From Lions to Luminescence:
Linking Land and Sea

Saturday, April 14, 2012
California State University, Monterey Bay
University Center, Seaside

Monterey Bay National Marine Sanctuary Symposium
Sanctuary Currents 2012

From Lions to Luminescence: Linking Land and Sea

Saturday, April 14th 2012
California State University, Monterey Bay
University Center, Seaside

Planning Committee

Liz Love, Andrew DeVogelaere, Erica Burton, Chad King, and Dawn Hayes:
Monterey Bay National Marine Sanctuary

James Lindholm, Heather Kelley, and Ashley Knight:
California State University Monterey Bay

Chris Harrold:
Monterey Bay Aquarium

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http://montereybay.noaa.gov/research/symposium.html

PROGRAM OF EVENTS

8:00 – 8:45 A.M. **REGISTRATION**
(THIS IS A FREE EVENT, PRE-REGISTRATION IS NOT NECESSARY)

9:00 A.M. **WELCOME**

Paul Michel
Superintendent, Monterey Bay National Marine Sanctuary

Dr. James Lindholm
James W. Rote Distinguished Professor of Marine Science & Policy, and Director - Institute for Applied Marine Ecology
California State University, Monterey Bay
Member, Sanctuary Research Activity Panel

Dr. Andrew DeVogelaere
Research Coordinator
Monterey Bay National Marine Sanctuary

9:15 – 9:40 A.M. **MOUNTAIN LION BEHAVIOR IN A HUMAN DOMINATED LANDSCAPE**

Yiwei Wang, PhD Candidate
Department of Environmental Studies
University of California, Santa Cruz

9:40 – 10:05 A.M. **GLAMOUR, DRAMA AND INTRIGUE – A CENTRAL COAST WATER QUALITY STORY**

Robert Ketley
Engineer, City of Watsonville

10:05 – 10:30 A.M. **FROM SOURCES TO SEA OTTERS: WHAT ANIMALS CAN TEACH US ABOUT WATER QUALITY AND FECAL PATHOGEN POLLUTION IN CALIFORNIA**

Dr. Woutrina Miller
University of California, Davis

10:30 – 11:00 A.M. **BREAK**

11:00 – 11:25 A.M.	**INTO THE DEEP AND WHAT WE SAW THERE: CHARACTERIZING THE SHELF IN THE MBNMS** Dr. James Lindholm Institute for Applied Marine Ecology California State University, Monterey Bay
11:25–11:50 A.M.	**WHAT GLOWS BELOW…BIOLUMINESCENCE IN THE DEEP-SEA** Dr. Steven Haddock Monterey Bay Aquarium Research Institute
11:50 -12:30 P.M.	**LUNCH**
12:30 -2:15 P.M.	**RESEARCH POSTERS**
2:15 -3:00 P.M.	**RICKETTS MEMORIAL LECTURE** **WHAT DOES $4,000,000,000/YEAR IN AGRICULTURE MEAN TO OUR COASTAL OCEAN? LESSONS FROM LOBO (THE LAND/OCEAN BIOGEOCHEMICAL OBSERVATORY)** Dr. Ken Johnson Monterey Bay Aquarium Research Institute
3:00-3:15 P.M.	**RESEARCH POSTER AWARDS**

SPEAKER ABSTRACTS

YIWEI WANG, PHD CANDIDATE

University of California, Santa Cruz

Mountain Lion Behavior in a Human Dominated Landscape

Human development is the primary cause of species extinctions globally yet we know surprisingly little about how to develop in ways that limit the extinction of the most vulnerable species: top predators. Long considered vermin, top predators are now recognized as keystone species, who often keep other important components of an ecosystem from unraveling. In this talk, I will present preliminary results and insights from the first 3 years of the Santa Cruz Puma Project, an effort by wildlife ecologists, animal physiologists and electrical engineers to understand the impacts of human development on the physiology, behavior, ecology and conservation of wild mountain lions.

ROBERT KETLEY

City of Watsonville

Glamour, Drama and Intrigue – A Central Coast Water Quality Story

Sick and tired of hearing about Kim Kardashian?
All stressed out about the Higgs Boson?
Wonder what the folks at city hall are doing about water quality?
Watsonville is taking on a whole host of water quality issues. Why not blow off another 25 minutes of your life hearing all about it?

DR. WOUTRINA MILLER

University of California, Davis

From Sources to Sea Otters: What Animals Can Teach Us About Water Quality and Fecal Pathogen Pollution in California

Fecal pathogen pollution comes from many sources in coastal watersheds, and may be transported overland during storm events and in rivers downstream to the sea. Both point and non-point fecal sources contribute to fecal pathogen pollution, some related to humans and others coming from domestic animals and wildlife. The sea otter acts as a sentinel species in coastal ecosystems, acting as a canary in the coalmine for disturbances that may start subtlety but which can disturb the balance of species and health. The stories of researchers, animals, and pathogens discussed in Dr. Miller's presentation will highlight linkages and issues relevant to a broad audience, and will provide opportunities for

discussion about how interdisciplinary research and conservation can be undertaken using both controlled laboratory studies paired with complementary fieldwork and modeling to understand the flow of pathogens from land to sea. The role of resource managers, stakeholders, and policy makers is also critical, to implement longer-term change once useful interventions are identified to reduce pathogen pollution and associated health risks for people and animals that live or recreate in coastal ecosystems. This research approach is an example of One Health in action, with veterinarians, ecologists, biologists, epidemiologists, and stakeholders working together to address issues of importance to humans, animals, and the environment in California.

DR. JAMES LINDHOLM

California State University, Monterey Bay

Into the Deep and What We Saw There: Characterizing the Shelf in the MBNMS

The subitidal zone of the MBNMS encompasses a rich diversity of organisms and habitats, from kelp forests to deep sea canyons. Successful management of these exceptional resources depends first on an understanding of where organisms live and why, and second on how they are distributed relative to the boundaries of spatial management areas. Since 2007, CSU Monterey Bay's Institute for Applied Marine Ecology (IfAME) has been working with the MBNMS, as well as the state, environmental groups, and the fishing community, to characterize seafloor communities from Point Arena to La Jolla Cove, including many locations within the MBNMS. Remotely operated vehicles (ROVs) and towed video camera sleds have been used to collect videographic and still photographic imagery of organisms and their habitats in water depths ranging from 20 m to 400 m, providing a permanent archive of imagery on California's continental shelf.

DR. STEVEN HADDOCK

Monterey Bay Aquarium Research Institute

What Glows Below...Bioluminescence in the Deep-sea

The ability of an organism to produce light seems like magic, but it is common in the sea, where luminescence is used by everything from bacteria and jellies to fish and squid. Animals use light to avoid predators and find prey and mates, but this realm of flashes, sparkles, and glows is difficult to observe and study, so there are many discoveries yet to be made. This presentation will show experiments and images from some of Monterey Bay's bioluminescent organisms and discuss their elaborate adaptations to life in the dark. Hollywood's aliens are bland compared with the diversity found in the sea just off our shores.

RICKETTS MEMORIAL LECTURE

DR. KEN JOHNSON
Monterey Bay Aquarium Research Institute

What Does $4,000,000,000/Year in Agriculture Mean to Our Coastal Ocean? Lessons from LOBO (the Land/Ocean Biogeochemical Observatory)

Monterey Bay sits at the end of the Salinas Valley, one of the most productive and intensely farmed systems in the country. The value of Monterey County crop sales exceeded $4,000,000,000 in 2010 and agriculture is the largest element of Monterey County's economy. The runoff from this system flows in to Monterey Bay and presents a variety of potential impacts on the ecosystem, including stimulation of algal blooms due to excess nutrients. A delicate balance is required to maintain a sustainable food supply and to protect the ocean environment, which is a focal point of tourism, the second largest element of the County's economy. Managing such an ecosystem requires a timely flow of reliable information about the state of environment; just as running a business requires timely information on expenditures, revenues and projections of future opportunities. In modern business, the information must flow in real time, with up-to-date information on current market conditions, variable production costs and a multitude of other parameters required to remain competitive.

The focus of this talk will be on the benefits and opportunities that arise from using real time information systems in the environment. The Land-Ocean Biogeochemical Observatory (LOBO) is a network of chemical and biological sensors that have been operated in the waters of Elkhorn Slough, the Old Salinas River Channel and in Monterey Bay since 2003. Data flows directly to the Internet, where it is available to the public at www.mbari.org/lobo. The lessons learned in tracking nitrate concentrations as they flow through this system, and their impacts on the environment will be the main emphasis.

ABOUT KEN JOHNSON

Ken Johnson is a Senior Scientist at the Monterey Bay Aquarium Research Institute, where his work focuses on development of novel chemical sensors for seawater and their use throughout the world ocean. He received his BS degrees in Chemistry and Oceanography from the University of Washington in 1975 and his Ph.D. from Oregon State University in 1979. After 10 years at UC Santa Barbara, Ken moved to the Monterey Bay area with joint appointments at Moss Landing Marine Laboratories and the Monterey Bay Aquarium Research Institute in 1988. He moved to MBARI full time in 1999. Ken's interest in agriculture stems both from participating in ocean iron fertilization experiments during the 1990's and from working in the fields picking strawberries as a young teenager.

HISTORY OF ED RICKETTS MEMORIAL AWARD AND LECTURE

Ed Ricketts was born in Chicago in 1897 and studied ecology at the University of Chicago. He moved to the Monterey Peninsula in 1923 and opened Pacific Biological Laboratories, providing specimens and slides to research institutions. Ricketts met John Steinbeck in 1930 and became a major influence on the author's writing and philosophy, serving as the inspiration for many notable Steinbeck characters. On their famous trip aboard the *Western Flyer*, Ricketts and Steinbeck explored the Gulf of California and collaborated on the book *The Sea of Cortez*. Ricketts also wrote *Between Pacific Tides*, an ecological handbook of intertidal marine life that is still used as a textbook at many universities. The scientific catalogue of organisms documented by Ricketts, both aboard the *Western Flyer* and during his other studies, has been invaluable to marine scientists. His work and unconventionally holistic approach to science has inspired generations of researchers.

The Ed Ricketts Memorial Lecture was created to honor lifetime achievement in the field of marine science. The first award was presented in March 1986. Recipients are selected by members of the Monterey Bay National Marine Sanctuary Research Activity Panel.

Previous Award Recipients

2011 Michael Foster
2010 Rikk Kvitek
2009 Bruce Robison
2008 James P. Barry
2007 Gary B. Griggs
2006 Dave Epel
2005 Barbara A. Block
2004 John Pearse
2003 James Estes
2002 Jane Lubchenco
2001 Mary Silver
2000 Paul K. Dayton
1999 Joseph Connell
1998 George Somero
1997 Greg Cailliet
1996 Steve Webster
1995 Dick Parrish
1994 Wayne Sousa
1992 Jim Childress
1991 Walter Munk
1990 Gene Haderlie
1989 John Martin
1988 Sandy Lydon
1987 Dick Barber
1986 Joel Hedgepeth

RESEARCH POSTER ABSTRACTS

ABBEY, S AND B HUGHES
University of California, Santa Cruz

Impacts of anthropogenic nutrient loading and ephemeral algae on the health of the eelgrass *Zostera marina*

Estuaries are ecologically important yet delicate environments that reflect human perturbations in the surrounding watersheds. A major perturbation comes from anthropogenic nutrient inputs from surrounding agriculture, usually in the form of fertilizer run off. Agricultural fertilizers can add a considerable amount of nutrients to estuaries, which in turn can alter the composition of primary producer communities through eutrophication. In estuaries on the California coast eelgrass (*Zostera marina*) competes with ephemeral macroalgae such as the sea lettuce (*Ulva lactuca*) for space and nutrients. When over enrichment occurs *Ulva* is able to outcompete *Zostera*, which causes a shift in the natural composition of primary producers. *Zostera* creates important habitat for many species and its removal can have far reaching consequences for the estuary, as well as the surrounding marine environment. We tested the competitive interaction between *Ulva* and *Zostera* under ambient and nutrient enriched conditions using a mesocosm experiment. Also, field observations were carried out in high, medium and low nutrient enriched estuaries (Elkhorn Slough, Morro Bay, and Tomales Bay; respectively) to investigate the interactions of algae and *Zostera* populations at each site. Results from the mesocosm experiment indicated that nutrient enrichment shifts *Ulva* from a moderate to a highly dominant competitor of *Zostera.* However, results from the field observations indicated that multiple variables play a role in determining competitive dominance between eelgrass and macroalgae, such as nutrient enrichment, habitat suitability, and herbivory.

