CHANGE

Observations on the Shifting Ecology of the Sanctuary

Monterey Bay National Marine Sanctuary Symposium

Sanctuary Currents 2013

Saturday, April 27, 2013

California State University Monterey Bay

University Center, Seaside, CA

Monterey Bay National Marine Sanctuary Symposium
Sanctuary Currents 2013

Change: Observations on the Shifting Ecology of the Sanctuary

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California State University Monterey Bay
University Center, Seaside

Planning Committee

James Lindholm, Ashley Knight, Devon Warawa, and Ben Walker
California State University Monterey Bay

Andrew DeVogelaere, Erica Burton, and Chad King
Monterey Bay National Marine Sanctuary

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 – 9:15 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 of the Institute for Applied Marine Ecology
California State University Monterey Bay
Chair, Sanctuary Research Activity Panel
Research Representative, Sanctuary Advisory Council

Dr. Chris Harrold
Director, Conservation Research, Monterey Bay Aquarium
Chair, Sanctuary Advisory Council & Research Activity Panel

9:15 – 9:40 A.M. **OBSERVING, MONITORING, AND PROTECTING THE BLUE SERENGETI OFF THE CALIFORNIA COAST**

Dr. Barbara Block
Charles & Elizabeth Prothro Professor in Marine Sciences
Evolutionary, Cellular, and Molecular Physiology
Hopkins Marine Station, Stanford University

9:40 – 10:05 A.M. **WAVES IN THE SANCTUARY: IMPACTS FROM TOP-DOWN TO BOTTOM-UP**

Dr. Curt Storlazzi
Pacific Coastal and Marine Science Center
US Geological Survey

10:05 – 10:30 A.M. **AT THE CROSSROADS: WHAT MONTEREY BAY TELLS US ABOUT CLIMATE CHANGE, AND WHAT CLIMATE CHANGE TELLS US ABOUT THE FUTURE OF MONTEREY BAY**

Dr. Stephen Palumbi
Harold A. Miller Professor in Marine Sciences
Director, Hopkins Marine Station, Stanford University

10:30 – 11:00 A.M. **BREAK**

11:00 – 11:25 A.M. **THE EVER-CHANGING WORLD OF MARINE MAMMALS IN OUR SANCTUARY**

Dr. Karin Forney
Marine Mammal and Turtle Division
Southwest Fisheries Science Center
National Marine Fisheries Service, NOAA

11:25–11:50 A.M. **THE CHANGING FACE OF MANAGEMENT: A REFLECTION ON TWENTY YEARS OF OVERSIGHT IN THE MBNMS**

William J. Douros
Regional Director, West Coast Region
Office of National Marine Sanctuaries, NOAA

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 WOULD ED DO? INNOVATIONS IN SCIENCE AND MANAGEMENT OF KELP FOREST ECOSYSTEMS IN THE 21ST CENTURY

Dr. Mark H. Carr
Professor
Department of Ecology and Evolutionary Biology
University of California Santa Cruz

3:00-3:15 P.M. **RESEARCH POSTER AWARDS**

SPEAKER ABSTRACTS

DR. BARBARA BLOCK

Hopkins Marine Station, Stanford University

OBSERVING, MONITORING AND PROTECTING THE BLUE SERENGETI OFF THE CALIFORNIA COAST

Biologging science is revolutionizing our view of how animals use the ocean in the California Marine Sanctuaries. When free-ranging animals such as tunas, sharks, whales seals or seabirds are tagged with telemetry tags that log location, behavior, physiology and oceanography their movements and biology can be studied in relationship to the environment. The Tagging of Pacific Pelagics (TOPP) has demonstrated the important role of the marine sanctuaries for aggregating diverse predators from across the Pacific basin. New technologies, miniaturization, increased sensor capacity, in combination with gliders and buoys are creating a "Wired Ocean". Animal telemetry provides a significant advancement in our capacity monitor, observe and measure both the stability and change within the ocean ecosystem. Electronic tags provide the capacity to track animal behavior and physiology within the physical environment through which the animals are moving. Sometimes this can be done in near-real time – true telemetry - and often data can be stored for later acquisition. Autonomous vehicles instrumented with sensors for receiving tagged animal data acoustically are also contributing to our capacity to observe free-swimming animals in their environment in real time. Detailed observations of animal movements in their aquatic environment, have significantly improved our understanding of ecosystem function, population structure, fisheries management, physiological and evolutionary constraints of species. These data are critical for preventing extinctions, preserving biodiversity and implementing ecosystem-based management of living resources. Animal-borne sensors have also come of age and deliver high-resolution physical oceanographic data at a relatively low cost. Animals are particularly adept at finding areas of interest to oceanographers (fronts, upwelling areas) and they provide important insights into regions of the oceans that are difficult and expensive to monitor. Together these advances provide the capacity to observe our Blue Serengeti as of climate changes.

DR. CURT STORLAZZI

Pacific Coastal and Marine Science Center, US Geological Survey

WAVES IN THE SANCTUARY: IMPACTS FROM TOP-DOWN TO BOTTOM-UP

Ocean surface waves generate 2,700,000,000,000 watts (2700 gigawatts) of energy each day throughout the world, and they are the most energetic process influencing the water column, sea floor, and coastline in the Monterey Bay National Marine Sanctuary (MBNMS). The wave climate offshore central California is characterized by four general regimes: North Pacific winter swell, northwest wind waves, southern summer swell, and local wind

waves. This presentation will address not only these waves climates, but also how they vary between El Niño and La Niña events, and how the variations in wave heights, wave periods, and wave directions during the year and between years influence coastal geomorphology, water-column structure, and mobilization of sea-floor sediment in the MBNMS. Next, the impact of the resulting changes in these processes on coastal infrastructure and marine ecosystems in the Sanctuary will be addressed. Lastly, what we are learning about how waves along the U.S. West Coast may be affected by global climate change during the rest of the 21st century will be discussed, and what that might mean for humans and ecosystems along central California.

Dr. Stephen Palumbi

Hopkins Marine Station, Stanford University

At the Crossroads: What Monterey Bay Tells Us About Climate Change, And What Climate Change Tells Us About the Future of Monterey Bay

Monterey Bay has made a stunning comeback over the past 80 years. Massive pollution is gone. Wildlife has returned. The kelp forests are healthier than anytime in the past 100 years. And the ethic of sustainable use of the sea is stronger than ever. But another danger stalks the Bay and could undo all these gains - climate change. Over the past decades, the temperature of Monterey Bay has increased leading to increases in species that used to only be common in Southern California. And we see periods of dangerously low oxygen concentrations. Acidity is predicted to shift strongly, and has already affected some larval forms. Marine species in Monterey Bay are expected to see accelerating changes in temperature, acidity, hypoxia and sea level over the next century. New genomic research shows how some species can adapt to some of these changes in temperature, acidity and hypoxia. Our work on sea urchins and abalone shows that alleles conferring survival advantages in future conditions are widely spread up and down the west coast, perhaps given west coast species a way to adapt to the future. Such adaptive mechanisms are likely to be beneficial during climate change - but only for a while. We have no idea when these mechanisms will be exhausted and when climate change effects on critical marine species will become onerous. Marine research with 'eyes wide open' towards climate change is critical to chart the likely future of a healthy Monterey Bay, and can help our entire community prepare for the changes ahead.

