much needed basic biological information on the species, such as its home range size, longevity, feeding habits and reproductive cycles. Finding may illuminate ways to rebuild mice populations, protect coastal wetlands and enhance duck populations, as other research has suggested that larger mice populations can reduce predation on duck eggs and chicks.

Research mentor: Doug Kelt, UC Davis
Community mentors: Steve Culberson and Michael Chotkowski, U.S. Fish and Wildlife Service, and Laureen Barthman-Thompson, California Department of Fish and Wildlife

How do Shallow-Water Habitats Work? Using Smart Drifters to Understand How Flow and Geomorphology Interact to Establish High-Quality Habitats



R/SF-65; Sept. 2013 - Aug. 2015
Qingfang Wu, post-doctoral researcher, UC Berkeley, qingfangwu@berkeley.edu, 510.387.0078

A UC Berkeley research team has built a fleet of floating robots that can be deployed in estuaries and rivers to track water movements and monitor various aspects of water quality. The drifters, officially called the Floating Sensor Network, are equipped with sensors that measure position (GPS), water turbidity, chlorophyll, salinity, and water temperature. For this project, the fleet of mobile sensors will be deployed in the Liberty Island wetland to better understand processes that affect phytoplankton abundances and the transport of phytoplankton produced in wetlands to open-water (pelagic) food webs. Understanding how tidal flows affect mixing and dispersion of water properties and phytoplankton is also a major focus of the project. The project's three main objectives are to: 1) quantify effects of shallow-water flows through wetlands on water cloudiness (turbidity), chlorophyll (a measure of phytoplankton abundance), salinity and water temperature; 2) correlate drifter trajectories (i.e., water movements) to phytoplankton abundances, and 3) identify wetland features that encourage the transport of phytoplankton into the San Francisco Bay-Delta's open waters. Findings should help identify wetland designs that would be most effective at creating habitats to support the pelagic food web.

Research Mentor: Alexandre Bayen, University of California Berkeley
Community mentors: Brian Bergamaschi, Research Chemist, USGS and Tamara Kraus, Soil Scientist, USGS

Using Hyperspectral Remote Sensing to Map Methylmercury Concentrations in the San Francisco Bay-Delta
R/SFJPL-66; Jan. 2014 - Dec. 2015
Cédric G. Fichot, post-doctoral researcher, Caltech, cgfichot@gmail.com, 706.254.1629

Sediment-bound mercury in the foothills of the Sierras – the legacy of the Gold Rush – is an ongoing source of the toxic heavy metal in the San Francisco Bay-Delta. This project seeks to demonstrate the ability to estimate surface concentrations of mercury's toxic bioavailable form (methylmercury) based on the optical properties of methylmercury-containing organic material, as measured by NASA's Portable Remote Imaging Spectrometer (PRISM) sensor, developed by NASA's Jet Propulsion Laboratory. The fundamental premise of the research is that methylmercury, when bound to organic material in the water column, will have a uniquely defining spectral fingerprint. For this project, the PRISM sensor will be mounted on an airplane and flown over the Bay-Delta multiple times to obtain data on water color (reflectance) at 1- to 2-meter resolutions. The precise number of flights will depend on funding; however, the goal is to survey the region seasonally, before and after large rainfall events, and over a tidal cycle. The fellow will develop an algorithm for estimating methylmercury concentrations and will test and validate it with direct field measurements. If the algorithm proves reliable, the fellow will use the reflectance data to monitor the effects of wetland restoration, periodic flooding of rice fields and precipitation on methylmercury concentrations. The remote sensing data will also be used to quantify the photochemical degradation of methylmercury.