ADELAARS, J, K BECK, J BLAKELY, L CLARY, A CRAMER, B ESCAMILLA, J FEENY-MOSIER, B GILMORE, C HERNANDEZ, L JENSEN, K KEADY K, H KELLEY, F MOYE, M NGO, A REICHERT, B SPERBER, K TROXEL, E VERHAGE
California State University, Monterey Bay

What makes some spots "fishy": using video, 3-D water column and seafloor mapping to find and model the link between fish hotspots and seafloor habitat features

The ability to determine, model and predict the distribution and abundance of species with respect to their habitats is critical to sustainable ecosystem management. However, these tasks have been especially challenging in the marine environment where the coverage, scale, resolution and positional accuracy of traditional technologies used for species mapping often do not match those used to map the habitat. Here we seek to align the geospatial quality and coverage of species and habitat data acquisition to produce predictive, species-specific habitat models that we will use to assess why some patches of rocky reef are consistently “fishier” than other patches of the same reef. Our approach will be to use multibeam sonar for high resolution 3-D mapping of fish in the water column and the seafloor habitat, combined with ROV video groundtruthing of fish aggregations over the Delmonte Beach shalebeds, Monterey Bay. GIS landscape analysis and multivariate spatial statistics will then be used to test and model the association of fish aggregations with specific habitat parameters (depth, topographic position index, rugosity, slope,

etc.) derived from the seafloor bathymetry data. These results will be compared to those from previous ROV fish mapping surveys conducted in 2002-03 to assess spatial and temporal patterns of rock fish aggregation persistence. Water column mapping combined with species/habitat modeling techniques hold great promise for monitoring and predicting the response of species to environmental change at multiple time scales as well as assessing the performance of marine protected areas.

ADELAARS, J, N DONLOU, M KELLY, C MARKS, B PARDIECK, J LINDHOLM
California State University, Monterey Bay

Examining the conservation value of marine management areas within the Monterey Bay National Marine Sanctuary: how protected is the Sanctuary?

The abundance of spatial management regimes (ranging from no-take marine reserves to personal watercraft use zones) currently in place in state and federal waters off California has created the impression among selected stakeholder groups that "everywhere is protected." And that, in turn, is used as an argument for reducing the amount of management regimes. Yet, *more* management does not necessarily result in *more* protection, and that fact must be considered when evaluating the utility of new or existing management efforts. In this study we evaluated the general level of 'protectedness' in the Monterey Bay National Marine Sanctuary by quantifying the cumulative protection of 51 management areas currently in place, independent of the agencies responsible for their designation and management. Each management area received a protection score based on several criteria, including the type of prohibited activities, the area's size, and the permanence of the designation. We then evaluated the cumulative protection provided at any particular location in the MBNMS by overlapping management areas, as well as the role of adjacent protective measures in enhancing protection. Results indicate that more than 99% of the MBNMS receives moderate to low protection from existing management areas. Selected areas, such as the waters adjacent to Point Lobos, are well-protected based on the overlap of several small, but long-standing management measures. State waters are, in general, more protected than federal waters at this time. These results should provide important context to on-going marine spatial planning efforts in the Sanctuary.

ADELAARS, J[1], J LINDHOLM[1], A DEVOGELAERE[2]
1 California State University, Monterey Bay
2 Monterey Bay National Marine Sanctuary

Spot the prawn: estimating the distribution of Spot Prawn (*Pandalus platyceros*) within the Carmel Bay Submarine Canyon

Determining species-habitat associations within marine ecosystems provides a reference point from which to estimate a species' spatial distribution based on the extent of their habitat. Given the cost of research at-sea and the long timeline associated with planning expeditions, developing this capability will enhance resource management. The abundance of spot prawn (*Pandalus platyceros*) within the Carmel Bay submarine canyon presented a suitable scenario for making these predictive distributions founded on fine-scale observations. The objective of this study was to estimate the distribution of spot prawn within Carmel Bay by their habitat association. This was achieved by incorporating geographically referenced prawn observation points with physical parameters derived from high-resolution bathymetry maps. These data were synthesized using a

general linear model and surface analysis software. The resulting map depicted the probability of occurrence of spotted prawn within the canyon. Based on this map, prawns occur predominantly along the canyon walls with greater densities just below the continental shelf-break. The outputs of this project are useful to marine resource management agencies by providing a tool for visualizing benthic ecosystems off the California coast when direct measurements are not possible.

AIELLO, I AND C ENDRIS
Moss Landing Marine Laboratories

Terrestrial laser scanning documents rapid erosion of estuarine habitats at Elkhorn Slough, California

In the last century Elkhorn Slough has been dramatically affected by human actions causing reduction of freshwater influence, restrictions of tidal flow and the increase of tidal scouring in the main channel after the opening of the Moss Landing Harbor. Between 2008 and 2012 we performed repeated, long- (>1 year) and short-term (months/days) TLS (Terrestrial Laser Scanning) surveys in several key geomorphologic habitats across Elkhorn Slough to document rates and distribution of geomorphologic change. Our 3D time series show that all habitat types have experienced erosion. Mudbanks and marsh edges displayed the highest and broadest range of erosional rates (between ~8 and 94 mm/year). Mudflats showed the lowest rates (between ~11 and 20 mm/year). Our data show that these differences are mainly related to the style of erosion rather than the location or elevation of the habitat: mudbanks and marsh edges erode rapidly mainly because of undercutting and slope failures. Exceptions to this trend have been mainly observed near man-made structures such as culverts and sills where some net sediment accumulation or very rapid mudbank erosion can also occur. Moreover, our work demonstrates for the first time the usefulness of TLS technology to document geomorphologic change in estuarine environments at very high resolutions and within a broad range of temporal and spatial scales.

AIKEN, E, A KNIGHT, J LINDHOLM
Institute for Applied Marine Ecology, California State University, Monterey Bay

Quantifying the distribution of burrowing Ophiuroids (brittle stars) relative to rippled scour depressions (RSDs) in Southern Monterey Bay

The role of rippled scour depressions (RSDs) in structuring ecological communities in unconsolidated sedimentary environments is largely unknown, despite the abundance and wide distribution of RSDs along California's continental shelf. Ophiuroids (brittle stars) are an important part of benthic food webs, redistribute organic matter, and serve as biogenic habitats for fish and other invertebrate species. In this study we examined the density patterns of infaunal Ophiuroids relative to RSDs and adjacent habitat using video imagery from a towed camera system. We quantified the percent cover of Ophiuroids in non-overlapping video quadrats along 12 ~1km long transects in southern Monterey Bay. In a comparison of densities inside and outside of RSDs, we found that the proportion of Ophiuroids was significantly greater outside RSDs. Further, the relationship between Ophiuroid densities and the boundaries of RSDs in deep (>30m) and shallow treatments (<30m) indicated that water depth also contributed to observed patterns. The distribution of Ophiuroids was plotted relative to the 2006 boundaries of the RSD field, with congruence between the two suggesting that RSD features are persistent over time. An improved

understanding of the ecology of RSDs, when considered in light of their distribution inside and outside of the state's new MPAs, will support more specific monitoring which will in turn advance management of MPAs.

ALANIS, J, M HERNANDEZ, F LAZARO, M SOLANO
Pajaro Valley High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Tiny Creatures in the Soil: Macroinvertebrates in the Oak and Eucalyptus

According to Dr. Jonas Salk, "If all insects were to disappear from the Earth, within 50 years all life on Earth would end. If all human beings disappeared from the Earth, within 50 years all forms of life would flourish." Like Dr. Salk claimed, macroinvertebrates are primary consumers and decomposers which have an important role that is required to drive the food web and maintain the ecosystem. Our research was conducted at Elkhorn Slough in an effort to understand whether a native oak woodland site or non-native eucalyptus grove had a higher macroinvertebrate biodiversity. We predicted that the oak site would have higher species richness because it allows different plants to grow underneath the canopy which attracts a variety of species that compete for the resources. We thought the eucalyptus site would have higher species dominance because the chemicals in the leaves prevent native plants from growing under its canopy so the species that do manage to survive there would have a larger population. The macroinvertebrates were collected by digging into the soil multiple times for separate samples. We hope our findings will show how valuable macroinvertebrates are to their ecosystems and promote the restoration of the native oak woodland.

ALFASSO, A
California State University, Monterey Bay

Edge effects: using multibeam bathymetry and video assessment techniques to observe transitional habitat zones in Bodega Bay, California.

The Marine Protected Area (MPA) in Bodega Bay, California is characterized by both hard and soft substrates, which supports a number of fish and invertebrate species. The purpose of this study is to examine the differences in species richness, density, and abundance that are found over soft, transitional, and hard substrate types. We used multibeam sonar bathymetry data to identify transition areas transitioning between hard and soft substrate types. Using a remotely operated vehicle (ROV), several video transects were recorded crossing between the sandy soft sediment to the rock habitat. We analyzed the video data for substrate type, relief, and species presence. We then associated the positional data from the ROV with the species observations to estimate species distribution.

AZEVEDO, A, A HERNANDEZ, S MACIAS, R ORTIZ
Watsonville High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

What do Red-legged frogs need in order to reproduce? Helping restoration through habitat research

The California Red-legged frog is protected under the Endangered Species Act, and has disappeared from 70% of the land they once populated. A spot were the Red-legged frogs currently inhabit and reproduce in is Elkhorn Slough National Estuarine Research Reserve. In order to observe if the environment in the rookery pond and the restoration guzzlers are suitable for the frogs, we are doing water quality tests and plant coverage percentage. A guzzler is a small man made container that has constant flowing fresh water. Elkhorn Slough staff has informed us that Red-legged frogs reproduce in the pond and once the frogs are born they move to the guzzlers. We hope our research will show why the frogs reproduce in the pond as opposed to the guzzlers. A major difference in the two types of sites is the amount of turbidity. Our prediction is frogs may be reproducing in the rookery over the guzzlers because the turbidity can be used as coverage for the young frogs. The guzzlers are not as turbid as the pond, but they do have protection provided by plants. To prevent the population of this endangered species to decline, restoration acts are needed. The Environmentally Sensitive Habitat Area group has started the attempt to restore the Red-legged frog habitat. We hope our research can be used to understand the habitat and help restoration to save this amazing species of frog.

BARNES, C[1], R STARR[1], D WENDT[2], K SCHMIDT[1], N HALL[2]
1 Moss Landing Marine Laboratories
2 Cal Poly San Luis Obispo

Collaborative fisheries research: a transition from data-poor to data-rich management

From 2007-2011, California Collaborative Fisheries Research Program (CCFRP) scientists collected data regarding species compositions, sizes and catch rates of nearshore fishes inside four MPAs. Nearby areas open to fishing were also surveyed as reference sites, against which MPA data were compared. Since 2007, 180 hook-and-line surveys have been conducted to identify, measure and release caught fishes. More than 650 volunteer anglers spent 3,597 hours using standardized methods, resulting in the catch of 32,865 fishes from 43 different species. Of those caught, 22,157 were tagged in order to gain information about movement patterns and survivorship through recapture. To date, species compositions, CPUE and biomass estimates have demonstrated great similarity between MPA and associated reference sites. Additionally, differences in lengths between protected and unprotected areas measured over time are essentially the same as those observed prior to reserve establishment. CCFRP data collected from the Point Lobos State Marine Reserve (est. 1973), however, indicate larger sizes and higher densities of 8 out of the 11 most abundant species, indicating a need for longer temporal scales to evaluate MPA performance in terms of fisheries management. While continuing to expand our dataset in order to meet these scaling requirements, we plan to incorporate existing information into new fishery models with the purpose of comparing individual model performance to each other and to traditional stock assessments. By examining model function through time and under various control rules, we can project the long-term costs and benefits of various management actions for stock sustainability and fishery profit.

BATTALIO, R, L WHITE, D REVELL
ESA PWA, San Francisco

Quantified Conceptual Model of Sandy Shore Response to Sand Supply and Sea Level Rise

Coastal erosion poses challenges to land use and resource conservation in California and is particularly acute in southern Monterey Bay. Sea level rise will exacerbate this challenge by raising the elevation of wave breaking and runup. Predictions of the potential extent of erosion over time are needed to assess vulnerabilities and evaluate adaptation strategies. ESA PWA (formerly Philip Williams & Associates, Ltd. (PWA)) has developed a methodology to approximately model sandy shore response to waves, sea level, sand supply and typical adaptation strategies (retreat, beach nourishment and armoring). The methodology uses simplified representations of key processes to provide an approximate but reasonably precise, efficient and transparent means of evaluating alternative scenarios. The methodology divides the shore into reaches represented by typical profiles, similar to a shoreline evolution model. Changes to shoreline position are determined using the concept of an equilibrium profile, incorporating sand supply changes (e.g. beach nourishment or sand mining) and sea level changes. Backshore conditions, defined by the adaptation strategy, are then set to allow or prevent shore recession, and are adjusted at discrete time steps for which the cross-shore widths of elevation zones of interest (e.g. dry beach) are measured. Ecologic, recreation and damage models, dependent on the width of each elevation zone, compares the economic impact associated with the landward migration of the profile. The modeling has shown promise in southern Monterey Bay and Ocean Beach, San Francisco, although still under development and testing. Methods and results of these applications will be presented.