DR. KARIN FORNEY

Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA

THE EVER-CHANGING WORLD OF MARINE MAMMALS IN OUR SANCTUARY

The ecosystem of the Monterey Bay National Marine Sanctuary supports a great diversity and abundance of marine mammals, including at least 27 whale, dolphin, and porpoise species (cetaceans), 6 seal and sea lion species (pinnipeds), and the southern sea otter. Species abundance and distribution, however, have undergone dramatic changes over time – partly caused by anthropogenic impacts and partly driven by natural variation within the California Current Ecosystem. Large whales and fur-bearers were heavily hunted during past centuries, reducing their populations to very low levels by the early 1900s. Subsequent protective measures allowed most (but not all) of these exploited marine mammal populations to rebound, most notably the seals, sea lions, and eastern Pacific gray whale. Although dolphins, porpoises, and other small cetaceans were not generally hunted, incidental mortality in fisheries adversely impacted harbor porpoises off central California during the late 1900s, and there is recent evidence that beaked whale populations have declined dramatically since 1991. Causes of the beaked whale decline are not clear but could include natural or anthropogenic factors. Throughout the California Current Ecosystem, natural variation caused by seasonal cycles, periodic El Niño and La Niña events, and decadal-scale oceanic 'regime shifts' can impact marine mammals in a variety of ways, including reproductive success, species distribution patterns, and population size and trends. This makes it challenging to monitor the health and status of marine mammal populations, but also offers a glimpse into potential future effects of climate change on marine mammals along our coast.

WILLIAM J. DOUROS

West Coast Region, Office of National Marine Sanctuaries, NOAA

THE CHANGING FACE OF MANAGEMENT: A REFLECTION ON TWENTY YEARS OF OVERSIGHT IN THE MBNMS

Not only has the ecology of Monterey Bay National Marine Sanctuary changed in the past 20 years, but so too has the governance and management of the region. All agencies, from local to state to federal, have undergone change in both the practice of their trade but also in the nature of what they regulate. This evolution of management philosophies and practices has been driven by technological advances as well as in response to changes within the ecosystem, most often declines in habitat quality or in population or species abundance. One of the more dramatic expansions has been how conventional management tools have been replaced by (or certainly heavily compete with) non-conventional tools such as education and outreach programs or broadly non-regulatory initiatives. The internet barely existed when MBNMS was designated, and smart phones or digital cameras had yet to be invented. Now science, management and education/outreach programs depend heavily upon and are clearly influenced by the

internet, social media and technologically advanced equipment. All of these changes have expanded the scope of management in a region, while at the same time increasing the role the public can play, particularly in commenting on and participating in management actions.

RICKETTS MEMORIAL LECTURE

DR. MARK H. CARR

University of California Santa Cruz

WHAT WOULD ED DO? INNOVATIONS IN SCIENCE AND MANAGEMENT OF KELP FOREST ECOSYSTEMS IN THE 21ST CENTURY

Edward Ricketts was among the exceptional marine natural historians of the 20th century. His creative and diligent observations of species and communities through time generated insights into the environmental processes and species interactions that shape rocky intertidal ecosystems. Today we emulate these approaches by combining long-term observations with emerging technologies to generate insights into the processes that determine geographic patterns of community structure, population replenishment and productivity of kelp forest ecosystems. By combining remotely sensed oceanographic and seafloor features with advanced diving technology and large scale, long-term surveys we reveal the processes that drive the structure of coastal marine communities and provide insights into their conservation and management.

ABOUT MARK CARR

Dr. Mark Carr is a Professor in the Department of Ecology and Evolutionary Biology at the University of California at Santa Cruz (http://research.pbsci.ucsc.edu/eeb/rclab/). He received his BA in Biology at UC Santa Cruz, his MS at San Francisco State University and Moss Landing Marine Laboratories, and his PhD at UC Santa Barbara. Before coming to UCSC, he was a postdoctoral fellow in the Zoology Department at Oregon State University and a faculty researcher at UC Santa Barbara.

Mark's research focuses on the population and community ecology of tropical and temperate coastal marine fishes, and coastal marine ecosystems. Much of his research has focused on the oceanographic processes and habitat features (e.g. giant kelp forests) that influence patterns of fish recruitment and population replenishment; interactions within and between species that regulate marine populations; and biotic and abiotic processes that influence the structure and functions of kelp forest ecosystems. To explore each of these, he combines long-term, large scale monitoring studies and field experiments. His ecological research informs management and conservation topics including artificial reefs, ecosystem-based management of kelp forest ecosystems, the design and evaluation of marine protected areas, collaborative fisheries research, ecosystem-based fisheries management, and large-scale, long-term monitoring studies. He is a principal investigator with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), a multi-university consortium designed to conduct interdisciplinary research that informs coastal marine management and policy.

Mark teaches undergraduate and graduate courses in ecology, marine ecology, and marine conservation. His graduate students study the ecology of coastal marine fishes, freshwater salmonids, and kelp forest ecosystems. He is a Fellow of the California Academy of Sciences, and an Aldo Leopold Leadership Fellow. He served as Co-chair of the Science Advisory Team to California's Marine Life Protection Act (MLPA) and California's Ocean Protection Council (OPC). He sits on the steering committee for CAMEO, a funding program for marine ecosystem research jointly sponsored by the U.S. National Science Foundation and the National Marine Fisheries Service.

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

2012 Ken Johnson
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

Twenty-Two Students of MSCI 470 Science, Policy & Management in the Marine Environment
California State University Monterey Bay

CHARACTERIZATION OF DEMERSAL FISH ASSEMBLAGES WITHIN SEVEN SANCTUARY ECOLOGICALLY SIGNIFICANT AREAS IN THE MBNMS

The Monterey Bay National Marine Sanctuary (MBNMS) has recently embarked on a new program dedicated to identifying areas special significance within the Sanctuary. The process has resulted in the designation of 17 Sanctuary Ecologically Significant Areas (or SESAs) across the length of the Sanctuary. All of the SESAs occur entirely within Federal waters. We used imagery collected via remotely operated vehicle and towed camera sled between 2007 – 2012 to extract data on the distribution of demersal fishes within selected SESAs. We conducted transects across the seven SESAs, ranging from Ascencion Canyon in the north to Pt. Piedras Blancas in the south, and observed a total of 43,047 fish across those transects. Each fish was identified to the lowest taxonomic level possible and was precisely geo-referenced. The substrate beneath each fish was also characterized. Patterns in the distribution of selected fishes within and across SESA's offer insights in the ecological attributes of the SESAs and will guide additional sampling in summer 2013. Though there are no new regulations associated with the SESAs, an understanding of the communities within each SESA will aid the MBNMS in meeting its management objectives, and can serve as a baseline against which any future change in the SESAs can be measured.

Aiken, Emily A. (1)**, Steve I. Lonhart** (2)**, and James B. Lindholm** (1)
1) Institute for Applied Marine Ecology, California State University Monterey Bay
2) Monterey Bay National Marine Sanctuary, NOAA

NATIVE CRAB, *CANCER GRACILIS*, MAY AFFECT THE SPREAD OF THE INVASIVE BRYOZOAN *WATERSIPORA SUBTORQUATA*

Invasive species continue to affect marine systems by altering community structure and function. The hull-fouling bryozoan *Watersipora subtorquata* was unintentionally introduced to the central coast of California in the 1990's and subsequently spread and monopolized several harbor ecosystems. While conducting a research diving project on the dispersal potential of *Watersipora* bryoliths in Monterey Harbor, we observed native cancer crabs *Cancer gracilis* demolishing bryoliths used in our experiments. We then began a series of experiments to determine if the crabs were feeding on the bryolith itself or destroying the bryolith to gain access to the numerous invertebrates (e.g., shrimp, annelids, flatworms) that use the bryolith as habitat. Preliminary data indicate the crabs are focusing on the inhabitants rather than the bryozoan. Since bryoliths may contribute to the spread of *Watersipora*, destruction of bryoliths by crabs may serve as a natural impediment to dispersal and slow the rate of spread within the harbor.