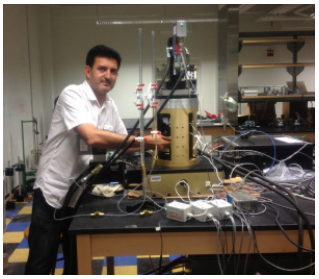
Research mentor: Michelle Gierach, NASA's Jet Propulsion Laboratory
Community mentors: Brian Bergamaschi and Michael Sauer, U.S. Geological Survey

Using Advanced Radar Remote Sensing Techniques to Measure Subsidence and Levee Instability in the Sacramento-San Joaquin Delta
R/SFJPL-67; Sept. 2013 - Aug. 2015
Priyanka Sharma, post-doctoral researcher, California Institute of Technology, psharma@caltech.edu, 520.260.9072

The Delta Science Fellow will apply techniques she developed to study the dune fields on Titan – Saturn's largest moon – to monitor very small deformations and movements at and around levees in the Sacramento-San Joaquin Delta. These levees protect freshwater canals and land from flooding due to subsidence and sea level rise. Her project builds on a NASA-funded study, led by her academic mentor, that has used some of the data from NASA's L-band Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) instrument to track levee stability in the delta. The goal of this project is to combine and use all available L-band UAVSAR data to more fully characterize levee stability and movement, as well as seepage of water behind levees. If the work goes as planned, results will help determine underlying

processes affecting levee subsidence and movement. Such information would be of great use to water and land management programs in the region.

Research mentor: Dr. Cathleen E. Jones, NASA Jet Propulsion Laboratory
Community mentor: Joel Dudas, California Department of Water Resources



Seismic Deformation Potential of Peaty Organic Soils Underlying Delta Levees
R/SFDWR-68; Sept. 2013 – Aug. 2015
Ali Shafiee, doctoral student, UCLA, ashafiee@ucla.edu, 858.210.2029

The Delta Science Fellow leading this project will study the post-earthquake volume change (settlement) of peaty soils. Peaty soils are associated with wetlands and contain high amounts of partially decomposed plant debris. These soils underlie many of the region's earthen levees and their deformation potential is an important factor in seismic hazard assessment. Though the engineering community is well aware of this mechanism's importance, most previous studies have focused on understanding the post-seismic response of "traditional" soils such as clay and sand. This project will fill a much needed gap in the ability to evaluate levee stability following the next "big one" by looking more closely at peaty soil dynamics. In the project's first year, the fellow will conduct laboratory tests on peaty soil samples gathered from Sherman Island, the site of a field-scale model levee test in 2011 and 2012, to measure their seismic deformation potential and cyclic deformation potential. The fellow will utilize a digitally controlled simple shear device, recently modified to perform cyclic shearing under realistic field conditions during and after an earthquake. These modifications will greatly enable relevant soil testing. Findings will further refine and improve seismic hazard assessment within the geologic context of the delta.

Research mentor: Scott Brandenberg, UCLA
Community mentor: Curtis Schmutte, professional engineer and consultant

National Sea Grant Aquaculture Research Program

Genomically Enabled Crossbreeding to Improve Yields of Farmed Pacific Oysters
R/AQ132-NSI; Oct. 2010–Feb. 2014
Dennis Hedgecock, University of Southern California, 213.821.2091, dhedge@usc.edu
Donal Manahan, University of Southern California, 313.740.5793, manahan@usc.edu
Paul Olin, CA Sea Grant Extension, 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.

Development of Sustainable Tuna Aquaculture in the United States Using Yellowfin Tuna as a Model
R/AQ-133; Feb. 2012–Jan. 2015
Mark Drawbridge, Hubbs-SeaWorld Research Institute, 619.226.3943, mdrawbr@hswri.org
Dan Margulies, Inter-American Tropical Tuna Commission,
858.546.7120, dmargulies@iattc.org