BIGMAN, J[1], H DEWAR[2], S KOHIN[2], J BIZZARRO[3], R VETTER[2], D EBERT[1]
1 Pacific Shark Research Center, Moss Landing Marine Laboratories
2 National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla
3 University of Washington

Basking sharks: how California's citizen scientists can aid in the recovery of an enigmatic shark

The basking shark (*Cetorhinus maximus*) is the second largest shark species in the world, reaching a total length of up to 10 m. The species has been reported globally from high latitude seas, including Arctic waters, to the lower latitudes including the tropics. The eastern North Pacific basking shark population has now been designated a "Species of Concern" by the National Marine Fisheries Service (NMFS). It fits this criteria for three main reasons: (1) the population observed off Canada and California appears to have declined dramatically, as thousands were observed in the early 1900's and now seeing even a few is a rarity, (2) although there have been no targeted fisheries for basking sharks in the eastern North Pacific for more than 50 years, there does not appear to be any increase in population size and in fact it may have declined significantly; this dramatic decline and lack of recovery, which may be due to persistent, undocumented mortality, their low intrinsic population growth rates, and/or potential changes in contemporary distribution patterns, is common across the globe where basking sharks have been targeted, and (3) a severe lack of data makes it difficult to develop a recovery plan. Therefore, given the lack of knowledge on its distribution, abundance, population status, and occurrence along the Pacific coast, a collaborative project has been initiated between the NMFS and the Pacific Shark Research Center to investigate these aspects of basking shark biology. This project has many facets including an outreach program, tagging, data-mining, and a sightings network.

BURNETT, S, A GARCIA, K GREEN, M MATA
Watsonville High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Assessing the effectiveness of wildlife corridors as a mitigation strategy for the City of Watsonville

Humans have a big impact on the animals in our habitat. Animals can be negatively impacted by trash, cars, and pedestrians. For example, animals can be run over by cars when trying to cross roads. On the other hand, animals can be impacted positively through mitigation. For instance, the city of Watsonville built two wildlife corridors under Ohlone Parkway as a form of mitigation so animals can safely travel from one habitat to another. We wanted to investigate if the presence of people increases or decreases animal activity in the area. We also wanted to see if domestic species and wild animals react differently to human presence. This will tell us whether humans affect how animals behave in a natural area. We used 8 motion-detecting cameras to monitor two wildlife corridors underneath the Ohlone Parkway in Watsonville and the trails around the corridors. We predict that animals will be present more during the night because people are mostly out during the day. Our results will become baseline data to help the city of Watsonville determine if the corridors are actually useful for the animals as a mitigation strategy.

CALLAGHAN, M, A VERA-LAGIER, H KIBAK
California State University, Monterey Bay

Is the subtidal population of *Mytilus spp.* different from the intertidal population at Moss Landing Harbor, California?

Native populations of *Mytilus trossulus* have continued to decline along the coast of California since the arrival of a morphologically identical invasive species *Mytilus galloprovincialis*. Yet there is a potentially unique situation developing on the Central Coast of California at Moss Landing. Here a hybrid zone of these two sibling species exists and the progress of the invasion is closely watched. Over the years, sampling has routinely occurred on floating docks, presumably because collecting is simplified. However, this habitat is essentially subtidal when contrasted with the intertidal zone, where the mussels are also found. Is the population of *Mytilus spp.* found on floating docks at Moss Landing different from the population found in the intertidal? Data we collected in 2010 at only two sites (one floating dock and one intertidal) suggested that the populations were not significantly different, but this was a very limited study. For a more informed answer we have collected GPS coordinates and produced a map of the distribution of mussels throughout Moss Landing Harbor and Elkhorn Slough. *Mytilus spp*. can be found in very different habitats ranging from Kirby Landing to the Old Salinas River tidal gates. In collaboration with the MS 206 “Molecular Biological Techniques” course at Moss Landing Marine Labs and the Bio 344L “Environmental Biotechnology” course at CSUMB, we are collecting and identifying mussels from multiple intertidal and subtidal sites in 2012.

CHACON, P, A OCHOA, M MARTINEZ, Y LUNA
Watsonville High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Water quality and the amount of debris in our sloughs

The water quality of our sloughs has to be clean and protected. Water pollution can dramatically affect a whole ecosystem by ruining the habitats of the species that live there. Water quality includes temperature, pH levels, salinity, turbidity, nitrates, and phosphates. These levels are very important to know because it helps scientists discover how polluted a place is. Some things that could affect the water quality in the sloughs are weather, animals, land, and human impact. The amount of debris in the water and land near the slough could be influenced by humans. Our hypothesis is that the sloughs are polluted because humans dump trash into the sloughs. That's the reason why our group wants to find out how polluted Watsonville and Struve Slough are, so we can raise awareness to everyone on how to improve our sloughs. Our method consists of testing the water quality and the amount of debris in Watsonville and Struve Slough. Based on our results, we want to find a way to improve our wetlands and teach citizens and local government officials what they can do to help to make them cleaner and even more beautiful. We believe our research and our goal of improving our sloughs is going to fascinate students and citizens who care about the environment like us. Also, we are sure our experiment is going to have a big impact on this area and our group is going to prove the importance of taking care of our sloughs.

CHAVEZ, C, D GONZALEZ, V MATA, L SINGH, E TOLEDO
Pajaro Valley High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

The Effectiveness of Two Wildlife Crossings in Watsonville:
Who Benefits The Most, Native or Domesticated Animals?

Today, urbanization is a major reason many animals are losing habitat. Our research focused on two wildlife crossings built next to each other. A wildlife crossing is a form of mitigation for development in a wetland that allows animals a safe passage from one place to another. The crossings we studied are located under Ohlone Parkway near the Watsonville Slough. Mitigation is a project intended to reduce human impact that harms habitat. The wildlife crossings we researched were built under a busy road. These wildlife crossings were built to connect the biological islands created by building a neighborhood in the habitat. Biological islands can sometimes be too small to provide enough resources for animals to be able to sustain themselves. For our research project, we set up digital cameras with passive infra-red motion sensors inside and outside of the crossings. We compared animal use of the crossings for native and non-native species. We predicted that the crossings are not being used as they were intended. The purpose of our project was to provide data for use by the City of Watsonville, other policy makers, and biologists on the effectiveness of the wildlife corridors in wetlands.

CHOW, B, C DRAKE, J KUO, S LOIACONO, C MANZER, M MARRAFFINI, G NAVAS
Moss Landing Marine Laboratories

Tracking invasive mussels in Moss Landing Harbor

Bay mussels in the genus *Mytilus* are found in sheltered, template areas around the world. Analysis of DNA samples has shown that what morphologically appears to be one species can be divided into three species called *Mytilus edulis, Mytilus trossulus,* and *Mytilus galloprovincialis.* Of the three species, only one has been shown to be a successful invader in non-native habitats, often after being transported as larvae in the ballast water of large cargo ships. On the U.S. west coast, the native *M. trossulus* is being replaced by the Mediterranean *M. galloprovincialis,* the invader. Both mussels are found around Moss Landing and we are using molecular biology techniques to study the interactions between natives and invaders. Invasive species have profound effects on native ecosystems and, unfortunately, are now a common occurrence in our global world. This work adds to our understanding of the spread of invaders and their interactions with closely related native species.

CLARK, R, K O'CONNOR, S RYAN, C CLARK, S STONER-DUNCAN
Central Coast Wetlands Group, Moss Landing Marine Laboratories

Central Coast lagoons revealed through historical analysis and the California Rapid Assessment Method

California's Bar-built estuaries (river mouth lagoons) are unique and important habitats that offer a range of ecological services, including providing habitat for native fish and wildlife, aiding in flood control, improving water quality, and sequestering greenhouse gases. Physical processes such as beach-bar formation and seasonal flooding make these dynamic systems and seasonally important to a variety of special status species. The health of bar-built estuaries depends not only on the physical and biological processes occurring within the system, but also on human management of the lagoon and anthropogenic impacts within the watershed. Management strategies often focus on specific species or environmental objectives, sometimes to the detriment of other species and services. The Central Coast Wetlands Group at Moss Landing Marine Labs aims to improve our understanding of the ecological services these systems provide. Our study used a newly developed rapid assessment method to describe and compare the condition of eleven bar-built estuaries along California's central coast. The California Rapid Assessment Method grades the lagoon on four attributes: buffer and landscape context, hydrology, physical structure, and biotic structure. These scores are averaged to generate lagoon specific condition scores. We used historical maps to calculate habitat loss and change since the 1850s. The results of the condition assessment and historical analysis were combined to reveal the change and current status of Central Coast lagoon function and health. Such surveys will enable resource managers to devise better strategies to enhance lagoon ecosystems to support regional objectives and evaluate the effectiveness of management actions.

COOPER, C
California State University, Monterey Bay
Reef Check California

Size and density analyses of *Sebastes* spp. inside and outside of a marine reserve - utilizing data collected by Reef Check California citizen scientist

Sebastes spp. populations in California have been significantly reduced due to fishing. Marine protected areas (MPAs) such as Point Lobos Marine Reserve, CA have been established in order to protect areas from fishing and conserve fish populations. Long-term surveys on SCUBA are required in order to understand how useful these protected areas are in protecting and restoring fish populations. Studies have shown that older, larger rockfish females produce greater numbers of larvae that are more resilient than the larvae produced by younger, smaller rockfish females. *Sebastes* spp. in MPAs will grow larger due to the lack of fishing, and may increase larval production. A spill over affect may occur to areas outside of the MPA. By collecting size and density data on *Sebastes* spp. we will be able to examine population trends inside and outside of MPAs over time. I compared sizes and densities of *Sebastes* spp. between two sites in Point Lobos Marine Reserve and two sites just north of the reserve in Carmel Bay, CA. The four sites were surveyed by Reef Check California, a citizen science group, from 2006-2011.

DAO, K AND D EAMES
San Lorenzo Valley High School

Amphibian adventures

Yellow Eyed Ensatinas and California Slender Salamanders are common amphibians found in Santa Cruz County. The goal of our project is to study the impact of abiotic factors on populations of these amphibians in the Fall Creek Section of Henry Cowell State Park (behind our high school) and Quail Hollow Ranch County Park. Our hypothesis is that because the soil in the Fall Creek Section of Henry Cowell is more moist and acidic than the soil at Quail Hollow Ranch, Yellow Eyed Ensatinas and California Slender Salamanders will be more abundant at Fall Creek. In the Fall Creek section of Henry Cowell, we walk an established transect and look under the same logs each time to record how many salamanders we find. We use a Vernier LabQuest with soil moisture, soil temperature, humidity, and air temperature probes to collect abiotic data at the same log location. At Quail Hollow Ranch, we follow the same procedures as above except we search for amphibians in the vegetation along the ground. So far, our results indicate more amphibians in the Fall Creek Section of Henry Cowell than at Quail Hollow Ranch. It also appears that the soil in Fall Creek was more moist than in Quail Hollow, and the pH of the soil in Fall Creek was more acidic than the soil in Quail Hollow. Our results seem to support our hypothesis; however we need to collect more data. We wish to thank our mentor Dr Kerry Kriger.

DEASY, L[1], J HARVEY[1], J SEMINOFF[2], S BENSON[3], R TAPILATU[4]

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Variation in reproductive output of Leatherback Turtles nesting in the northwest coast of Papua, Indonesia

As capital breeders, leatherback turtles (*Dermochelys coriacea*) obtain resources needed for reproduction in distant foraging locations. Leatherback turtles that nest in Papua Barat, Indonesia between April and September migrate to temperate (California Current Ecosystem and North Pacific Transition Zone) and tropical (South China Sea) foraging regions. These foraging regions differ in latitude, distance from the nesting area, and prey composition and abundance. The purpose of this study was to create a reliable method for determining foraging regions of leatherback turtles based on stable nitrogen and carbon ratios in skin tissue of nesting females and to compare within-season reproductive output of turtles that foraged in distinct regions. Stable nitrogen and carbon ratios of leatherbacks with known foraging locations were used in a discriminant analysis, and the resulting functions were used to classify turtles sampled in 2010 and 2011. Results indicated that the majority of the nesting population foraged in temperate foraging locations. As predicted, turtles that foraged in the California Current Ecosystem had greater d15N. Turtles that foraged in the South China Sea were distinguished from those that foraged in the North Pacific Transition Zone by their lesser (more negative) d13C. The discriminant functions correctly classified about 80% of original grouped cases. Measures of within-season reproductive output were compared, and preliminary results will be presented. Understanding how foraging location affects reproductive output will provide insights into the life history and dynamics of this population.

DONNELLY-GREENAN, E[1,2,3], H NEVINS[1,2,3], M HESTER[2,3], J BECK[3]
1 Moss Landing Marine Laboratories
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Plastic ingestion in Pacific Northern Fulmars (Fulmarus glacialis) collected from beach surveys in Monterey Bay, CA and Alaska fishery bycatch sources

Northern Fulmars (*Fulmarus glacialis*) migrate to Monterey Bay, during the non-breeding winter months. Fulmars are opportunistic surface feeders that often ingest plastic and other debris. We examined fulmar carcasses collected by volunteer BeachCOMBERS during monthly beach surveys on National Marine Sanctuary beaches and observers aboard Alaska commercial fishery boats from 2010-2011. The birds were necropsied, examined, and sampled at the Marine Veterinary Care and Research Center, California Department of Fish and Game, Santa Cruz. Fulmar stomach contents were assessed for plastic and marine debris ingestion; sorted, categorized, weighed, and compared. California beach-cast fulmars (n = 113) had a greater incidence of plastic compared to Alaska bycatch birds (n = 290): [total plastic (CA 72% vs. AK 40%), industrial plastic (CA 30% vs. AK 7%), user plastic (CA 71% vs. AK 38%)]. Additionally, beach-cast fulmars had significantly greater number of plastic pieces per stomach and contained significantly greater masses (g) of plastic than

bycatch fulmars ($p \leq 0.05$). Northern Fulmars are top predators that regularly ingest litter and accumulate indigestible items in their digestive systems, thus, stomach contents provide an integrated picture of litter in the marine environment, where they forage.