Alonso, Armando, Aurelio Anaya, Erika Cansino, and Alexis Rodriguez-Camacho
Pajaro Valley High School, Watsonville, CA
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

OCEAN ACIDIFICATION: ITS EFFECT ON BIVALVE FILTRATION AND BEHAVIOR

Bivalves, primary ecosystem engineers, play an important role sustaining healthy estuarine water quality by filtering eutrophying pollutants. By the year 2100, average ocean pH may decrease from approximately 8.1 to nearly 7.7 due to rising levels of atmospheric CO2. Ocean acidification alters water chemistry and is proven to affect marine organism behavior. Bivalves provide crucial ecosystem services, including regulating phytoplankton concentrations, decreasing turbidity, and cycling nutrients. Our research focuses on the filtering capacity and feeding behavior of the California mussel (*Californianus mytilus*) and Bent Nosed clam (*Macoma nasuta*) in "low" and "control" pH treatments. We hypothesized bivalve filtration and behavior would be negatively influenced by reduced pH. To measure filtration change we incubated bivalves in low pH (range = 6.31-6.41) and control pH (range = 7.9-8.23) treatment waters with phytoplankton (5-8 x103 cells mL-1). Short-term shellfish feeding resulted in net chlorophyll loss from the water which was measured with a fluorometer. Behavior was analyzed in similar pH treatments by observing bivalve gaping/siphon displays. Control mean filtration for clams was +7.19 ug/chl/min while mussels filtered -3.13 ug/chl/min, net gain was possibly a methodological error. Mean time for clams to expose a siphon in control pH was ~24 minutes and mussels opened on average by ~13 minutes; response time in low pH for clams is 26 minutes and in mussels 12 minutes possibly showing the increased response of mussels. We anticipate our findings will demonstrate ocean acidification's effect on bivalve health.

Ammann, Karah, Pete Raimondi, Melissa Miner, Christy Bell, and Maya George
University of California, Long Marine Lab

TWO DECADES OF MONITORING THE OWL LIMPET (*LOTTIA GIGANTEA*) ALONG THE CENTRAL COAST

The Multi-agency Rocky Intertidal Network (MARINe) conducts long-term, spatially extensive intertidal monitoring along the western coast of North America. One species targeted by MARINe is the edible owl limpet, *Lottia gigantea*. Because owl limpets are protandrous hermaphrodites (older males change to females), harvest by humans, who preferentially take the largest limpets in a population, can result in skewed gender ratios and decreased reproduction. Since 1999, owl limpets have been protected from commercial fishing, but a recreational fishery persists. *L. gigantea* monitoring began in the Central Coast Study Region (CCSR) in 1992 with additional plots established in 2007 after the Marine Protected Areas went into effect. MARINe groups monitor abundance and size structure of *L. gigantea* in 1 meter radius permanent circular plots throughout their range, including 19 sites within the CCSR, 12 within the Monterey Bay National Marine Sanctuary. Long-term monitoring of owl limpet populations reveals patterns of natural variation, as well as anthropogenic effects. Examining the size structure of populations over time has shown large recruitment pulses occurring on a periodic basis (typically several years between pulses). These recruitment events are often synchronous across several sites and can be followed for many years within a site. Identifying patterns in the occurrence of these recruitment pulses among sites, and their persistence within sites, can shed light on conditions that are favorable for successful

recruitment and survival. Large-scale, long-term monitoring of *L. gigantea* populations both within and outside of MPAs gives us the ability to separate patterns due to human impact from those that are simply a result of "natural" variation.

Andrade, Terra and Brittany Venlet
San Lorenzo Valley High School, Felton, CA

SEABRIGHT BEACH PROFILING

The purpose of our project is to determine whether Seabright Beach's profile fits the expected model. During the winter months, the beach will be narrower and have a steeper slope. During the summer, the beach will be broader and flatter in profile. Our tools are: stadia rod, hand level, eye level. We use these tools to measure the change in the height of the beach in centimeters every 3 meters down the beach until we reach the surf zone. We compare the changes in height of the beach on a monthly basis, to see how the seasons, waves, storm events and tides impact the slope. We do not have enough data to come to a conclusion as of now; however, looking at our December data the beach has lost sand and become steeper following a storm thus supporting the predicted model. We received assistance from our mentor Dave Schwartz , Cabrillo College.

Angulo, Michael, Enrique Ornelas, and Ivan Torres
Watsonville High School, Watsonville, CA
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

DISPERSAL OF THE EUROPEAN GREEN CRAB IN THE ELKHORN SLOUGH

Our research is focused on the invasive European green crab in the Elkhorn Slough National Estuarine Research Reserve (ESNRR) but most importantly how it has been able to survive in habitats distant to its native one. Due to the fact that the Elkhorn Slough has many recreational uses in our community, we would like to know how common the Green Crab is in the Slough. We measured abiotic factors such as pH, salinity, and topographic features at five locations to determine which factors might be associated with the success of the European green crab in the Slough. Following the protocol used in previous years, we set up crab traps, determined the number of crabs caught in the traps, and then released native crabs back into the water, while destroying the European Greens. We were unable to determine significant differences in abiotic factors in sites with high green crab presence compared to low presence. Surprisingly, we found that the native yellow shore crab was, by far, the most common species of crab. We feel that this may be due to removal efforts of the European green crab in our study and in previous studies. We learned that removal efforts can strongly influence population sizes of species in the Slough, and are disseminating our information to various bodies of science.

Avalos, Anabelen, Jesus Estrada, Gabriela Fernandez, Jonathan Fry, and Roxanna Rodriguez
Pajaro Valley High School, Watsonville, CA
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

LITTORAL AQUATIC MACROINVERTEBRATES: SPECIES DIVERSITY IN CORRELATION WITH POLLUTION

A healthy macroinvertebrate population is vital to the sustainability of an ecosystem. If the local water is heavily polluted the macroinvertebrate diversity will be negatively affected. This will cause impacts on the macroinvertebrate community, and affect animals higher up in the food web. Aquatic macroinvertebrates are indicators of water quality. Our research has been conducted around our testable question "Does microcystin effect the macroinvertebrate diversity?" We collected our data by selecting sites that would be of similar habitat to those at Pinto Lake and that do not contain microcystis. Then we sampled from close, medium, far, and off the edge of the habitat to prevent a large amount of bias. In our study we categorized anything smaller than a waterflea a microinvertebrate. We determined diversity and evenness by using the Shannon Weiner Diversity Index, and through the interpretation of these results we were able to determine richness. In Pinto Lake the macroinvertebrate pollution tolerant percentage found was 45.9% in comparison to Watsonville Slough's 26.9% of pollution tolerant macroinvertebrates showing that microcystin in Pinto Lake might be affecting the aquatic community.

Avila, Emmelie, Brian Navarro, Daisy Rocha, and Paulina Serna
Pajaro Valley High School, Watsonville, CA
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

OCEAN ACIDIFICATION: EFFECTS ON BEHAVIOR

The increase of carbon dioxide emissions is causing the decrease of pH in world oceans. Locally, this creates a problem for calcium-carbonate based echinoderms, like brittle stars. They are a key component in the food chain, in addition contributing to the diversity of life in the ocean. The long term consequences of the continuous decrease in pH on brittle stars are shown to be problematic for their movement, including adverse effects on muscle when an arm is regenerated in conditions with higher acidity. We predicted as the acidity of the water rises, their movement will decrease drastically. We conducted our experiments at Elkhorn Slough Lab, recording the time it took them to reach certain distances within a five minute time frame in pH levels of 8.1, 7.6, 7.0 and contrasting lighting. We selected brittle stars of three distinct sizes to distinguish the effect of size with speed of movement. In every treatment, large stars made it to rocks more often than small stars. We observed that those in dim light more seldomly reached the rocks than under bright light. (ex: 75% at pH 7.6 in bright light VS 42% in dim light) Lower pH levels caused a decrease of motion compared to control pH 8.1. (83% medium sized VS 50% in pH 7.0 bright light) Our results show the decline of pH made them nearly motionless especially in dim light. Our hypothesis was confirmed, brittle star movement decreases as water acidity increases.