Rearing fish during their larval stage is often the most difficult part of developing a new species for culture; however, for yellowfin tuna, this common difficulty is further complicated by the absence of a domestic population of breeding fish. Instead of setting up breeding tanks locally, which is expensive and logistically complex, researchers have been airfreighting tuna eggs and larvae from the Inter-American Tropical Tuna Commission's facility at the Achotines Laboratory in Panama (one of the few research facilities in the world designed specifically to study the early-life history of tropical tunas) to their aquaculture facility at Hubbs-SeaWorld Research Institute in San Diego. The survivorship of these animals, though, has been so low that it has been basically impossible to carry out the necessary research on their early life history requirements (e.g., nutritional requirements). The first main goal of this project is to identify what is causing low survivorship among airfreighted fish and to fix the sources of harm, if feasible. Preliminary experiments during the project's first year suggest that packing larvae for airfreight may itself be a problem, as low survivorship was observed in both larvae airfreighted to San Diego and in controls kept on the ground in Panama. In correspondence with scientists in August of 2013, Sea Grant was informed that all aspects of the project were delayed for the last 14 months because the captive tuna stopped spawning. According to the research team in

Panama, this was due largely to a smaller-than-normal number of breeding adults and an inability to replenish the brood stock with new fish, because of unusually poor fishing conditions. The scientists report that fishing has improved recently, and the population now stands at 24 with a target of 40 adults. They plan to resume their research in 2014.

Maximizing the Values of Offshore Aquaculture Development in the Context of Multiple Ocean Uses
R/AQ-134; Sep. 2012–Aug. 2014
Sarah Lester, UC Santa Barbara, 805.893.5175, lester@msi.ucsb.edu
Steven Gaines, UC Santa Barbara, 805.893.7363, gaines@bren.ucsb.edu
Christopher Costello, UC Santa Barbara, 805.893.5802, costello@bren.ucsb.edu
Libe Washburn, UC Santa Barbara, 805.893.7367, washburn@icess.ucsb.edu

The state of California is in the process of establishing a management framework for permitting and regulating open-ocean aquaculture. To assist in the planning process, this project seeks to model and evaluate the industry's economic and environmental tradeoffs. The emphasis of the work, to date, has been to decide on how to focus the modeling effort on specific species and culturing methods that together might broadly represent the full range of likely farming operations. After much research, the team has decided to model and evaluate these three scenarios: 1) finfish in net pen cages, based on white seabass, 2) shellfish on longlines, based on Mediterranean mussels, and 3) kelp on longlines, based on Laminaria. The model will examine the effects of these on: 1) the California halibut fishery, 2) water quality and the bottom environment, and 3) visual impact from operations that may be visible from the coast. In the coming months, the team will be running the finfish scenario in Aquamodel, a proprietary software model developed by colleagues at USC, and will be exploring how to model disease dynamics so as to be able to evaluate the risk of disease transmission to wild fish. Other modeling work will looks at patterns of larval dispersal and connectivity, and possibly pollutant dispersal. 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. The hoped for outcome of this project, scientists say, is to 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, iai@san.rr.com
Edward W. Glazier, Impact Assessment, 858.459.0142, edward.glazier@gmail.com

This project seeks to identify and analyze the social obstacles (constraints) to developing a domestic offshore aquaculture industry. The hope is that this type of information might lead to solutions that could help move the industry forward. 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. The team has, to date, completed its first phase of work in Hawaii, California and along the U.S. East Coast and is in the process of preparing a report on the "human context in which the offshore aquaculture industry is situated." Once this is done, their investigations will focus on

a second round of interviews, focus groups and data analyzes that they hope will identify strategies for resolving concerns, constraints and objections to the industry's growth. Findings will assist formal policy deliberations on the future of the industry.

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 2014 are listed below.