DUNKIN, R[1], S WILKIN[2], E WHEELER[3], E BERMAN-KOWALEWSKI[4], F GULLAND[3]
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An analysis of the 2007-2009 Harbor Porpoise (*Phocoena phocoena*) unusual mortality event in Central California

In 2007, the number of harbor porpoises (*Phocoena phocoena*) stranding along the central California coast increased, resulting in the declaration of an "Unusual Mortality Event" (UME). This increase continued throughout 2008 and 2009, with more than twice the mean annual number of strandings for the previous decade occurring each year. We looked at causes of mortality for harbor porpoise for 1998 through 2009 and found that no single cause of mortality explained the increase. During the UME, Trauma, including intraspecific aggression with bottlenose dolphins (*Tursiops truncatus*) and maternal separation, were the most common causes of death. Domoic acid toxicosis was documented for the first time in this species. The increase in strandings likely reflects changes in porpoise distribution or abundance locally rather than an epizootic of disease.

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A comparison of four methods to anesthetize a Pacific nearshore rockfish *Sebastes carnatus*

Anesthestizing agents are used in wild fish research to minimize stress and physical damage during routine experimental procedures. In the U.S., tricaine methanesulfonate (MS-222) is the only legally approved drug for anesthetic use on wild fish that will be released, and its use requires a 21-day holding period to ensure human food safety. Therefore, there is a compelling need for the development of an approved zero-withdrawal anesthetic or immediate-release sedative for use in field research. We conducted experiments using MS-222, carbon dioxide (CO2) gas, sodium bicarbonate (NaHCO3) and electroanesthesia to evaluate induction and recovery times and the survival of fishes for the four anesthetics. Although immediate-release methods such CO2 gas, NaHCO3 and electroanesthesia have been used on a variety of freshwater species, comparative studies evaluating these sedatives in marine fish are generally lacking and appropriate concentrations have not yet been determined. In this study, we established that 175 mg/L MS-222, CO2 flowing at a rate of 5 L/min, 2.66 g/L NaHCO3 and pulsed DC electroanesthesia (60 Hz, 150 volts, 3 second exposure) were optimal dosages to sedate Gopher Rockfish *Sebastes carnatus* to the level necessary to perform invasive surgical procedures. At these dosages, surgical immobilization required 2.56 to 3.48 minutes, except for electroanesthesia, which was nearly instantaneous, and recovery times ranged from 3.65 to 7.79 minutes depending upon treatment.

Of the immediate-release sedatives examined all three methods were effective. Electroanesthesia had recovery times comparable to that of MS-222, followed by NaHCO3 and CO2.

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Wildfire! Changing the dynamics of land-sea connectivity along the Big Sur coast

Terrestrial and marine ecosystems are inextricably linked by the movement of individuals, energy, and sediment across the invisible border that separates them. The magnitude and timing of delivery of subsidies depends largely on the rainfall patterns, topography, and land-use characteristics of the watershed. The Big Sur coast in central California is characterized by a Mediterranean climate, steep landscape, and nearly pristine terrestrial and marine habitats. In the summer of 2008, the Basin Complex Fire (BCF) severely burned over 180,000 acres of this pristine wilderness area. The BCF provided a unique opportunity to investigate the effects of wildfire on linked watershed, stream, and coastal marine habitats due to the availability of pre-fire water quality data (2005-2008) that were collected from two rivers and adjacent nearshore areas of Big Sur: the Big Sur River (watershed ~90% burned) and Big Creek (watershed 0% burned). Following the BCF, water samples were collected from 2008-2011 and analyzed for the same suite of constituents as pre-fire samples including chlorophyll-a, particulate organic matter, nitrate, and phosphate. Our data show that there were significant increases in the concentration of all parameters at the Big Sur River sites following the fire across all years and continued to show increases through 2011, while there was no statistically significant change in concentrations at Big Creek sites. This study highlights the importance of understanding how connectivity and subsidy delivery across the land-sea interface are altered by terrestrial disturbances and the duration impacts can persist in the system.

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Community-level effects of burial and exhumation on temperate rocky reef benthos

Benthic marine communities are exposed to energetic environments that can cause frequent disturbances such as burial or exhumation of the seafloor. The effects of these disturbances on local communities depend on their frequency, strength and the resilience of community members. To quantify the effect of disturbance by sediment burial on rocky reef communities in the northern Monterey Bay we generated maps of burial and exhumation of reefs using acoustic multi-beam surveys. To ground-truth these maps and to characterize the benthic communities we conducted scuba surveys. We categorized areas as stable or dynamic rocky reef (i.e. chronically buried and exhumed) using the acoustic surveys and compared communities of sessile and mobile organisms between those areas. Species richness and diversity of mobile and sessile organisms were significantly lower in dynamic areas than on adjacent, stable reefs. Multi dimensional scaling (MDS) indicated that communities in stable habitats are more similar to each other then benthic communities in adjacent dynamic areas. Sessile communities in dynamic areas were dominated

species that colonize rapidly or can endure scour and burial. Most mobile species (e.g., sea stars and urchins) were more abundant in stable than in dynamic areas, however some species (e.g., anemones) thrived in dynamic habitats. These results demonstrate that substrate dynamics operating at intra-annual time scales can structure marine communities. Therefore, efforts to map the distributions of benthic communities using remote sensing of the substrate must account for the frequency, intensity, and distribution of disturbances caused by sediment transport and require time-series of acoustic surveys.

GARCIA, P, K ZEPEDA, A RINCON, A FERREIRA
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Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Benthic Invertebrate Diversity in Two Elkhorn Slough Sites

Aquatic invertebrates are essential to the health of communities such as sloughs and water systems. They often act as water quality indicators for those communities and play a role in the food chain; the majority of them being food for fish. The levee that separates South Marsh from Whistlestop Lagoon in Elkhorn Slough is constricting one of the culverts which limits tidal flow into and out of the lagoon. Elkhorn Slough staff is considering a renovation of the area. Our background research on the aquatic life that exists there will help the Elkhorn Slough staff make their decision about what type of renovations are necessary. Our question was "Will Whistlestop Lagoon have a higher diversity of benthic invertebrates and a difference in turbidity, pH, salinity, and temperature, in comparison to South Marsh?" We set out a series of settlement plates on both sides of the levee to observe the benthic invertebrates that settled on those tiles. We collected the plates at five different times during the study and identified species that had settled. We also collected water quality data such as turbidity, pH, temperature and salinity. Our data collection will be used directly by the Elkhorn Slough staff to help make their decisions about restoration.

GELLER, J, H HAWK, K MEAGHER, M MARRAFFINI, G RHETT
Moss Landing Marine Laboratories

DNA barcoding of invasive invertebrates from fouling communities in San Francisco Bay, CA

Marine biological invasions are recognized as a key anthropogenic impact globally. State and Federal regulations seek to limit the rate of new invasions in U.S. waters by, for example, requiring open ocean ballast water exchange before discharge. Assessing the efficacy of such measures requires baseline data of invasive species already established, followed by repeated sampling for new invasions. To assist such a program by California Department of Fish and Game, we are creating a database of DNA sequences of epibenthic invertebrates from fouling plates deployed for three month intervals in San Francisco Bay, one of the most invaded estuaries globally. Specimens are removed from plates, identified morphologically, and analyzed for mitochondrial *Cytochrome c oxidase subunit I* and *28S rRNA* gene sequences. Repeated sequencing of several morphospecies has revealed cryptic species and instances of taxonomic misidentification. Formerly undetected invasions have been revealed, including the Atlantic barnacle *Amphibalanus eburneus*. DNA barcoding thus provides a method for rapid identification, discovery of cryptic

species and new invasions, and a means of taxonomic quality control. Continuing work expands geographically to all California and by habitat to plankton and soft sediments.

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Extreme plasticity in life-history strategy allows a migratory predator to cope with climate change

Dosidicus gigas (Humboldt squid) is a migratory predator with a single reproductive cycle. In the Gulf of California, these animals mature at large size (>60 cm mantle length) in 1-1.5 years and support the major commercial fishery in the Guaymas Basin. This fishery has been stable since 2000, with the exception of a collapse of several years following the 1997-98 El Niño. In 2009-2010 another El Niño event led to major changes in distribution, diet and reproductive strategy of this important predator. Squid abandoned their normal coastal-shelf habitats and appeared *en masse* in areas where productivity was less dependent on wind-driven upwelling. One alternate area was an archipelago north of the Guaymas Basin that depends on tidal upwelling, and both large squid and the commercial fishery relocated there. Prey there was largely krill, atypical for this squid. A second alternate was the open Guaymas Basin, where squid matured at an unusually small body size (20-30 cm mantle length) and young age (~6 months). Diet here consisted of myctophids and mesopelagic micronekton other than krill. Juvenile squid thus responded to El Niño with an alternative life-history trajectory in which gigantism and high fecundity in a normally productive coastal habitat were traded for accelerated reproduction at small size in an less-productive offshore environment that may be less impacted by El Niño. Such a switch in life-history strategy, along with dietary flexibility and migratory ability, might allow *Dosidicus* to rapidly adjust to climate change on a variety of time scales.

GUERRERO, E, M RAMIREZ, A ZAVALA
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The Effect of Ocean Acidification on Japanese Mud Snail Behavior

Ocean acidification is one of the largest problems caused by the emissions of carbon dioxide. Carbon dioxide is emitted into the air when people burn fossil fuels in their daily life. Carbon dioxide reacts with ocean water to form carbonic acid, which can be very hazardous to marine animals, especially those containing calcium carbonate (for example shelled snails, crustaceans, and coral reefs). The Japanese mud snail is an abundant and invasive species at Elkhorn Slough in coastal Monterey Bay, CA. We have tested the effect of ocean acidification on Japanese mud snail behavior by observing the snails in acidified ocean water (pH 6.5) and in control seawater (pH 8.0). Because the snails' membrane is very permeable, water has direct access to their anatomy. We hypothesized that acidic water might interfere with respiration and that the snails would therefore move slower in acidified water. We hope that our results will help us better understand the impact ocean acidification has on marine life behavior, and add another reason why we as humans should reduce our daily emission of carbon dioxide.

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Dune Habitat Plant Biodiversity and Effects on Soil Chemistry

Plants determine the type of species and biological activity that take place in dune ecosystems. The invasion of non-native species on dunes may change the balance of soil nutrients. Non-native species often out-compete natives, crowding them out of their original habitat. Non-native species reduce plant diversity and make it difficult for native animals to thrive. To assess the effect of plant biodiversity on soil chemistry, we analyzed the soil chemistry at several Moss Landing dunes over a two month period and compared the following three sites: non-restored, recently restored, and fully restored dune habitat. At each site, we tested important soil chemistry parameters (pH, Nitrogen, Phosphate and Potassium) to better understand the different levels of soil nutrients. In addition to soil chemistry, we noted the abundance of plant species. Our comparison study highlights the importance of restoration and native plants in the local sand dune habitat.

HARVEY, J AND S MANUGIAN
Moss Landing Marine Laboratories

Survival and movements of radio tagged adult female harbor seals (*Phoca vitulina*) in San Francisco and Tomales Bays, California

Knowledge of basic life history data for harbor seals (*Phoca vitulina*) in northern California is lacking. Tagging animals with radio transmitters allows data collection including lifespan and general movement patterns. These data over time will support inferences about movement behavior, site fidelity, survivability, and other components of harbor seals' biology.

Traditional tracking uses external tags applied to hair however the tag is lost during annual molt. Internal placement of transmitters has been explored to negate this loss subsequently extending monitoring time. This ensures multiple seasons of data providing the tag is formatted correctly, no infection occurs during implantation process, and the animal survives and does not migrate out of the studied area.

In June and July 2011, thirty adult female harbor seals (plus an additional eleven pilot study animals prior) were implanted with Telonics tags in San Francisco and Tomales (PRNS) bays to assess post parturition survival rates using anxiolytic (diazepam) and local anesthesia (lidocaine). Post-release, animals have been stringently tracked using aerial surveys (x1-2/month) and use of a passive listening station installed in Tomales Bay (downloaded x2/month).

Preliminary aerial tracking results show 17 resighted seals (1/3rd of those more than once) and movement between bays. We plan to continue tracking through December 2012 and hope to tweak the listening station to gather un-noisy results. This is the first study to assess US west coast harbor seal survival and the first to assess survival not utilizing subsistence harvesting. Results, important to understanding status and behavior, will be shared with managers.