Barnes, Cheryl L. (1)**, Richard M. Starr** (1,2)**, James T. Harvey** (1)**, Scott L. Hamilton** (1)**, and Paul N. Reilly** (3)
1) Moss Landing Marine Laboratories, Moss Landing, CA
2) CA Sea Grant, University of California San Diego
3) CA Department of Fish and Wildlife

REPRODUCTIVE CHARACTERISTICS OF CALIFORNIA HALIBUT *(PARALICHTHYS CALIFORNICUS)* OFF CENTRAL CALIFORNIA, WITH COMPARISONS TO THE SOUTHERN CALIFORNIA BIGHT

Differences in key biological processes can greatly influence localized population dynamics. Thus, it is important to investigate intraspecific variation at several spatial scales to better understand biological limitations and develop effective fishery management strategies. During the summer of 2012, a total of 152 (65 female, 73 male, 14 sex unknown) California Halibut (*Paralichthys californicus*) were opportunistically collected off central California to reduce existing data deficiencies surrounding reproduction. Specimens were measured, weighed, and placed on ice until further processing. Sex and maturity stage were assessed using macroscopic characteristics. Gonads were then weighed to calculate gonadosomatic indices (GSI) and preserved for later evaluations of fecundity. Livers were weighed for use in calculating hepatosomatic indices (HSI) and otoliths were removed and stored for subsequent ageing. The total lengths of fish collected ranged from 544 mm to 847 mm and 536 mm to 1169 mm for males and females, respectively. All males were either sexually mature or actively spawning at the time of capture. However, 5% of females collected at or near the legal size limit (i.e., 559 mm) were not yet reproductively viable. GSI for both sexes peaked in July, whereas HSI remained relatively constant throughout the season. To assess growth, length- and age-at-maturity, spawning activity, and batch fecundity for central California Halibut, additional samples will be collected and analyzed in 2013. Life history data will be compared among location before being pooled for comparisons with existing data from southern California to provide information on spatial variability within the species.

Barraza, Stephanie, David Ortiz, and Giovanni Ramos-Godoy
Watsonville High School, Watsonville, CA
Watsonville Area Teens Conserving Habitats (WATCH) Program, Monterey Bay Aquarium

FROM MICROBES TO OTTERS: IMPACTS OF ABIOTIC FACTORS ON CYANOBACTERIA TOXIN CONCENTRATIONS IN THE PAJARO RIVER WATERSHED

Microcystis, a type of cyanobacteria, is a microscopic organism that is naturally found in bodies of freshwater, such as lakes and streams, and produces a toxin, microcystin, that can harm animals, including sea otters, by damaging the liver. Miller et al. (2010) suggests that a large ongoing *Microcystis* bloom in Pinto Lake is currently spreading to other bodies of water in the Monterey Bay, throughout the Pajaro River. We hypothesized that microcystin concentration would be positively correlated with water temperature and negatively correlated with tree canopy cover and water current speed. We examined tree canopy cover (reducing light), water temperature, water current speed, and microcystin concentration at Pinto Lake, the Pajaro River, West Struve Slough, Watsonville Slough, and Corralitos Creek. Contrary to Miller et al. (2010), we measured microcystin levels greater than 5 ppb at only Pinto Lake, possibly because there was a smaller bloom in Fall 2012 than in Fall 2007 when Miller et al. (2010) conducted their study. We observed a sudden large mortality of carp (*Cyprinus carpio*), which may be due to microcystin.

Understanding how abiotic factors impact microcystin concentration will help people make informed decisions about where to conduct recreational activities, such as swimming and fishing.

Beltran, Roxanne and Megan Connolly
University of California Santa Cruz

A PICTURE IS WORTH A THOUSAND MEASUREMENTS: A CALIBRATION PROCEDURE FOR PINNIPED VIBRISSAL LENGTH ESTIMATIONS USING PHOTOGRAMMETRY

Vibrissae, or whiskers, are ideal tissues for obtaining time-integrated dietary information for free-ranging pinnipeds using stable isotope analysis (SIA). However, accurate interpretation of SIA data relies on known tissue growth rates. Present understanding of vibrissal growth dynamics within the surrounding mystacial bed suggests that growth is complex and species-dependent. Photogrammetric analysis is presently the best non-invasive method for documenting mystacial bed growth and shedding patterns in living animals, but photogrammetry cannot produce the precision required for SIA without calibration to direct vibrissal measurements. In this study, we tested a calibration procedure for photogrammetric estimation of vibrissal length. We developed a Vibrissal Measurement Station (VMS) to obtain standardized photographs of the vibrissae and associated mystacial beds in nine post-mortem subjects (three *Mirounga angustirostris*, three *Phoca vitulina*, and three *Zalophus californianus*). We assessed extradermal length of each vibrissa using VMS scaled photos and ImageJ© software. After identifying vibrissal position, and marking their entry point into the follicle, we extracted vibrissae for direct total and extradermal length measurement. We compared individual vibrissal measurements to create models for variance in total length from photogrammetric estimation. The calibrated VMS procedure provided consistent photogrammetric estimates of total vibrissal length. Extradermal shaft length was a reliable indicator of total shaft length, but depth of vibrissae within capsules varied by species. These procedures can be applied to obtain precise measurements of vibrissal growth dynamics in trained, captive pinnipeds. We discuss the implications for differences in follicular capsule length across species and applications for the VMS in future studies.

Bigman, Jennifer S. (1)**, Heidi Dewar** (2)**, Suzanne Kohin** (2)**, Joseph J. Bizzarro** (3)**, Russ Vetter** (2)**, and David A. Ebert** (1)
1) Pacific Shark Research Center, Moss Landing Marine Laboratories, Moss Landing, CA
2) Southwest Fisheries Science Center, La Jolla, CA
3) University of Washington, Seattle, WA

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 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 multi-faceted project includes an outreach program, tagging, data-mining, and a sightings network.

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ASSESSMENT OF THERMAL TOLERANCE AND ADAPTIVE ABILITY OF *MYTILUS CALIFORNIANUS*

California ribbed mussels (*Mytilus californianus*) are a dominant intertidal species that range from Alaska to Baja California. Understanding the mechanisms by which this species responds to rising temperatures is important in the context of climate change. The species is thought to be genetically homogenous, and yet populations exhibit differences in thermal tolerance across broad latitudinal gradients, even after common garden acclimation. Differences could be due to undetected genetic differentiation, developmental plasticity, maternal effects, or within-site thermal heterogeneity. To test for within-site thermal heterogeneity, we investigated whether mussels living in "hotter" microsites had higher thermal tolerance than mussels living a few meters away in "cooler" microsites before and after common garden acclimation. We measured the critical temperature of cardiac failure (Hcrit) for mussels collected from three 1m2 microhabitats (a low intertidal, and two upper intertidal sites with "sunny" and "shady" exposures) at Hopkins Marine Station (Pacific Grove, CA) . Mussels were heated in air at 8°C/hr to determine Hcrit using infrared heart monitors. Field-acclimatized mussels showed significant differences among microsites (ANOVA, df=22, F=6.93, p=0.005), with mussels from the high sites exhibiting significantly higher Hcrit values than low site mussels. Following exposure to common garden conditions, no significant differences remained (df=34, F=1.45, p=0.249), suggesting that mussels have the ability to acclimate in order to compensate for thermal stress.

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A LANDSCAPE BASED APPROACH TO QUANTIFYING RECRUITMENT VARIATION IN AN INTERTIDAL COMMUNITY

We aimed to better understand the variety of physical factors that are thought to influence the abundance and distribution of barnacle settlement in a rocky intertidal ecosystem. In particular, we studied the role of intertidal substrate complexity, topography and tidal height in affecting larval recruitment of two barnacle species (Cthalamus sp. and Balanus sp.) at Hopkins Marine Station in Pacific Grove, California. We applied spatial statistical models to barnacle distribution data in order to estimate the relative importance of physical parameters on variation in barnacle recruitment as estimated via of counts on recruitment plates installed in an intertidal boulder-field. Our model parameters were derived from local water velocity measurements and detailed topographic data as interpolated from georeferenced intertidal habitat laser scans. The model results suggests landscape features were important in determining larvae abundance; topographic position index (TPI), elevation, position (onshore facing or offshore facing), as well as substrate complexity all had significant relationships to variation in larval recruitment. A more complete understanding of factors controlling barnacle population depends on further attention to habitat complexity in sites with such high spatial variability.