Efficiency Costs of Restrictions in Tradable Permit Programs: Analysis of the Alaskan Halibut and Sablefish Individual Fishing Quota System
E/PD-7; Jun. 2012–May 2015
Kailin Kroetz, UC Davis, 603.219.6933, kkroetz@ucdavis.edu

The Alaskan halibut and sablefish fisheries are currently managed under a "catch-shares" program, known as an individual transferable quota (ITQ). Loosely speaking, ITQs grant quota holders "rights" to catch a certain amount of fish and to buy and sell quota, much as stocks are traded. To meet certain social goals, however, ITQs are not purely free-market-based and are often established with restrictions on who can trade with whom and own quota. With the halibut/sablefish fishery, for example, smaller vessels must maintain a certain amount of the total quota, and there are limits to corporate ownership and consolidation. Though these rules keep more boats on the water, they also decrease the fishery's economic efficiency. The goal of this project is to develop a model that can quantify the costs of these inefficiencies for the halibut and other ITQ fisheries. In the project's first year, a preliminary model was developed and is now being fine-tuned. Results from this project are relevant to fishery managers and can be used to inform the design of new catch-shares programs.

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, UC San Diego/Scripps Institution of Oceanography, 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.

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 2015
Lewis Barnett, UC Davis, 530.665.0019, labarnett@ucdavis.edu

Climate change may exacerbate year-to-year fluctuations in fish stock sizes, and if this occurs, managers will be faced with new challenges. This project aims to identify management techniques that might "undo" some of these climate-related effects and thus dampen swings in fish population sizes and protect the structure of natural food webs. In work to date, the fellow has been identifying data sources for a model that will be used to simulate the effects of climate change on fish stocks. He and his colleagues are especially interested in understanding how climate-driven variability in the size of one fish stock will affect stock sizes at higher and lower levels of the food chain. The case study for the model's development will look at interactions between hake (whiting), forage fishes (anchovies, herring and sardines) and krill.

Development of a Novel Nested Patch Occupancy Model Applied to River Network Data
E/PD-11; 6/1/2013-5/31/2016
Lynn Waterhouse, SIO/UCSD, lwaterho@ucsd.edu

Efforts are underway to rebuild Chinook salmon and steelhead populations in the Columbia River basin in Washington through hatchery and habitat-restoration programs. To assist with these recovery efforts, groups have been tagging and tracking millions of salmon and steelhead through the elaborate Pacific Northwest river system, with a technology similar to pet microchipping, known in science circles as passive integrated transponder (PIT) tags. This project seeks to "get more" from existing PIT-tagging data, using advanced mathematical and statistical methods. The goals include being able to improve methods for modeling fish movement patterns through river systems and for estimating the numbers of fish returning to specific river areas. This type of information will help scientists identify, or further verify, habitat areas that should be prioritized for restoration. Other benefits of the project include being able to potentially optimize the deployment of in-river fish detection stations – to lower project costs and reduce the number of fish that need to be implanted with tags. This would have the added benefit of reducing tagging-related fish mortalities. Though the model is being applied to salmon and steelhead in the Columbia River basin, the method under development may be adapted to other species in other river systems.

Knauss and State Sea Grant Fellows

2014 Knauss Sea Grant Fellows:

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.

Alyson Fleming - Office of Marine Conservation (State, OES)
Laura Henson – Office of International Affairs (US DOC, NOAA)
Alexis Jackson – Highly Migratory Species Division (US DOC, NOAA, NMFS, HMS)
Emily Trentacoste – Aquaculture Program Office (US DOC, NOAA, NMFS)

2014 California Sea Grant State Fellows:

Modeled after the highly successful Knauss Marine Policy Fellowship Program, the State Fellows Program provides an opportunity to acquire "on the job" experience in the planning and implementation of marine and coastal resource policies and programs in the state of California. The program matches graduate students and recent graduates with "hosts" in state or federal agencies in California for a one-year paid fellowship.