HOFVENDAHL, R
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Something in the Water

Phytoplankton are of incredible ecological importance; they are the basis of the marine food web, and are responsible for roughly 60% of global oxygen production. However, their natural life cycle is being disrupted by pollutants released into the environment. The purpose of this project is to increase our understanding of how the pollutants we release affect phytoplankton populations, so as to allow us to develop policies to minimize our negative impact on the environment. This year I am focusing on the effects of urban runoff on phytoplankton. My investigative question: what pollutants present in urban runoff have the greatest disruptive effect on phytoplankton populations? My hypothesis is that the most significant pollutants in urban runoff are nitrates and phosphates. To answer this question, I have spent considerable effort developing an automatic sampling mechanism, capable of taking a total 24 samples from three enclosed incubation tanks over the course of its four-day deployment. I will use this sampling mechanism to conduct a series of tests on pollutants present in a sample of urban runoff, which will allow me to isolate and compare the effects of each pollutant. While I have yet to run many of the tests, all preliminary work has been completed, including the design and construction of the automatic sampler. I am confident that all testing will be complete within a month. Special thanks to Susan Coale, Gregg Langlois and Kendra Hayashi for mentoring me in this project, and to the San Lorenzo Valley Water District for funding.

HOVING, H AND B ROBISON
Monterey Bay Aquarium Research Institute

Vampire squid feed on marine aggregates in the oxygen minimum zone of the Monterey Submarine Canyon

Vampire squid (Vampyroteuthis infernalis) are considered phylogenetic relics with cephalopod features of both octopods and squids. They lack tentacles, but have eight arms, and two long extendable retractile filaments, the exact function of which remains subject to speculation. In the pelagic waters of the Monterey Submarine Canyon Vampyroteuthis is typically found at ~ 700 m depth, the center of the oxygen minimum zone (OMZ). We investigated the vampire squid's feeding ecology. The feeding behavior was analyzed using in situ video from MBARI's remotely operated vehicles (ROVs), and by performing feeding experiments in the lab with ROV-captured individuals. Crop contents of ROV and trawl caught individuals from Monterey Bay, southern California and the Gulf of California were analyzed. The morphology of the retractile filament, the suckers and cirri were examined by SEM and histology. Vampire squid feed on marine aggregates that include remains of gelatinous zooplankton like salps, larvaceans and medusae, moults of crustaceans and also complete copepods, ostracods, amphipods and isopods. Faecal pellets and microscopically small crustacean parts were found in almost all crops contents. Both ROV observations and lab experiments led to the hypothesis that vampire squid use their retractile filaments, which we found to have high sensory capability, for the detection and/or capture of marine aggregates. The vampire squid's feeding behavior is unlike any other cephalopod, and reveals another unique adaptation that allows these animals to spend most of their life in the centre of the OMZ, an environment where predators are few and typical cephalopod food is scarce.

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Prevalence and virulence profiles of *Vibrio* spp. in Pacific Harbor Seals (*Phoca vitulina richardii)* off central California

Vibrio bacteria were isolated from Pacific harbor seals (*Phoca vitulina richardii*) within San Francisco Bay (SFB), Tomales Bay (TB), Elkhorn Slough (ES), Humboldt Bay (HB), and from live stranded animals from the Marine Mammal Center (TMMC). Virulent strains of *Vibrio* cause deleterious pathological affects across a broad range of taxa, however it is unknown how *Vibrio* affect populations of marine mammals, including harbor seals. The objective of this study was to determine the prevalence of *Vibrio* bacteria in harbor seals among study sites, and assess their virulence potential. Sampling commenced in 2010 following through 2011 (n=283). The isolates of *Vibrio* were identified to species level via biochemical assays, and PCR. The species observed were *Vibrio parahaemolyticus (Vp)*, *V. alginolyticus (Va)*, and *V.cholerae (Vc).* No seasonal difference was detected for total prevalence of *Vibrio* in harbor seals, however significance was found ($P<0.001$) among study sites. Elkhorn Slough had the greatest percentage of seals harboring *Vibrio* (57%, n=47) followed by HB (46%, n=28), SFB (36%, n=33), TMMC (25%, n=61), and TB (13%, n=114). *Vp* and *Vc* isolates were then screened for toxin (*ctx)* or hemolysin (*tdh, trh,* and *tl)* virulence genes. Two isolates of *Vc* were obtained from stranded seals (*ctx-)*. Five isolates of *Vp* (SFB=2, ES=3) contained all three hemolysin genes, while the majority contained only *trh, tl,* or both. These data demonstrate harbor seals in urbanized environments carry virulent *Vp*. Future studies include developing epizootic predictive models, and phylogenetic analysis of seal isolates and human epidemic strains.

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Developing a passive acoustic monitoring network for harbor porpoise in central California

The harbor porpoise (*Phocoena phocoena*) is common in coastal waters of the temperate northern hemisphere, but has experienced population declines in many areas due to diverse anthropogenic impacts, especially bycatch in fisheries. Aerial surveys are currently used to satisfy basic monitoring needs along the U.S. West Coast but are costly, weather-limited, and provide coarsely resolved data. To address the significant need for improved harbor porpoise monitoring methods we are developing a passive acoustic monitoring network in central California using porpoise click detectors (C-PODs). Between October and December 2011, we conducted a pilot study with a single C-POD in Monterey Bay and collected 84 days of continuous acoustic data, 7 days of cliff-top observations, and 8 days of aerial over-flights. Here we present initial analyses of the relationships between visual and acoustic observations. Our data indicate that C-PODs can be successfully used for monitoring of harbor porpoise in this region. Future work will focus on determining the optimal spatial and temporal configuration for a large-scale monitoring network.

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Science and Environmental Policy, California State University, Monterey Bay

Comparing the Abundance, Diversity, and Potential Toxicity Freshwater Cyanobacteria in Two Central California Coastal Lakes.

Freshwater cyanobacteria harmful algal blooms (CHABs) threaten humans and other organisms with an array of potent toxins (Codd et al. 1999; WHO 1999). The hepatotoxic microcsytins are some of the most pervasive cyanotoxins (Sivonen et al. 1992, Iberlings et al. 2005) and are produced by many cyanobacterial taxa including *Microcystis, Anabaena,* and *Oscillatoria* (Sivonen, K., and G. Jones. 1999), all of which are found in freshwater and estuarine systems of the Monterey Bay Area (Miller et. al 2010). These toxins present a threat to both terrestrial and marine mammals in the Monterey Bay (Miller et al., 2010, Stewart et al. 2007). In this project we determined the extent of CHAB formation in two freshwater lakes in the Monterey Bay. We used an interdisciplinary approach combining molecular biology and ecology to study the abundance, diversity, and potential toxicity of cyanobacteria in Pinto Lake (Watsonville, CA) and Loch Lomond Reservoir (Santa Cruz, CA). The abundance and diversity of toxic cyanobacteria was determined using established techniques for planktonic enumeration via microscopy, and the toxicity and potential toxicity was elucidated with the polymerase chain reaction (PCR) and enzyme linked immunosorbent assays (ELISAs). This research provides baseline data to assist the cities of Watsonville and Santa Cruz in evaluating the potential health risks posed by the CHABs in these two lakes that are frequented by the public. These data will also support further study of the environmental causal factors controlling the proliferation of toxic CHABs.

JUAREZ, E, C PIZANO, J RIOS, G SERRANO
Watsonville High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Water oxygen levels and fish biodiversity: a preliminary study of fish at Elkhorn Slough

Elkhorn slough contains about 102 types of fish. It is an important habitat because 80% of the fish found at the slough use it as a nursery; this contributes to our commercial fishing industry. According to the studies conducted in 2002 by The Elkhorn Slough Foundation, human impact on Elkhorn Slough has fundamentally changed available fish habitat, resulting in decreased fish types and quantity. This fact has a great affect on Elkhorn Slough because fish are the most studied inhabitants of the reserve. We are investigating the effect of water oxygen levels on fish biodiversity at Elkhorn Slough. Our project takes place on both sides of Whistle Stop lagoon. Our research is important because it will reveal if the ecosystem at Whistle Stop is healthy. For our study we are comparing the amount of fish sampled in relation to the oxygen levels. We predict that the oxygen levels are restricting the variation of fish at the Slough. The Elkhorn Slough National Estuarine Research Reserve (ESNERR) is considering reconstructing or removing the levy separating Whistle Stop Lagoon and South Marsh. We hope our project will help ESNERR make a decision.

KELLY, M AND J LINDHOLM
Institute for Applied Marine Ecology, California State University, Monterey Bay

Distribution and habitat utilization of lingcod (*Ophiodon elongatus*) off central California: implications for conservation and management

A clear understanding of how organisms are dispersed relative to landscape features is critical for resource managers seeking to successfully manage marine ecosystems. This is particularly valid for management strategies as specific as the designation of essential fish habitat (EFH), or more broadly in the context of marine spatial planning efforts. However, the designation of EFH has proven challenging for many species due to a lack of information on fine-scale habitat associations. For instance, our understanding of the habitat associations of lingcod (*Ophiodon elongatus*), an important commercial and recreational fish, is limited. Furthermore, much of our knowledge derives from studies in the Pacific Northwest and British Columbia, with considerably less known about lingcod associations in the southern portion of their range. We used a towed camera sled to quantify the distribution and habitat associations of lingcod from Ascension Canyon to Piedras Blancas, within the Monterey Bay National Marine Sanctuary.

Video imagery, collected across 78 towed camera sled transects from 2007 to 2011, was used to identify the total length and habitat association of 400 individual lingcod. From these data, generalized linear models (GLMs) were created and compared using Akaike's Information Criterion (AIC). GMLs evaluate the extent to which selected environmental factors significantly predict lingcod presence. The GLM models were also used to test if there is a significant difference in habitat utilization between lingcod at different size classes. Ultimately, we expect the results of this project to inform ongoing management of lingcod off California, in both state and federal waters.

KELLY, S[1], S RICHMOND[2], D SMITH[1]
1 California State University, Monterey Bay
2 Balance Hydrologics

Quantifying geomorphic change in the upper Carmel River following the 2008 Basin Complex Fire

Protecting the Carmel River watershed is of regional importance as both an ecological and economic resource on the Central California Coast. Increased understanding of natural processes, such as wildfire, in the Carmel River watershed, helps improve management strategies to maintain both ecosystem and public interest. Wildfire generally accelerates the sediment supplied to stream channels, thereby posing threats to both native species and local residents. Studying the sediment response of the recent 2008 Basin Complex fire increases the existing knowledge of wildfire's role in the Upper Carmel River. The objective of this study is to compare event-based and annual surveyed cross sections and pebble counts to assess whether the post-fire response generated significant geomorphic change. Preliminary results suggest that river channel geomorphology did not significantly change beyond the expected natural variability; however, the data will be analyzed using paired t-tests for statistical significance. The geomorphic change following the 2008 Basin Complex fire is expected to contrast greatly with the pronounced channel aggradation that Hecht (1981) detected following the 1977 Marble Cone fire. Fire history, pre-fire climate, and the timing and magnitude of rainfall following each fire are thought to explain most of the variability between the two geomorphic responses in the Upper Carmel River.

KHANDELWAL, D, S LOPP, K PORTER
C.T. English Middle School

Tsunami!!! The effect of structure size, strength, and placement of harbor protection

In 2011, the earthquake in Japan caused a tsunami to hit all the way on the coast of California. That tsunami traveled across the whole Pacific Ocean to hit harbors all along the coast. Harbors in Santa Cruz and Crescent City sustained major damage, comprising much of California's $35 million in damages. One possible cause for this damage is the low level of protection of the harbors, with both being confined (funnel shaped), outward facing, and without defenses such as walls. We tested how different structures would affect the damage done by a tsunami. We put six different "harbor plans" in the tank and pounded each with a volley of waves. Results showed that structures that were higher, stronger, and placed correctly (walls that are angled towards the wave and are in the middle of the channel) stopped the force of the tsunami better than others that were weaker (wall was thin and wave pushes through) and less strategically placed. We conclude that if you make a higher and stronger structure and place it correctly in the channel then it will prevent a harbor from getting damaged.

LAUNER, A[1], T WADSWORTH, L BREAKER[1], R STARR[1,2]
1 Moss Landing Marine Laboratories
2 California Sea Grant Extension Program

Paradigm or paradox: can we attribute species changes to environmental variables in central California?

Basin wide changes in temperature and productivity have occurred over the past 100 years in the Pacific with many more predicted in the future. On the central California coast, a cooling trend in sea surface temperatures over the past 12 years has been observed. Given these environmental conditions, it is unclear how marine fishes will respond to climate change. The goals of this study were to (1) refine our understanding of trends in sea surface temperature in central California (2) determine the relationship between environmental variation and changes in demersal fish assemblages in central CA and (3) quantify changes in the distance of warm isotherms off the central California coast to determine potential relationships with abundance of pelagic species. We compared fish abundance estimates from fishery dependent surveys, commercial landings, and stock assessments with *in situ* and satellite sea surface temperature and basin-scale climate indices, to determine if there are relationships among these variables. Time series analyzed were 1920-1975 and 1980-2003. Results of cross correlation and logistic regression analyses of temperature and abundance provided significant but conflicting results. However, basin-scale climate indices include salinity and chlorophyll-a as well as sea surface temperature. Results of cross correlation analyses using these indices provided clear relationships with fish abundances although conflicting results were still observed. We conclude changes in temperature alone are not driving changes in fish populations, and other environmental factors are additionally important.