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THE POTENTIAL IMPACT OF OCEAN ACIDIFICATION ON PHOTOTACTIC RESPONSE OF COPEPODS

Ocean Acidification (OA) is increasingly becoming an alarming environmental problem of the century. It is the result of excessive amount of the carbonate ions in the ocean due to the pollution. OA affects all marine organisms across the food chain, and the most vulnerable are those at the bottom of the chain, like zooplankton. For this study we were interested in testing how OA affects the phototactic behavior of copepods, the most abundant type of zooplankton. The phototactic behavior of copepods is their attractability to light. We hypothesized that as pH decreased their attractability to light would also decrease. We collected water samples from Elkhorn Slough by the Crab Bridge. The samples were transferred to a close container with just one light source. The container was partitioned into three sections and we extracted samples from three different depths per section. We counted the abundance of copepods under the microscope for every sample. The process continued as we decreased the pH twice by 0.5 from its original state. It was seen that the near section had higher abundance with an average of 15, middle section had an average of 8 and far section had an average of 3. Our study was specific at Elkhorn Slough, therefore it was a small scale experiment. We recommend similar studies on different areas at a larger scale to develop a clear understanding about how copepods react with unnatural pH environment. Our research showed as we decreased pH, no change was shown on their abundance.

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DOES SOIL CHEMISTRY REFLECT EFFECTIVENESS OF RESTORATION?

The amount of native habitats in California has been greatly depleted due to expansion of agriculture and urbanization; thus, it is necessary to restore native habitats to their previous conditions. Grassland, shrub land and oak are the three different types of habitats that comprise the Elkhorn Slough National Estuarine Research Reserve and have been depleted. Our research is focused on comparing potassium, phosphate, nitrates, and pH between restored and unrestored grassland, shrub land, and oak habitats to prove if restoration is effective. If restoration was effective pH would become more basic allowing the prime amount of nutrients to be released into the soil. Our soil was collected from 6x6 meter squared plot using systematic random sampling and later tested in the lab with a LaMotte soil testing kit. We hypothesized soil from unrestored sites would be more acidic; consequently resulting in a higher level of nutrients. In addition, we hypothesized that soil pH from restored sites would be higher, or more basic; resulting in lower levels of nutrients. Our results for pH agreed with our hypothesis but our results for nitrates, phosphates, and potassium did not. Although the results of our nutrients did not agree with our hypothesis, we still conclude restoration has a positive impact due to the fact that there were substantial differences in our pH levels between our unrestored and restored sites. Soil pH is directly correlated to the levels of bioavailable nutrients for vegetation because it determines how readily nutrients dissociate from clay in the soil. Therefore, restoration is effective.

Clark, Cara
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DEVELOPMENT OF A RAPID HABITAT CONDITION ASSESSMENT FOR DEPRESSIONAL WETLAND SYSTEMS

The California Rapid Assessment Method for Wetlands is a diagnostic tool that two trained practitioners can use to assess the condition of a wetland over a period of 1-3 hours using visual indicators in the field. The CRAM method expresses condition as an Index score. Project partners developed conceptual models for, and adjusted the module metrics representative of different depressional wetland types from various regions across the state. A team of expert CRAM practitioners then tested new metrics at a range of depressional wetlands across the state and revised the module to adequately assess systems with different periods of inundation. The method was tested in several watersheds that drain to the Monterey Bay National Marine Sanctuary. It provides a way to track changes in the condition of important freshwater wetlands in these watersheds, the habitat type that has been most impacted by conversion and development in the last two centuries.

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COMPARING SIZE-FECUNDITY RELATIONSHIPS IN TWO CALIFORNIA ROCKFISH (*SEBASTES*) SPECIES

Understanding the reproductive ecology of exploited species is vital to providing the scientific information necessary to support fisheries management. Rockfish (*Sebastes*) reproduce by internal fertilization and release live larvae, with great variation between species in terms of size at maturity, fecundity, and longevity. In general, fecundity increases with the size of the female, however in many *Sebastes* species, it has been found that relative fecundity, or the number of eggs and larvae produced per gram of somatic body weight, also increases, emphasizing the important contribution of older and larger females to population production. Increasingly, stock assessments are incorporating size-specific relative fecundity relationships into spawning output models to account for the disproportional decrease in larval production in an exploited population where the size structure has shifted to that of a smaller, younger population. However, for many *Sebastes* species, including the two in this study, this relationship is unknown. By counting eggs and larvae from subsamples of the ovaries in females at varying stages of embryo development, we can determine the relationship between total fecundity and relative fecundity with length and weight. For this study, we estimated fecundity in canary (*S.pinniger*) and squarespot (*S. hopkinsi*) rockfish collected along the California coast. This research is part of a continuous effort to better understand the reproductive ecology of rockfish in the California Current ecosystem.

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MICROCYSTIN VS. ZOOPLANKTON: EFFECTS ON DIVERSITY AND ABUNDANCE

Microcystin, a toxin released during the breakdown of blue-green algae *Microcystis*, can be harmful to humans and some animals. Large quantities of this toxin have also been known to kill off sea otters in the Monterey Bay area by causing liver failure. Hearing this we were engaged in wanting to see if microcystin affects zooplankton diversity and abundance by sampling at Pinto Lake, a water body known to exhibit high levels of microcystin, and Watsonville Slough, an area similar in habitat, but with relatively low microcystin concentrations. Our hypothesis is that we believe the zooplankton diversity and abundance will be lower at Pinto Lake because of the microcystin. From both sites we collected surface water and then added ethanol (50/50) to preserve and kill the zooplankton. Then using a dissecting scope, we identified and counted the zooplankton. Preliminary data interpretation shows that there are 18 species in higher abundance at Watsonville Slough than in Pinto Lake which has 12 species in higher abundance. In conclusion we believe that microcystis is affecting the zooplankton and we need to find a way to reduce and clean Pinto Lake from microcystis.

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TEN YEAR BATHYMETRIC TIME SERIES ANALYSIS OF GEOMORPHIC CHANGE IN THE MONTEREY SUBMARINE CANYON HEAD: WILL IT BECOME THE CANYON THAT ATE MOSS LANDING?

Submarine canyon heads are the dominant landscape feature intersecting many continental margins, where they bring deep water habitats close to shore, serve as active conduits for sediment transport, and can spawn tsunamigenic landslides. Massive in size, highly dynamic and often extending into the surf zone, do these monsters threaten to erode into our shorelines? Here we use a time series of 16 multibeam bathymetry data sets collected between 2002 and 2013 by the CSUMB Seafloor Mapping Lab to evaluate a variety of hypotheses pertaining to the geomorphic evolution and rates of change at the head of Monterey submarine canyon. These include testing if, where and at what rates the size, depth, shape, slope, bed forms and edges of the canyon are changing, and to what extent these changes may pose a threat to the Moss Landing Harbor mouth. We also use the data set to track rates of change in submarine landslide scars to test an assumption employed in many tsunami models that the size of a submarine landslide scar can be reliably used to represent the magnitude of the actual landslide event that generated the tsunami. Finally we take advantage of the results from the recently completed state-wide California Seafloor Mapping Project to test the hypothesis that nearshore submarine canyons heads that connect with the littoral zone are more active than those that terminate on the continental shelf offshore.

Ebert, David A., Kristin Walovich, and Gregor M. Cailliet
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DISCOVERING SHARKS: BIODIVERSITY AND CONSERVATION OF CHARISMATIC PREDATORS

The Pacific Shark Research Center (PSRC) at Moss Landing Marine Laboratories (MLML) has developed a highly ambitious, internationally recognized, research program studying the biodiversity, life history, and ecology of sharks and their relatives. The program's objectives are to conduct and advance basic and applied scientific research; provide scientific information to public policy makers; expand scientific cooperation on national and international shark issues; communicate scientific research and news; and increase public understanding. Activities conducted by the PSRC provide benefits in the areas of original research, education, and cooperative programs involving U.S. shark resources. This allows better decision-making in public policy, especially in the management of marine fisheries. Original research by PSRC/MLML staff and students on shark life histories, population dynamics and fisheries characterization provides critical information on the status of global and regional shark populations. As an academic institution, MLML contributes to formal education at the university level, and as a state organization it is part of a federal-state partnership in collaboration with NOAA Fisheries. Education of the public and interest groups promotes understanding and wise use of limited resources. National and international research collaborations and

conferences involving PSRC personnel also serve to promote global cooperation even beyond issues dealing with sharks. The PSRC over the past ten years has conducted more than 80 research projects, produced nearly 600 publications and participated in more than 60 conferences and workshops, trained over 30 graduate students, pioneered innovative research techniques, and described over 10% of all new shark species over the past decade.