Lauren Bernadett – CA State Lands Commission
Jennifer Bigman - Delta Science Program Independent Science Board
Evyan Borgnis – CA Coastal Conservancy South Coast Program
Ryan Freedman – Channel Islands National Marine Sanctuary Research Program
Sean Herron – Channel Islands National Marine Sanctuary Resource Protection Program
Karen Kayfetz – CA Ocean Protection Council Marine Debris Program
Laura Lilly – West Coast Oceanographic Data Integration Fellowship
Kelly Malinowski – CA Coastal Conservancy Climate Ready Program
Mary Matella – CA Coastal Commission
Liz Parissenti – CA Ocean Protection Council Policy Specialist
Meghan Powers - State Water Resources Control Board
Eve Robinson – CA Ocean Science Trust
Meiling Roddam – Delta Science Program Delta Council
Nicole Bobco – Department of Fish & Wildlife, Aquaculture Program
Rosa Schneider – San Francisco Bay Conservation and Development Commission
Anthony Shiao – CA Department of Fish and Wildlife Marine Region

Index of Researchers/Fellows

Iryna Dronova, UCB, Delta Science Fellow; R/SF-52
Jenifer Dugan, UCSB; R/MPA-24, R/MPA-38

E

Christopher Edwards, UCSC; R/FISH-218

F

Cédric G. Fichot, Caltech, Delta Science Fellow; R/SFJPL-66
Victoria Fabry, CSUSM; R/OPCENV-09
Alyson Fleming, Knauss Fellow
Ryan Freedman, Sea Grant Fellow
Jan Freiwald, Reef Check Foundation; R/MPA-21, R/MPA-34
Carolyn Friedman, UW; R/SSFS-01

G

Steven Gaines, UCSB; R/AQ-134, R/RCC-03, R/SOC-01
Monica Galligan, CSUMB; R/OPCCFRW-7MG
Marisol Garcia-Reyes, Farallon Institute; R/MPA-31
Emma Gatti, SU; R/SF-53
Brian Gaylord, UCD; R/HCME-03
Kirsten Gilardi, UCD; R/OPCCFRW-12MG
Edward W. Glazier, Impact Assessment; R/AQ-135
Bob Godfrey, Marina Del Rey Angler; R/OPCCFRW-11MG
Richard Golightly, HSU, R/MPA-35
Michael Graham, MLML; R/CC-05
Edwin Grosholz, UCD; R/HCME-02
Robert Guza, UCSD/SIO; R/RCC-01

H

Steven Hackett, Humboldt State University; R/MPA-36, R/SOC-03
Scott Hamilton, MLML; R/CC-05
Alan Hastings, UCD; R/FISH-211
David Hankin, HSU; R/OPCFISH-10, R/MPA-37
Kristin Hardy, CPSLO; R/CONT-220
Laura Henson, Knauss Fellow
Dennis Hedgecock, USC; R/AQ-132-NSI, R/SSFS-01
Sean Herron, Sea Grant Fellow
Tessa Hill, UCD; R/HCME-03
Gregor Hodgson, Reef Check Foundation; R/MPA-21, R/MPA-34
Gretchen Hoffman, UCSB; R/OPCENV-09
Sally Holbrook, UCSB; R/HCME-07
Kevin Hovel, SDSU; R/MPA-25
Emily Howe, UW, Delta Science Fellow; R/SF-54

J

Alexis Jackson, Knauss Fellow
Jaime Jahncke, PRBO; R/MPA-28, R/MPA-35
Kenneth Jeffries, UCD, Delta Science Fellow; R/SF-60
Ryan Jenkinson, HSU; R/MPA-32

Burt Jones, USC, R/OPCCONT-12

K

Brittany Kammerer, UCD, Delta Science Fellow; R/SF-55
Karen Kayfetz, Sea Grant Fellow
Andrew Kinziger, HSU; R/MPA-33
Lisa Komoroske, UCD, Delta Science Fellow; R/SF-56
Kailin Kroetz, UCD; E/PD-7
Raphael Kudela, UCSC; R/OPCCONT-12
Stephen Kullman, Wiyot Tribe; R/MPA-40