LINDHOLM, E[1] AND J LINDHOLM[2]
1 Carmel River School
2 Institute for Applied Marine Ecology, California State University, Monterey Bay

Movement of blue banded hermit crabs (*Pagurus samuelis*) at Carmel Point

We wanted to see how far hermit crabs move and wanted to have fun. We took a waterproof notepad to the tide pools at Carmel Point. Then we found hermit crabs that we wanted to watch. Next we watched each hermit crab for five minutes, remembering where each crab went and how far it moved. We estimated the distance moved by the hermit crabs with a pen and then figured out how many centimeters it was. And then we traced each hermit crab's shell to see how big it was. We expected all the hermit crabs to move far. What we found was that some crabs moved far and some did not. Some moved in straight lines others moved all over the place, while some of them liked to stay put. Also, some of our hermit crabs were eating or wrestling with other hermit crabs and some were even pulling other hermit crabs out of the water and onto the rocks. We think some hermit crabs like to move at sundown, but we haven't tested that yet.

LOREN, E, D GENIS, J PRAMBS
San Lorenzo Valley High School

Fall Creek: stream restoration or stream corruption

In Fall Creek, a subunit of Henry Cowell State Park, there is a small section of stream that was restored about 20 years ago. Our group decided to investigate whether or not this restoration was successful. We are comparing a restored section of creek to a natural section further upstream ideal to steelhead rearing. We hypothesize that if the two sites are very similar in stream structure over time, then the restoration was a success and beneficial to the stream and its steelhead population. To measure rate of change of stream structure, we are profiling the stream and conducting pebble counts. We are using stadia rods and hand levels to profile the stream channel at both sites once a month. To map the substrate structure of the streambed, we walk along 100 foot sections of both sites recording size of pebbles and gravel. From these two data sources, we anticipate being able to determine the rate of structural change between the two sections. We have not yet collected enough data to make any firm conclusions. We would like to thank our mentor, Dr. Mark Strudley.

MAHONEY, B
Department of Ecology and Evolutionary Biology, University of California, Santa Cruz

Temporal and spatial variability in algal-invertebrate associations in benthic red algal communities, Monterey Bay, CA

Mechanisms that operate across spatial and temporal scales regulate distribution and abundance of available habitat and can influence abundance and diversity of associated fauna. The understory algal community in a kelp forest is comprised primarily of red algae, which provide important habitat to a diverse community of small, mobile invertebrates that are, in turn, important food sources for kelp forest fishes. Morphological complexity of algae can influence the composition and abundance of associated fauna. To understand spatial variability in red algae and how this

translates to variability in associated invertebrates, I conducted benthic surveys and collections in 6 kelp forests along the Monterey Bay peninsula, CA every 3-4 weeks from July-December 2011. Percent cover of red algae was quantified using UPC along transects. To determine abundance and composition of associated invertebrates at each site and for varying complexities of algal morphology, I collected 6 species of red algae that represent a range of algal morphologies from simple to complex. Associated invertebrates were removed and enumerated. Red algal coverage as well as abundance of the 6 algal species were compared among sites and over time. The invertebrate composition associated with algal species and among sites were analyzed using multivariate approaches in PRIMER. I found considerable spatial variability in both algal and invertebrate communities. In addition, the relationship between algal substrate and invertebrate community varied over space indicating that local drivers may have pronounced effects on the interactions between availability of habitat and structure of associated communities.

MARKS, C AND R KVITEK
California State University, Monterey Bay

Mapping the Elkhorn Slough: combining wide-swath sonar and vessel-based lidar technologies to measure the effects of sill construction at the mouth of Parsons Slough

The Elkhorn Slough has undergone decades of anthropogenic modification. In particular, the opening of the main channel to Moss Landing harbor in 1947, which substantially increased tidal flow and subsequently, rates of tidal erosion. The increased rate of tidal scour, sediment transport, and erosion in the Slough has been identified as a threat to the preservation of coastal wetlands and ecologically important estuarine habitats. To decrease tidal scour and reduce erosion, a submerged sill was constructed at the mouth of Parsons Slough in 2011. The goal of this project is to contribute data for the continued evaluation of the effects of the newly constructed sill. Using bathymetric sidescan sonar and vessel-based mobile marine LiDAR, we created seamless topographic and bathymetric digital elevation models (DEM) of the Elkhorn Slough channels and tidal marshlands. The result is a high-resolution baseline map for the year the sill was completed. These data can be used to quantify sediment transport and erosion through comparative analyses with past and future mapping efforts. In addition, we aim to quantify erosion rates at the mouth of Parsons Slough by calculating the vertical and horizontal differences in DEMs from surveys conducted pre-sill construction (2009), the year of sill construction (2010), and post-sill construction (2011). These analyses will contribute to the management plan to evaluate projects implemented through the Elkhorn Slough Foundation and the Elkhorn Slough National Estuarine Research Reserve in an effort to mitigate the loss of unique tidal marsh habitat.

MEAGHER, K, S GABARA, D STELLER
Moss Landing Marine Laboratories

Preliminary estimates of cryptofaunal and algal diversity in a Catalina Island Rhodolith bed and assessment of disturbance on associated assemblages

Rhodoliths are free-living calcified red algae (Rhodophyta, Corallinaceae) that creates complex three-dimensional habitat supporting rich assemblages of invertebrates and algae. Rhodolith beds are globally distributed and in California seven beds were recently documented in six Catalina Island coves. Fragile and slow growing, rhodoliths are easily crushed into carbonate sand. Within

these Catalina coves, mooring chains create high disturbance areas located among areas of intact rhodoliths. This study aims to estimate the diversity and abundance of invertebrates and algae in Catalina Island rhodolith beds and compare these parameters between intact rhodoliths (R), crushed rhodolith sand (CRS), and non-rhodolith sand habitat (SS). From each substrate type, benthic cores were collected and substrates were sieved through a 0.5mm mesh and examined using a dissecting scope. All invertebrates were identified to the lowest taxonomic level. The mean abundance (# individuals/core +/-s.e.) varied among substrates (R=67.7 +/-6.57, CRS=52.0 +/-18.00, and SS=19.0+/-6.57). Despite the difference in total abundance, species richness (#spp/core) was very similar among habitats (R=23.3 +/- 0.33, CRS=15.0 +/- 3.06, SS=14.0 +/- 4.58). One striking difference was that all mollusks found in the SS habitat were bivalves, while in the rhodolith and CRS habitats supported other mollusk forms in addition to bivalves. Algae were removed from the substrate, distinguished from drift, then pressed and identified to genus. The mean abundance (# thalli/core +/-s.e.) varied among substrates (R=68.0 +/-16.5, CRS=20.6 +/-10.3, and SS=3.5+/-1.5). These preliminary findings suggest that rhodoliths support diverse communities varying from dominant non-carbonate substrates and that mooring disturbance negatively alters these fragile communities.

MELCHER, M AND D CHABOT
San Lorenzo Valley High School

Anemone plot: is the biodiversity changing?

Our goal is to learn how to identify tidepool organisms, gather data following LiMPETS protocols and compare the data we collect to historical data. We hypothesize that over time we will see a change in species numbers and types. We collect data approximately twice a month during low tides at Davenport Landing State Beach. We follow the LiMPETs (Long-term Monitoring Program and Experiential Training for Students) protocols for collecting data in the already established 15m X 15m anemone plot. Using a random number table, we determine the populations of various invertebrates and algae species utilizing a one-meter square quadrat. We record this data, repeat the process, and create graphs to monitor the fluctuation of each species population. We are in the process of comparing our data to data previously collected at this site. From our data, we will determine which species populations have changed over time and then hypothesize, test, and research why. As we continue observing and collecting data over this next year we will be able to make more concrete conclusions. Thanks go to our mentor Dr. John Pearse.

MORENO, A[1], N KELLEY[2], C BATMALLE[3], A AMEND[4], A MARTINY[3,4]
1 Marine Science, California State University, Monterey Bay
2 Biology, Dakota State University, Madison, South Dakota
3 Earth Systems Science, University of California, Irvine
4 Ecology and Evolutionary Biology, University of California, Irvine

Fungi and salinity gradient in New Port California affect nutrient ratios

Contents of carbon (C), nitrogen (N), phosphorous (P) play key roles in the make-up of organisms and the structural and functionality of those organisms in a community. In this study we examined terrestrial fungal cultures and a gradient from fresh water to salt water, in order to measure C, N, and P content. Results show that an average C:N:P ratio for the terrestrial fungal cultures is

145:48:1. In the fresh to salt water gradient, levels of N were inadequate and could not be detected; therefore levels of C and P were compared. The average C:P ratios for the gradient from fresh to salt increases during ebb tide (58, 86, 131, and 195) and increases slightly with some overlap in the middle sites (49, 56, 55, and 63) during flow tide. We conclude that levels of P decline from terrestrial to aquatic to marine regions. Many factors can be influencing this decline; including but not limited to sediment and soil run off, amounts of biomass, if one is homeostatic or not and growth rate of organisms.

ORNELAS, D, L ROCHA, J MARTINEZ, M VALTIERRA
Watsonville High School
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

Ecological Impact of European Green Crabs on Native Crabs Species at Elkhorn Slough

European green crabs have affected marine and estuarine ecosystems, aquaculture, and fisheries worldwide. They impact native crab species by competing for food and habitat. They impact other native species with their great capacity for prey, extreme aggression, and strong chelipeds used to fight native species. European green crabs arrived in the 1980s or 1990s at the Elkhorn Slough wetlands in Monterey Bay, Central California, most likely as larvae in ballast water. Ballast water is water from a port or other location that is taken on-board a ship and stored in tanks to add weight, thereby maintaining the ship's trim and stability. We are focusing on comparing the relative abundance of green crabs and native crabs between regions of Elkhorn Slough. By deploying crab traps at several sites in Elkhorn Slough from November 2011 to January 2012, we determined that at the beginning of our project we found that about 90% of the crabs we caught were European green crabs and by then end of or study the numbers were 60%. We returned the native crabs and collected the European green crabs that we caught. We anticipate that our research will further inform a number of stakeholders of the Monterey Bay in regards to the large amounts of European green crabs impacting California's Ocean ecosystems and in hopes to mitigate the impacts of invasive species.

PERALES, B[1], B SMITH[2], B ALVARADO JR[2, 3]
1 Divison of Science and Environmental Policy, California State University, Monterey Bay
2 Department of Wildlife and Fisheries Sciences, Texas A&M University
3 Department of Marine Biology, Texas A&M University at Galveston

Genetic identification of Tuna species via high-resolution melting analysis

Tunas of the genus *Thunnus* include some of the most economically and ecologically important fish species in the world, because of this it is important that they can be identified in the larval and juvenile stages. However, tuna larvae and juveniles are difficult to identify by morphological characteristics. Previous genetic methods of identifying tuna larvae have been unsuccessful in identifying every species of *Thunnus* and are expensive and time consuming. The method we used was high-resolution melting analysis (HRMA) which is a highly sensitive, low cost, and fast genotyping method amenable to high throughput that can be used to identify tuna species. In this study we developed a genetic tuna species identification assay using HRMA of single nucleotide polymorphisms (SNPs) in the mitochondrial DNA (mtDNA) nitrogen dehydrogenase subunit 4 (ND4) gene. Short amplicon HRMA primers and an unlabeled probe generate diagnostic species

specific melting curves. Northern bluefin tuna (*T. thynnus*), southern bluefin tuna (*T. maccoyii*), albacore tuna (*T. alalunga*), blackfin tuna (*T. atlanticus*), yellowfin tuna (*T. albacares*), and bigeye tuna (*T. obesus*) are easily identified using this newly developed genetic assay.

PINCETICH, C AND M ONG
Sea Turtle Restoration Project

Documenting critically endangered Pacific Leatherback Sea Turtles through the Sea Turtle Restoration Project's Leatherback Watch Program

Endangered Pacific leatherback sea turtles migrate across the Pacific ocean to forage in and around 41,914 square miles of federally protected critical habitat, which includes 16, 910 square miles offshore of California and overlaps with the Monterey Bay National Marine Sanctuary. The Leatherback Watch Program works collaboratively to record and communicate sightings of leatherback sea turtles off the west coast of North America and uses the information obtained for education, research, and conservation purposes. The objective is to obtain the date, time, name of observer, exact GPS coordinates, a photograph or video as evidence of the sighting, weather and behavior details from each sighting. During 2011 the program compiled 23 sightings from California to British Columbia, Canada through outreach to approximately 150 program participants that receive our monthly emails, phone calls and connect through the program Facebook page. The first sighting in 2011 was recorded June 29 offshore of Point Sur, sightings peaked offshore of Moss Landing in August, and the frequency of opportunistic sightings increased with increased program participants. The 2011 observations represent a significant contribution to the limited information currently available describing the habitat use and behavior of the critically endangered Western Pacific population of leatherbacks. Sea Turtle Restoration Project's outreach and education programs have found many Californians are not aware leatherbacks exist offshore and rely on critical feeding habitat within National Marine Sanctuaries The photos and videos obtained from leatherback sightings are invaluable components of the growing public awareness of this amazing sea turtle.