English, William F., Ryland J. Denny, and Ian R. Rathmann
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TIDEPOOLING AT DAVENPORT LANDING

The purpose of our project is to collect data on the diversity and abundance of invertebrates and algae along the LiMPETS vertical transect at Davenport Landing State Beach. We will be comparing our data to data collected by other students at the locale in the past. Our hypothesis is that in an area with hermit crabs, the diversity of other species will be dramatically decreased as we move farther down the transect towards the ocean. We go out to Davenport landing about twice a month. We find the I-bolts that designate the LiMPETS vertical transect and attach our meter tape. Using a random number table we deploy a 1 meter square quadrat on four locations along the transect. We record species occurrence and abundance within the quadrat as directed by the LiMPETS datasheet. We are in the beginning stages of our project and have not yet collected enough data to come to any firm conclusions. We would like to thank our mentor, Dr. John Pearse for the guidance and assistance we have received.

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MICROCYSTIS: A DEADLY BYPRODUCT OF NUTRIENT POLLUTION

Microcystis Aeruginosa is a cyanobacteria responsible for producing a hepatotoxin known as Microcystin. Microcystis is becoming a threat to hydroecosystems across the globe. Pinto Lake, a communal, recreational park located in Santa Cruz County, has been diagnosed with some of the highest levels of microcystin ever recorded in the world. Pinto Lake is surrounded by heavy agricultural activity which is a likely source of nutrients, and is one of the main factors of Microcystis blooms. This study is a comparative analysis of the level of nitrates, phosphates and microcystin found in Pinto Lake and other nearby bodies of water. We expected to find a correlation between nutrient levels and microcystin levels however, water quality data suggest otherwise. We used an Immunochromatographic Strip Test for the detection of Microcystins and Nodularins (Abraxis). During the first half of the testing period we were placing the strip directly in our water sample, but midway through the testing period we began performing serial dilutions (by a factor of 1000) to our samples with distilled water. This allowed us to get a more accurate reading of microcystin. Thus, our results vary from >5 ppb to >5,000 ppb. The study found similar

nutrient levels in Pinto Lake and nearby waters, yet Pinto Lake was the only body of water with the confirmed presence of microcystin. We can conclude that nutrients are only a part of a larger group of factors that contribute to the growth of the cyanobacteria.

Gaddam, Rani, Christy Bell, Maya George, Pete Raimondi
University of California Santa Cruz

ASSESSMENT OF THE PATTERN OF INTERTIDAL COMMUNITY COMPOSITION AS A FUNCTION OF DISTANCE FROM THE ALDER CREEK LANDSLIDE

In the spring of 2011, a series of landslides occurred along Highway 1 south of Big Sur, California where Alder Creek meets the ocean. Surveys were conducted to characterize the intertidal community near the Alder Creek landslide in December 2012. Because of the gradient of tidal exposure, intertidal areas have strong species zonation patterns. Often this gradient is divided into three zones: high, mid and low. Our surveys were designed to sample the shoreline so that all three zones would be evaluated. This will allow us to determine if the pattern of community composition in each zone varies as a function of distance from the landslide. Some of the survey methods used in these surveys (i.e., permanent photo plots and mobile invertebrate counts) were the same methods used in our baseline assessments of California Marine Protected Areas and in our impact assessments of the Cosco Busan and Dubai Star oil spills in San Francisco Bay. Subsequent surveys and data analysis over the next few years will help determine if the patterns of intertidal community composition change over time and if they are consistent with an impact to the community resulting from the landslide.

Gaddam, Rani, Melissa Miner, and Pete Raimondi
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PACIFIC ROCKY INTERTIDAL MONITORING: TRENDS AND SYNTHESIS

The Pacific Rocky Intertidal Monitoring Program is a product of over three decades of research at nearly 200 rocky intertidal monitoring sites ranging from Southeast Alaska to Mexico. Long-Term Monitoring Surveys developed by a consortium of organizations collectively called “MARINe” (Multi-Agency Rocky Intertidal Network) use fixed plots to document changes in percent cover and species abundance. Biodiversity Surveys done by a single group at UC Santa Cruz provide detailed information about biodiversity and community structure. The synthesis of this research has resulted in the pacificrockyintertidal.org website. By mid 2013 we will have completed site pages for the 33 sites located within the Monterey Bay National Marine Sanctuary (MBNMS), which include site descriptions and photos, trend graphs, and species lists. Through the Interactive Map and Graphing Tool, users can also create customized map displays and graphs. Our monitoring program is the largest, and longest-running of its kind. This long-term information enables us to: 1) Assess impacts due to natural and human induced disturbance, 2) Detect shifts in community structure, and 3) Provide context for focused experimental work.

Gallagher, Natalie and Connor Lydon
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VERTICAL METEOROLOGICAL MEASUREMENTS IN SAN LORENZO VALLEY

For our Atmospheric Monitoring project, our goal is to learn more about the lower atmosphere of the San Lorenzo Valley (SLV). Our experimental question is what is the pattern of air inversions in SLV? This will be the first attempt at determining when and where inversion layers form in the Valley. We used weather balloons, iMet-1 Radiosondes, and the iMet-3050 Sounding System to gather data on atmospheric dynamics. We launched standard weather balloons twice a day early in the morning and mid-afternoon 3 days a week from mid-November 2012 to mid-January 2013. Our findings should help the public and scientists understand when smoke from numerous wood-burning appliances cast a possibly unhealthy orange pall over our valley. We have not yet analyzed the data we have collected. We would like to thank Mike Gilroy, Scott Norton, William Chevalier and Bob Nunes from the Monterey Bay Unified Air Pollution Control District for mentoring us and InterMet for providing equipment and consumables.

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BATHYMETRIC CHANGES OF ELKHORN SLOUGH CAUSED BY TIDAL SCOUR

The bathymetry of the Elkhorn Slough has been significantly altered by human and natural causes over time. In 1946 the Army Corps of Engineers constructed the Moss Landing Harbor which connected the Elkhorn Slough to the Monterey Bay. As a result of this construction the Elkhorn Slough became a seasonal estuary and tidal marsh allowing natural forces to alter the bathymetry more. It has been suggested that tidal influence has and will continue to erode the substrate of the Slough. Tidal scour alters the continued functioning of the salt marsh and mudflat ecosystems which mussels, oysters, clams, and crabs depend on. By determining if there was a correlation between flow, turbidity, and depth we sought to determine whether tidal scour occurred at different sites of the Elkhorn Slough. From our results we were unable to conclude correlations between flow, turbidity, and depth, further analysis is needed. In order to help preserve this fragile (or threatened) environment, awareness must be promoted among the scientific community and the general public and further study is needed.

Glanz, Jessica S., Brett Bulkin, and Brent Hughes
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THE ANATOMY OF A TROPHIC CASCADE

Biodiversity contributes to the overall stability of ecosystems and their ability to provide important ecological services. Arms races played out by primary producers in their competition for resources can strongly influence the biodiversity of an ecosystem. The outcomes of these arms races are driven by direct and indirect effects of both bottom-up and top-down factors. The objective of our study was to determine how bottom-up (light and nutrients) and top-down (herbivory and predation) factors influence outcomes of this ecological arms race in eutrophic estuarine systems where seagrass and epiphytic algae compete for light. We specifically investigated the growth strategies of the eelgrass *Zostera marina* under two different trophic scenarios using a mesocosm experiment and a comparative survey of Elkhorn Slough and Tomales Bay. Our results demonstrated that when there was a simplified trophic structure (top predator removed), eelgrass abandoned old shoot growth in favor of rhizome elongation and new shoot growth. As trophic diversity increased (top predator inclusion), seagrass was able to outcompete epiphytic algae and allocate resources to old and new shoot growth as well as rhizome elongation. Given that seagrass provides many essential ecological services understanding this arms race is important for assessing how this ecosystem is shaped and its health is maintained.