L

John Largier, BML UCD; R/HCME-04, R/MPA-31, R/MPA-40
Rosa Laucci, Smith River Rancheria; R/MPA-33, R/MPA-38
Anita Leinweber, UCLA; R/CONT-209
Sean Lema, CPSLO; R/CONT-220
Sarah Lester, UCSB; R/AQ-134
Lisa Levin, UCSD/SIO; R/CC-04
Laura Lilly, Sea Grant Fellow
James Lindholm, Cal State Monterey Bay; R/MPA-26
Jeremy Long, SDSU; R/ENV-221
Kirk Lynn, CDFW; R/OPCCFRW-10

M

Kelly Malinowski, Sea Grant Fellow
Donal Manahan, USC; R/AQ-132-NSI
Dan Marguiles, Inter-American Tropical Tuna Commission; R/AQ-133
Todd Martz, UCSD/SIO; R/CC-04
Mary Matella, Sea Grant Fellow
Gavin McNicol, UCB; Delta Science Fellow, R/SF-58
Woutrina Miller, UCD; R/CONT-216
James Moore, USC; R/SOC-05
Steven Morgan, UCD; R/FISH-218
Timothy Mulligan, HSU; R/MPA-37, R/MPA-38, R/MPA-40

N

Karina Nielsen, Sonoma State University; R/MPA-24, R/MPA-38

O

Paul Olin, CASGEP; R/AQ-132-NSI
William O'Reilly, UCSD/SIO; R/RCC-01

P

Henry Page, UCSB; R/MPA-24, R/ENV-221
Céline Pallud, UCB; R/HCME-05
Liz Parissenti, Sea Grant Fellow
Ed Parnell, UCSD/SIO; R/OPCCFRW-3; R/MPA-25, R/FISH-209, R/CC-04
Julia Parrish, UW; R/SOC-04
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Kim Penttila, CDFW; R/OPCCFRW-11MG
Charles Perretti, UCSD/SIO; E/PD-9
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Daniel Pondella, Occidental College; R/MPA-27
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R

Peter Raimondi, UCSC; R/MPA-22, R/FISH-208, R/HCME-06; R/MPA-33
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Laurie Richmond, HSU; R/MPA-36
Dan Robinette, PRBO; R/MPA-28, R/MPA-35
Eve Robinson, Sea Grant Fellow
Megan Rocha, Smith River Rancheria; R/MPA-39
Meiling Roddman, Sea Grant Fellow
Hawk Rosales, Inter-Tribal Sinkyone Wilderness Council; R/MPA-39
Dirk Rosen, MARE; R/MPA-26
Shawn Rowe, Oregon Sea Grant; R/SOC-04
Ann Russell, UCD; R/HCME-02
Nicole Russell, Sea Grant Fellow
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S

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Richard Starr, CASGEP & MLML; R/OPCCFRW-1, R/OPCFISH-13, R/MPA-41
Charles S. Steinback, Ecotrust Fisheries; R/MPA-29, R/MPA-36
Craig Strong, Cresent Coastal Research; R/MPA-35
Anna Sturrock, UCB; Delta Science Fellow; R/SF-61

Rachel Sundberg, Cher-Ae Heights Indian Community of the Trinidad Rancheria; R/MPA-39
Jan Svejkovsky, Ocean Imaging; R/MPA-30
Peter Swerzenski, USGS; R/OPCFISH-10, R/CONT-218
William Sydeman, Farallon Inst.; R/ENV-220, R/MPA-31

T

Theresa S. Talley, CASGEP, R/OPCCFRW-8MG
Brian Tissot, HSU; R/MPA-31
Lars Tomanek, CPSLO; R/CONT-220
Thomas Torma, Wiyot Tribe; R/MPA-39
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Joe Tyburczy, CASGEP; R/MPA-33, R/MPA-37
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V

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W

Adam Wagschal, H.T Harvey & Assoc.; R/MPA-32, R/MPA-40, R/OPCCFRW-13MG
Barbara Walker, UCSB; R/SOC-02
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Brian Wells, NOAA/SWFSC; R/OPCFISH-10
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