SANCHEZ, M
San Lorenzo Valley High School

Fecal coliform: a study of water contamination in the San Lorenzo Valley

My goal is to identify and measure the presence of fecal coliform bacteria in the San Lorenzo Valley Watershed. My investigative question is: What is the main source of fecal coliform in our local water? I predict that animal waste is a contributing factor, but there is a possibility that some of it could be human waste from septic tank leaks. I monitor once or twice a month taking water samples from the San Lorenzo River, Zayante Creek and Fall Creek using sterile whirl-pak bags. In the classroom lab, I use membrane filtration to isolate and culture the fecal coliform bacteria. Then I incubate my petri dishes at 44.5 degrees Celsius for 24 hours. I am using *Escherichia coli* as a positive control, and insure all materials are sterile by running sterile phosphate buffer through the membrane filtration system. Data is still being collected and results are not yet available. I would like to thank my mentors Jennifer Slaughter, Water Quality Specialist, Santa Cruz County Environmental Health Services, and Jane Orbuch, Biology teacher, SLVHS.

SANKARAN, S
Moss Landing Marine Laboratories

Nutrients and metals in eutrophic coastal environments: interactions in *Ulva* spp.

A general survey of trace metal content in *Ulva* spp. (Linnaeus) around Moss Landing, California was carried out. The next objective of this study was to evaluate whether either tissue nitrogen or media nitrate affect metal uptake (As, Pb, Mn, Zn) by *Ulva* spp. under eutrophic conditions. Additionally, the role of metal burden in the invertebrate *Idotea resecata* as a function of metal content in their diet was examined. Mean trace metal concentrations in *Ulva* differed significantly among sites in Moss Landing, California. Laboratory experiments using samples from 15 sites along the central California coast revealed a significant positive correlation between *Ulva* spp. tissue nitrogen and both arsenic and manganese uptake, but no relationship with lead or zinc, and a significant positive correlation with the relative change in manganese and lead was observed. Though statistically insignificant, a regression analysis revealed a logarithmic relationship between media nitrate and both tissue arsenic and manganese. Lead and zinc content in *Ulva* demonstrated no relationship with media nitrate. Metal in *Idotea resecata* showed no significant relationship to diet treatments; however, a bioaccumulation trend was observed for arsenic and manganese. Given the role of trace metals in the production of photosynthetic enzymes and proteins, variability in productivity may drive the uptake of essential and non-essential elements. Depending on the amount of *Ulva* consumed, elevated metal content in this macroalgae could pose a health risk to invertebrates and/or humans.

SCHMIDT, K, R STARR, S HAMILTON, G CAILLIET
Moss Landing Marine Laboratories

A comparison of the length at maturity of the Blue Rockfish, *Sebastes mystinus,* before and after overfishing

Increased size-selective mortality that results from intense fishing pressure has been shown to cause reproductive compensation in several marine fishes, whereby subsequent generations of the fished population mature smaller and younger, and may also become more fecund for a given size. The Blue Rockfish, *Sebastes mystinus,* is a large component of nearshore recreational fisheries in central California. Catches from the 1970s -1980s were large enough to cause a decline in the spawning biomass, down to 10% of its unfished biomass, by 1994. During this decline of spawning biomass, the mean lengths of Blue Rockfish also declined, and currently remain well below historic mean lengths. Because Blue Rockfish are faster growing and quicker to mature relative to many other rockfishes, resulting in shorter generation times, they are a good candidate species to determine whether reproductive compensation is possible in Pacific rockfishes. Historic estimates of fecundity and size at maturity are available for Blue Rockfish from the 1960s and early 1980s, collected in central California. A comparison of the historical data to samples also collected in central California 2010 - 2011 indicates that the current population of Blue Rockfish is maturing at sizes smaller than prior to the onset of overfishing.

SCOLES, R[1,2], R EBY[1,2], R CHAFFIN[2], D MALDINI[2]
1 Elkhorn Slough National Estuarine Research Reserve
2 Okeanis

Sea Otters at Elkhorn Slough estuary: Linking Land to Sea

Prior to the near extirpation of the southern sea otter, it was common to find otters occupying tidal wetlands along the California coast. While southern sea otters are commonly associated with rocky bottom kelp forests the highest density of these otters is in Elkhorn Slough, a soft substrate estuary located near the midpoint of Monterey Bay. Up to 149 otters (mostly male) raft together in the harbor and over 50 females and pups utilize a protected tidal creek and adjacent waters further up the slough. We have studied these two distinct groups of otters over a five year period. We observed that, when not disturbed, otters frequently come ashore to rest, interact, and groom. Many otters in the harbor raft spend the night hauled out on the protected beach leaving during the day to forage in the bay. The female group and their pups further up the slough have been studied for the past three years and are our current focus. These otters use this area for foraging, resting, giving birth, and other activities. They seldom leave. The number of otters in this part of the slough appears to be increasing. Using photographic techniques and time budgets, we have documented the behaviors of these otters. Based on historical references and our observations estuarine habitats appear to support especially high densities and unique behaviors, and allow the otters to make use of terrestrial, estuarine, and marine resources. No other local mammal is as adapted to both the terrestrial and marine environments.

SMITH, L AND M PETERSON
San Lorenzo Valley High School

Bird Biodiversity in Henry Cowell Redwoods State Park

The San Lorenzo Valley is a unique area for wildlife, birds in particular. The reason for this is the diverse habitats and the rich riparian corridors. In this project, we are comparing the diversity and abundance of birds in three different types of habitats (meadow, redwood forest, and river) in Henry Cowell Redwoods State Park. Our hypothesis is that River-Meadow habitat will have the highest bird biodiversity. We survey once a month 8 sites along a predetermined loop at Henry Cowell. We record, using binoculars, all the birds we see and hear at the sites over a 10 minutes period and weather conditions. So far, our data has shown that the Meadow habitat has both the highest Shannon Diversity Index (8.9) and the highest species count (27). The River-Meadow has the second highest Shannon Diversity Index of 6.2 and the second highest species count (20). The River-Redwood habitat is the third diverse with a Shannon Diversity Index of 6.0 and a species count of 19. The Redwood habitat has shown to be the least diverse. It has a Shannon Diversity Index of 5.2 and a species count of 14. Throughout all the sites, the total species count is 42. We are still conducting our research and have yet to make a conclusion. We would like to thank our mentor, Dr. Jeff Smith.

SPRIGGS, J, T ADAMS, Z WAMBAUGH
San Lorenzo Valley High School

Men with a lot of Mussels; Part 2: revenge of the turban snails

Our goal is to explore the biodiversity of the Davenport Landing tide pools along a pre-established vertical transect. Our investigative question is: How will biodiversity of organisms change along the plots of the vertical transect as the season changes. The biodiversity of the plots on the vertical transect will vary with respect to the seasons: biodiversity will be lower during winter and higher in the summer for each plot; this is due to the increasing populations of turban snails, honeycomb tube worms, and mussels during the winter, while in summer the populations of these organisms are reduced, allowing other organisms to inhabit the space, increasing biodiversity. We have been monitoring the vertical transect, established in 2002, twice a month (as conditions allow) during low tides since June 2010. We measure wind speed, tides and temperature. Then using permanent eyebolts, we secure a tape measure and center a quadrat over the transect every 3 meters out to 21 meters. Following LiMPET'S protocols (Long-term Monitoring Program and Experiential Training for Students), we count and record the abundance of 30 species of invertebrates and algae in each quadrat and also note bare rock and sand. So far, we have found increasing numbers of mussels, honeycomb tube worms, and turban snails during winter. This observation supports our hypothesis since these organisms compete for the limited space of the tidepools. We would like to thank our mentor Dr. John Pearse, Professor Emeritus, UCSC.

STARR, R[1,2], D WENDT[3], K SCHMIDT[2], C BARNES[2], N HALL[3]
1 California Sea Grant Extension
2 Moss Landing Marine Laboratories
3 Cal Poly San Luis Obispo

Collaborative fisheries research: a transition from data-poor to data-rich management

From 2007-2011, California Collaborative Fisheries Research Program (CCFRP) scientists collected data regarding species compositions, sizes and catch rates of nearshore fishes inside four MPAs. Nearby areas open to fishing were also surveyed as reference sites, against which MPA data were compared. Since 2007, 180 hook-and-line surveys have been conducted to identify, measure and release caught fishes. More than 650 volunteer anglers spent 3,597 hours using standardized methods, resulting in the catch of 32,865 fishes from 43 different species. Of those caught, 22,157 were tagged in order to gain information about movement patterns and survivorship through recapture.

To date, species compositions, CPUE and biomass estimates have demonstrated great similarity between MPA and associated reference sites. Additionally, differences in lengths between protected and unprotected areas measured over time are essentially the same as those observed prior to reserve establishment. CCFRP data collected from the Point Lobos State Marine Reserve (est. 1973), however, indicate larger sizes and higher densities of 8 out of the 11 most abundant species, indicating a need for longer temporal scales to evaluate MPA performance in terms of fisheries management.

While continuing to expand our dataset in order to meet these scaling requirements, we plan to incorporate existing information into new fishery models with the purpose of comparing individual

model performance to each other and to traditional stock assessments. By examining model function through time and under various control rules, we can project the long-term costs and benefits of various management actions for stock sustainability and fishery profit.

STANFIELD, E, A SREENIVASAN, M LOS HUERTOS
California State University, Monterey Bay

Environmental factors associated with toxic cyanobacteria blooms in Pinto Lake Monterey Bay Area, California

Freshwater cyanobacterial harmful algal blooms (CHABs) threaten humans and other mammals with a range of potent cyanotoxins. Produced by many cyanobacterial taxa, hepatotoxic microcystins are among the most pervasive and potent cyanotoxins in freshwater systems. Multiple environmental factors promote development of toxic CHABs, however specific drivers are varied and system-dependent. Recently, microcystins have been implicated in the deaths of endangered sea mammals in the Monterey Bay National Marine Sanctuary (MBNMS). Pinto Lake, a Monterey Bay Area coastal water body, is a potential source of toxic cyanobacteria and microcystins to the MBNMS. In this project, we combined freshwater ecology and molecular biological approaches to characterize cyanobacterial abundance, intracellular microcystins, and the microcystin gene *mcy*B in association with environmental factors in Pinto Lake. In 2009 and 2011, we documented dense CHABs with cyanobacteria abundance increasing from undetectable levels in the spring to over 1012 cells·L-1 in summer and autumn. The microcystin synthesis gene *mcy*B was present June through November of both years. Intracellular toxin levels increased from below detection (0.15 µg·L-1) to 90 µg·L-1 and 7 µg·L-1 in 2009 and 2010 respectively (far exceeding the World Health Organization's recommended exposure limit of 1 µg·L-1). In both years, cyanobacterial abundance and cyanotoxins positively correlated with orthophosphate, organic carbon, surface dissolved oxygen, surface PAR, and surface water temperature. This research will contribute to more effective management strategy for reduction, remediation and prevention of toxic CHABs, while providing baseline data on ecological dynamics and proliferation of toxic CHABs in the Monterey Bay region.

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Academic and municipal graduate course tackles local land-sea policy

Anthropogenic and organic pollutants enter coastal marine ecosystems partly through urban stormwater runoff. In addition to the challenges of studying land-sea interfaces in a scientific context, transforming findings into action within the complex regulatory framework is a challenge, and one with which students are often unfamiliar. In 2010 MARINE (the Monterey Area Research Institutes' Network for Education, an education consortium run by the Center for Ocean Solutions) offered a 2.5-day course on mitigating urban runoff in the City of Pacific Grove. The course brought together seventeen students from six marine institutes around Monterey Bay to address the issue using a project-based learning cycle approach for interdisciplinary problem solving. This provided a unique opportunity for students with diverse backgrounds (including policy,

communications, coastal and watershed sciences, ecology, oceanography, engineering and chemistry) to work with city managers and experts in the field to design science-based policy recommendations for the monitoring program for stormwater runoff in the Monterey Bay area. Working with the Monterey Bay National Marine Sanctuary's stormwater monitoring data as well as information gathered through interviews with local legal, urban planning, and water-quality experts, students created comprehensive plans that the City of Pacific Grove could pursue to mitigate stormwater runoff into the Monterey Bay Sanctuary. This course produced concrete deliverables and was a very exciting bridge between students and local government. Since the course, MARINE has facilitated further student action related to this academic-municipal partnership, and has designed another course using a similar framework that focuses on Elkhorn Slough.