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THE EFFECTS OF EUCALYPTUS TREES ON NATIVE PLANTS

Eucalyptus trees are controversial because they are non-native, large trees that reproduce well in the central coast. eucalyptus trees are native to Australia but were widely planted in California. We observed that oak habitat appeared to have higher diversity than eucalyptus habitat. We wanted to test whether eucalyptus trees had a negative effect on native plants and what the mechanism might be. We measured diversity in both eucalyptus and oak habitats. We transplanted a native species, *Stachys bullata*, into both habitats and measured survival. We conducted a greenhouse experiment to test differences in soil quality between soil collected from underneath both eucalyptus and oak trees. We also tested seed germination in water strained from leaf litter from both habitats to test for toxic water soluble compounds. We found that on average the number of species in the two habitats were not different (~1.25 species/ quadrat), but the overall diversity was much greater in the oak habitat (9 species verses 21 species, respectively). However, there was no difference in *Stachys* survival between habitats. Greenhouse plants grew the same in eucalyptus and oak soil until 3 months later when all plants in eucalyptus soil died. There was also no difference in seed germination in water leached from eucalyptus and oak leaf litter. While we found a difference in diversity between the habitats, we cannot attribute this difference to soil differences or water soluble compounds. Future work should address the effects of light, temperature, and the thick duff layer observed under eucalyptus trees.

Kelley, Heather and James Lindholm
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PREDICTING THE DISTRIBUTION AND HABITAT ASSOCIATIONS OF CANARY ROCKFISH (*SEBASTES PINNIGER*) IN THE NORTH CENTRAL COAST REGION USING A REMOTELY OPERATED VEHICLE (ROV)

While commercially important, Canary Rockfish (*Sebastes pinniger*) are emblematic of our limited knowledge of baseline distribution and fish-habitat associations in the Marine Life Protection Act's (MLPA) north central coast region. The purpose of this research is to test whether the accuracy of predictive species-specific habitat suitability models increases with the spatial resolution of input data. The input data, rockfish relative abundance and habitat associations, will be extracted from ROV imagery at the fine scale (<1 m), intermediate scale (meters to kilometers) and broad scale (10-100 kilometers). Fish observations will be coupled with abiotic and biotic habitat attributes, i.e. substrate type, substrate relief and biogenic structure (>10 cm), at each of the three spatial scales. The results will be considered in context of recently established MPAs to establish baseline conditions in the MLPA's north central coast region. The inclusion of spatial scale and abiotic and biotic habitat attributes has the potential to increase the performance and resolution of habitat suitability and predictive maps in this and future studies. This research is part of a larger baseline characterization study and improvements to habitat suitability and predictive maps, as well as underwater imagery collection, have direct implications for marine spatial planning and long-term monitoring as required by the MLPA.

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TIDE POOL SCULPINS AT CARMEL POINT: THE RELATIONSHIP BETWEEN TIDE POOL SIZE AND THE NUMBER OF FISH

We wanted to see how important tide pool size is for the number of fish in it, and we wanted to have fun. We took a waterproof notebook and a plastic measuring tape to Carmel Point. First we looked for any tide pool that had a fish in it. And then we watched for approximately five minutes to count any other fish without falling in while doing it (Dad did but Zib didn't). We placed all the fish we saw into four categories- small, medium, large (and we added extra-large). Then we used the measuring tape to measure each tide pool, first length and then width. In the end, we observed 131 fish in 36 tide pools over 6 weeks, mostly at low tide. The largest pool measured 229 cm long by 107 cm wide. The smallest pool measured 58 cm long by 53 cm wide. Several pools only had only a single fish, while two pools had eleven fish, the highest count we observed. One the questions that we still have is whether fish stay in the same tide pools over many days. But this will be hard to track.

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ASSOCIATIONS BETWEEN DEMERSAL FISHES AND STRUCTURE-FORMING INVERTEBRATES IN TEMPERATE WATERS ON THE CONTINENTAL SHELF OF THE PACIFIC NORTHWEST

Plans are underway to deploy wave energy capture devices off the coast of the Pacific Northwest as a solution to the region's ever-growing demand for energy. Implementation of wave energy fields could have far-reaching effects on structure-forming invertebrates, which are slow-growing, fragile, and sensitive to siltation. Impacts on these invertebrates could in turn have adverse effects on associated fish species by reducing available or preferred habitat. I aim to evaluate the extent to which fishes associate with the structure-forming invertebrate community at sites that may be impacted by wave energy generation. Video footage was collected for this study by the remotely operated vehicle (ROV) *Hammerhead* from Gray's Bank, Washington and Siltcoos Reef, Oregon in late summer 2011. I characterized the proximity between 660 individual fishes and 907 structure-forming invertebrates in the study area. More than 75% of individual fishes were within one body length of an adjacent invertebrate. Chi-squared tests suggest a difference in associating groups of fishes between soft-sediment and hard-bottom habitat. Furthermore, regression testing showed significant relationship between structure-forming invertebrates and fish in only the soft-sediment habitat.

Mahoney, Brenna
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VARIABILITY IN SMALL INVERTEBRATE PREY COMMUNITIES AS A FUNCTION OF ALGAL HABITAT AND PHYSICAL DISTURBANCE

Understanding changes in species diversity resulting from natural or anthropogenic environmental alterations are key to management strategies of species and ecosystem functioning. This study examines how both algal habitat and physical disturbance in the kelp forest ecosystem influence the abundance and diversity of small, mobile invertebrates that are a functionally important group of prey items for most kelp forest fishes. Benthic surveys of algal habitat were conducted within the Monterey Bay National Marine Sanctuary at 6 kelp forests along the Monterey Peninsula, from July-December 2011, March, August, and September 2012. 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 5 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 algal species were compared among sites and by date sampled as well as with inshore oceanographic data (collected from NOAA Buoy Data Center). Statistically significant relationships exist between algal and invertebrate prey communities but this varies as a factor of algal species indicating that identity of biogenic habitat may have pronounced effects on the interactions between availability of habitat and structure of associated communities.

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LIFE BELOW THE DOCKS: HOW INITIAL COMMUNITY ATTRIBUTES SHAPE SPECIES COMPOSITION

With continued global expansion of humankind and climate change, how will native communities be affected by introduced species? Factors regulating the success of non-indigenous species are of interest to scientists and managers, yet few experiments have investigated such factors in the marine realm. Understanding the relationships between native and introduced species is essential to protect ecosystem functioning and native biodiversity. To examine these relationships, I manipulated initial community structure on artificial hard substrates in Monterey Harbor. This experiment varied the diversity, the proportion of native species, and amount of free space within the initial community. Differences among percent cover of treatments were observed through bimonthly photographs. The results show that many factors influence the final community composition and structure. Most notably initial bare space influenced the species richness of the final community. The initial native community influenced final non-native species richness. These results can help demystify aspects of invasion ecology, particularly what allows some areas to be more heavily invaded then others.

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San Lorenzo Valley High School, Felton, CA

THE ANEMONE PLOT: ENVIRONMENTAL IMPACTS ON BIODIVERSITY AND INTERSPECIES RELATIONS

Our goal is to successfully collect data following LiMPETs (Long-term Monitoring Program and Experiential Training for Students) protocols and examine the possible impacts of environmental change. We hypothesize that the increased populations of some species of common algae and animals in the tidepools will be related to fluctuations in the tidepool environment and/or seasons. We have been collecting data approximately twice a month during low tides the last two years in the already established 15m X 15m anemone plot at Davenport Landing State Beach. 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. From our data, we determine which species populations have changed over time and then hypothesize and research why. In our data so far, we have noticed a dramatic increase in turban snails and a slight decrease in anemone populations. Thanks go to our fabulous mentor, Dr. John Pearse.