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Pajaro Valley High School
Watsonville Area Teen Conservation Habitat (WATCH) Program, Monterey Bay Aquarium

Infaunal Benthic Invertebrate diversity between South Marsh and Whistlestop Lagoon

Invertebrates are one of the most important sources of food for all life at Elkhorn Slough. They serve as food for shorebirds, sea otters, fish and many other animals. Invertebrates are near the bottom of the food chain. They are also bio-indicators which means they can indicate whether or not the slough is healthy. Our group was studying whether the biodiversity of benthic invertebrates was greater in South Marsh where the gravel size and tidal influences were greater versus Whistlestop Lagoon where the gravel size was larger and had less tidal affect. The research sites we were testing at were located in Whistlestop Lagoon and South Marsh, where we gathered samples from sediment cores. A culvert connects our two sample areas. This culvert was installed in order to permit tidal exchange but it also restricts tidal flow. The Elkhorn Slough Reserve Team has discussed restoring this culvert because it is being crushed under the weight of the levy that separates the two water systems. Our study will show which area has the greater infaunal benthic invertebrate diversity. By learning about the differences in biodiversity between Whistlestop Lagoon and South Marsh we can better understand the conditions under which diversity thrives. Our research will provide important information that can help the Elkhorn Slough Reserve Team in their plans to restore the culvert. Our research will add to our understanding of the health of the slough, the impact of the culvert and the biodiversity of the slough.

VERGA-LAGIER, A, M CALLAGHAN, H KIBAK
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Return of the natives to Moss Landing Harbor

At the turn of the century, Bay Mussels collected by California museums were exclusively *Mytilus trossulus* from San Diego to the Monterey Bay. When sampled again in the 1990s, genetic analysis demonstrated that all the native *M. trossulus* in Southern California had been replaced by the Mediterranean mussel, *Mytilus galloprovincialis*. The invasion apparently having gone unnoticed due to the morphological similarity of the two sibling species. The invading mussel has now been found as far north as Puget Sound, but is still absent from many sites along the Northern California and Oregon coasts. It appears that Moss Landing Harbor is emerging as a dynamic "hybrid zone"

where each species and hybrids exist. To capture a snapshot of this dynamic hybrid zone, we are collecting mussels from the same floating dock in Moss Landing Harbor each year. In 2010 and 2011 the mussels were identified as one species or the other, or hybrid, using two nuclear genetic markers. Mussels from 2012 were being collected and analyzed at the time this abstract was written. In 2010 the invasive mussel or hybrid was dominant, however, in 2011 samples collected from the same floating dock showed a significant increase in the native population and a decline in the invasive species.

VERNON, M AND M LOS HUERTOS
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Investigation nitrous oxide production: using dentrification and nitrification assays in crop specific soils

Greenhouse gases (GHGs) contribute to global climate change. The Global Warming Solutions Act of 2006 sets goals to minimize GHG emissions within California by the year 2020. Agriculture is a main contributor of nitrous oxide (N2O). Management practices (i.e. organic or conventional) may contribute to differing N2O emissions. For example, previous research has found varying biodiversity among conventional and organic systems in tomato agroecosystems. However, no research has focused on microbial drivers of N2O emission within California's central coast. This project measured microbial processes that may contribute to N2O emission in contrasting management practices, and determined if these processes can predict N2O emissions. Three locations throughout the central coast of California were sampled four times beginning in September through November 2011. Denitrification enzyme assays were used to determine maximum activity of denitrifying enzymes as potassium nitrate was converted to N2O under non-limiting conditions. Nitrification potential was measured over 24 h as ammonium sulfate was converted to nitrate under non-limiting conditions by nitrifying bacteria. In September denitrification rates in all three locations were lowest while nitrification rates were the highest, as soils were well aerated during the Mediterranean drought season. These trends are consistent with the preferable conditions of the diverse bacterial enzymes. Results may be used to promote management methods to reduce N2O emission during dry and wet seasons by accounting for the microbial processes which generate GHG emissions. Results may also be used to improve inventory estimates of GHG emissions.

WEIGEL, A AND A MAXWELL
San Lorenzo Valley High School

Sudden Oak death: is it progressing?

Our goal is to monitor the progression of Sudden Oak Death (SOD) at two locations in the San Lorenzo Valley. We will be collecting data on the abiotic factors that may affect the spread of the pathogen. Sudden Oak Death is a disease caused by *Phytophthora ramorum* a fungus-like organism that has been rapidly infecting and killing oak trees in California and Oregon. Not only do oak trees provide shelter and food resources for nearby species, but if they continue to die at such a rapid pace the fallen trees will affect water quality by increasing erosion into nearby streams and rivers. Sudden Oak Death is more common in areas with wetter climates because the pathogen is spread through water. Our hypothesis, is that our Fall Creek site will see a higher

incidence of SOD due to its wetter nature than our drier Quail Hollow Ranch site. Our procedures include recording trees infected at Quail Hollow Ranch and Fall Creek State Park and confirming our diagnosis with ImmunoStrips. We are also collecting air temperature, soil temperature, soil moisture, relative humidity, and light exposure along a transect at each site using a Vernier LabQuest. Our monitoring has just begun and we will have data to share as our study progresses. We would like to thanks our mentor, Dr. Michael Loik, UCSC.

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OMEGAS: A large-scale approach to studying the effects of ocean acidification on calcifying organisms in intertidal and nearshore habitats

Due to increases in the release of anthropogenic CO2, the acidity of the ocean is increasing. The implications of this phenomenon, ocean acidification (OA), are widespread with some organisms being more heavily affected than others. For example, growth rates of many calcifying organisms are inhibited by decreases in both pH and the saturation state of calcium carbonate. Further, changes in ocean chemistry and its effects may vary among oceanographic regions.

The Ocean Margin Ecosystems Group for Acidification Studies (OMEGAS) consortium, comprised of research groups from Oregon State University, University of California, Davis, University of California, Santa Cruz, Monterey Bay Aquarium Research Institute, Stanford University, and University of California, Santa Barbara, began field work in Spring of 2011 to investigate the effects of OA on two ecologically important intertidal biomineralizing species, the purple urchin (*Strongylocentrotus purpuratus*) and the California mussel (*Mytilus californianus*). Eight sites, each with its own intertidal/subtidal pair, were chosen that range from south of Point Conception to Central Oregon and cover a range of upwelling intensities. Based upon previous studies, pH is expected to be generally lower along the coasts of Oregon and Northern California (higher upwelling), increasing into Central and Southern California (lower upwelling) and these differences in pH are expected to affect growth rates of the two focal species and might also underlie differences in the ability of organisms from these regions to acclimate or adapt to OA.

Information gathered by the OMEGAS consortium will aid in 1) providing a more complete picture of the oceanic environment, 2) predicting how biomineralizing species like urchins and mussels will respond to changing pH levels, and 3) providing data for regulating agencies regarding which areas are most vulnerable to the increasing acidification of the oceans, ultimately aiding in decision making associated with marine conservation policy.

WYSE, DE, E MCPHEE-SHAW, C HUNTER
Moss Landing Marine Laboratories

Oxygen at the canyon head in Monterey Bay: coastal hypoxia in Moss Landing

At the submarine canyon head in the heart of Monterey Bay, Moss Landing Marine Laboratories (MLML) maintains an intake system to pump raw seawater from 17-m water depth for the MLML aquarium. The intake system has been fitted with oceanographic sensors for continuous monitoring of ocean temperature, salinity, and dissolved oxygen, from a fairly unique and valuable subsurface depth. The data are available to the public via the Central and Northern California Ocean Observing System (CeNCOOS, http://www.cencoos.org/). This study builds upon the foundation of a previous study (Booth, 2011) showing intense oxygen variability, driven by upwelling and modulated by internal tides, over the inner shelf of southern Monterey Bay. In this study we find variability similar to that of the southern site, yet with even more intense semidiurnal fluctuations due to intensification of internal tide oscillations near the canyon head. We assess the variability of processes at seasonal, wind-driven, and internal tide time scales to characterize dissolved oxygen, including episodes of hypoxia, between December 2010 and March 2012. Monitoring nearshore and inner shelf oxygen levels in Monterey Bay has important ecological and resource management implications, particularly due to the proximity of this location to several sources of terrestrial inflow to the coast.

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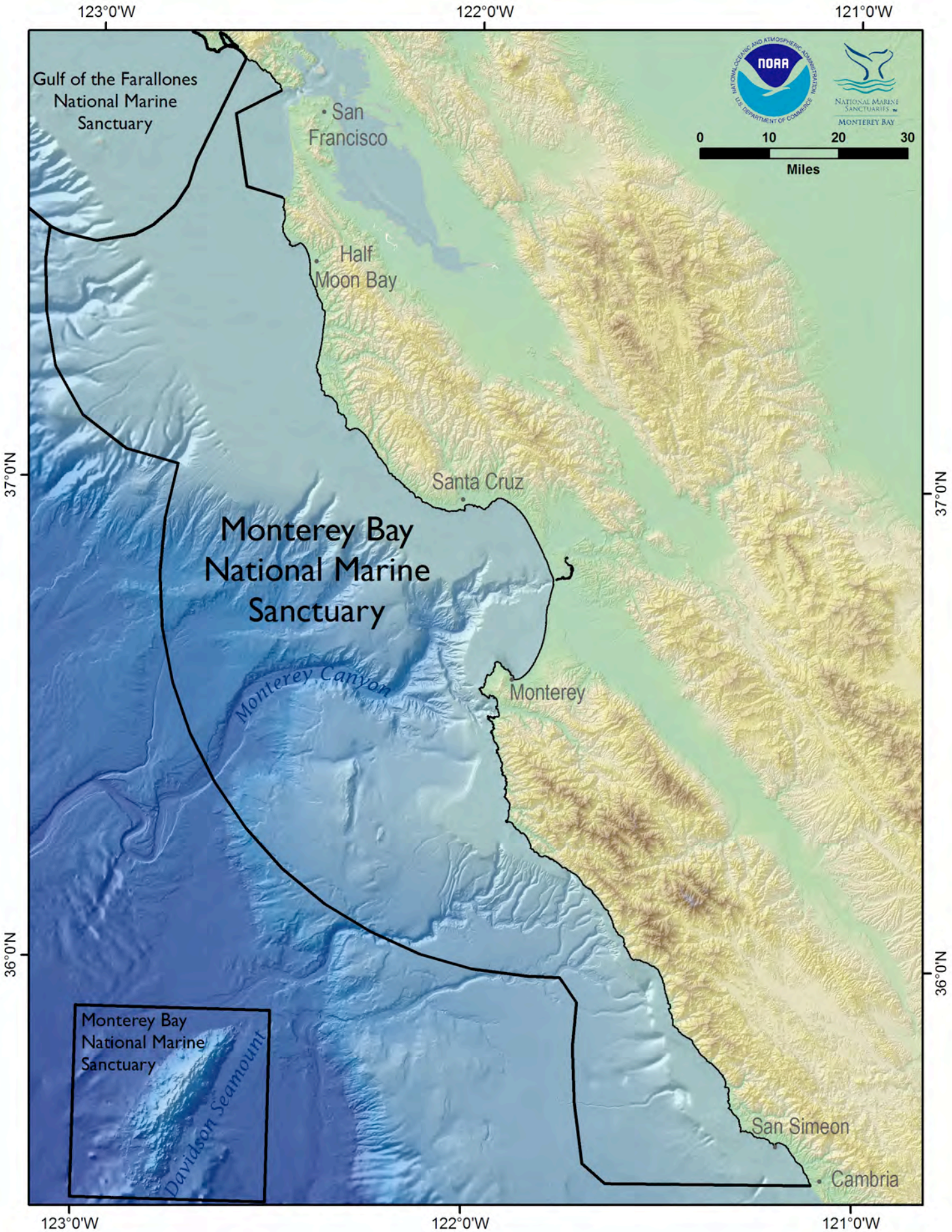
Autonomous Detection of Fecal Indicators and Pathogens in Coastal Waters Using In-Situ Real-Time PCR

The development of rapid methods to enumerate “health-relevant“ organisms has been a major focus of research on recreational water quality with the goal of protecting human health. Adaptation of current quantitative polymerase chain reaction (QPCR) assays to technology developed at the Monterey Bay Aquarium Research Institute (MBARI) and Lawrence Livermore National Laboratory (LLNL) may provide researchers, beach managers and the general public with near real-time data on microbial indicator concentrations that can subsequently be used to inform beach closures. An overview of this technology is presented, and the MBARI Environmental Sample Processor (ESP) and Microfluidics Block (MFB), which provide in situ collection and analysis of environmental water samples, are discussed. Preliminary research reveals that Taqman® QPCR assays can be applied to the MFB for real-time in situ detection and quantification of *Enterococcus* spp. and the human specific marker in *Bacteroidales* spp. Using this technology, high amplification efficiencies of >95% and low detection limits (>10 copies) can be achieved. A deployment of the ESP at the Santa Cruz Wharf used QPCR assays to evaluate water quality and provided a proof of concept for obtaining near real-time water quality data. This technology provides a new means for water quality monitoring by enabling real-time, remote detection of microorganisms in the environment without requiring a person to conduct water sampling and perform subsequent laboratory analyses.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