Mikaela, Slade and Jurgen Prambs
San Lorenzo Valley High School, Felton, CA

AMPHIBIAN BIODIVERSITY

We are monitoring the population of amphibians in the Fall Creek Watershed of Henry Cowell State Park in Santa Cruz County California. Amphibians are important members of the Redwood Forest ecosystem, but their numbers world-wide are declining. We would like to determine what the status and population density of amphibians, specifically salamanders, is in our study area. To conduct our study, we deployed 5 wood (1.5 x1 meter) cover boards every 10 meters along a 50-meter transect. We monitor the 3 transects twice a month by lifting up each board and noting the number and type of salamanders that are present. We also describe the sample area and note important biotic and abiotic factors such as temperature and seasonal changes in vegetation. So far, we have found several salamanders of two different species, yellow-eyed *Ensatinas* and California Slenders, under our boards. As our boards continue to season and the wet weather continues we hope to collect more data on salamander abundance and diversity. We would like to thank Stephanie Bourcier who assisted in the development of our project.

Moreno, Allison (1)**, Judith Canner** (2)**, and Arlene Haffa** (1)
1) Division of Science and Environmental Policy, California State University Monterey Bay
2) Department of Mathematics and Statistics, California State University Monterey Bay

GLOBAL MARINE HARVEST IMPACTS OCEAN IRON CYCLE

Although iron (Fe) is the fourth most abundant element in the Earth's crust, bioavailable Fe is a limiting factor in marine primary production. We hypothesize that removal of Fe due to the harvest of marine species is a significant loss term that is absent from current mass balance equations for oceanic Fe cycles. Total commercial catch data for 1950 to 2010 was obtained from the Food and Agriculture Organization of the United Nations (FAO). The data was separated by taxa and fresh water species were excluded. High and low end values for elemental composition were obtained from the literature, and used to determine Fe per mass of total harvest over time using Matlab. The marine commercial catch is estimated to have removed 2-6x109 grams of Fe (0.4-1 x108 moles) in 1950, which constitutes the lowest values on record. There is an annual increase to 0.9-3x1010 grams (2-5 x 108 moles) in 1996, and then a slight decline to 0.7-2x1010 grams (1 – 4 x108 moles) in 2010. To determine if this is significant, seawater data compiled by Moore and Braucher was used to estimate total dissolved iron (Fe(d), that which passes a <0.4 micron filter). The total ocean Fe(d) is estimated as 0.1-2 x1013 grams (0.2 - 3 x1011 moles) from 1978-2004. These calculations support our hypothesis that ocean catch data is a term that has been neglected in global oceanic Fe cycles because it is in a bioavailable form, and much of this removal is permanent on biological time scales.

Morse, Marisa (1)**, Akana Noto** (2)**, Krista Bergesen** (2)**, and Jonathan Shurin** (2)
1) California State University Monterey Bay
2) University of California San Diego, Department of Biology

INFLUENCE OF TIDAL ELEVATION ON MACROINVERTEBRATE DISTRIBUTION IN SALT MARSHES OF SOUTHERN CALIFORNIA

Invertebrate species have a wide ecological impact in the salt marshes of Southern California due to their ability to provide a link between primary producers and larger fauna. In this study, the influence of tidal elevation on macroinvertebrate distribution was measured in the Kendall-Frost Mission Bay Marsh Reserve. We predicted that canopy invertebrates would be most abundant in areas at lower tidal heights due to the disturbance from greater tidal activity at ground level. In addition, we expected to find more ground-dwelling invertebrates in areas of higher elevation that receive less influence from tides. These predictions were supported by sweep net and pitfall trap techniques which revealed that canopy and ground-dwelling invertebrates varied in abundance based on elevation. A non-metric multidimensional scaling (nMDS) approach was used to determine that some taxonomic orders were particularly important in driving observed trends. Investigating the relationship between salt marsh invertebrates and elevation is crucial to understand the distribution of all marsh organisms in the trophic pyramid and is necessary to predict the response of these communities to sea level fluctuations under climate change.

Moye, Jessica (1)**, James B. Lindholm** (1)**, Donna E. Kline** (1)**, and Dirk Rosen** (2)
1) California State University Monterey Bay
2) Marine Applied Research and Exploration

GENDER-MEDIATED HABITAT ASSOCIATIONS OF KELP GREENLING (*HEXAGRAMMOS DECAGRAMMUS*) WITHIN THE NORTH CENTRAL COAST REGION OF CALIFORNIA

Marine fish assemblages are broadly distributed based on large-scale oceanographic and physical conditions, such as water temperature and depth. Within this classification, various demersal fishes are known to associate with specific substrate types such as rocky reef or unconsolidated sediments. One such case of limited information is on fine-scale habitat associations of Kelp Greenlings (*Hexagrammos decagrammus*), an exploited species in California. In this study, video imagery and still photographs were collected by a remotely operated vehicle as part of the baseline characterization of the new California marine protected areas (MPAs) in the Marine Life Protection Act's North Central Coast study region. From this imagery, data on the micro-habitat associations of 316 female, 414 male, and 134 sexually indeterminate fish were quantified and the geo-referenced position was plotted over high-resolution (2 m) bathymetric multibeam maps of the seafloor within and adjacent to MPAs. These data suggest that kelp greenlings associate with rocky, low-relief habitat, despite gender. Ultimately, the information provided by this study will advance our understanding of this exploited species in support of current and future efforts for spatial management efforts such as designation and monitoring of MPAs and essential fish habitat.

Palacios, Sherry L. (1)**, Liane S. Guild** (1)**, Raphael M. Kudela** (2)**, and Juan Torres-Perez** (1)
1) NASA Ames Research Center
2) University of California, Santa Cruz

MONTEREY BAY AS A TEST-BED FOR NASA'S EXISTING AND FUTURE OCEAN COLOR REMOTE SENSING CAPABILITIES

The early vision and ongoing investment and dedication of researchers in the Monterey Bay region have resulted in a rich resource of people and technology to study the ecosystem of the bay. Monterey Bay is frequently a test-bed for new technologies, including ocean color algorithm development for existing and future airborne and satellite remote sensing imagers. These new ocean color algorithms have been used to monitor water quality, track river plumes, differentiate among phytoplankton taxa, and identify if the coastal ocean is a sink or source of carbon to the atmosphere. One application of these algorithms is to track regime shifts in phytoplankton taxa, like the shift in 2004 from a diatom to dinoflagellate-dominated ecosystem. Researchers at NASA Ames Research Center, UC-Santa Cruz, and MBARI have collaborated through the years to leverage the resources at each institution to study the Monterey Bay and to develop novel techniques in a 'sensor web' approach to understand ecosystem status and change. Several recent and upcoming projects are highlighted and include NASA's Coastal and Ocean Airborne Science Testbed (COAST), Hyperspectral Infrared Imager (HyspIRI) airborne simulation, and Ocean Color Ecosystem Assessments with Novel Instruments and Aircraft (OCEANIA) missions. The future of satellite remote sensing of the coastal ocean depends on these proof-of-concept missions. Researchers at NASA Ames and UC- Santa Cruz are uniquely positioned to support this research in the Monterey Bay.

Peglow, Justin R.
Moss Landing Marine Laboratories, Moss Landing, CA

STRESS AND GEOMORPHOLOGY: A QUANTITATIVE ANALYSIS OF COMMUNITY STRUCTURE IN THE ROCKY INTERTIDAL USING TERRESTRIAL LASER SCANNING

Conspicuous patterns of ecological stratification are ubiquitous throughout rocky intertidal ecosystems. Current literature primarily considers physical and biological stressors to be the chief drivers of community structure in these habitats. However, it has been suggested that substrate geomorphology may also hold significant influence in shaping the distribution and abundances of organisms inhabiting rocky intertidal systems, yet few studies offer robust scientific evidence in support of this theory. The present study investigated how geomorphologic and lithologic properties may shape community structure by exacerbating or ameliorating various environmental stress mechanisms acting on resident organisms. A novel methodological approach combined cutting-edge terrestrial laser scanning (TLS) technology with traditional ecologic surveying, namely random point contacts (RPCs). These methods were designed to quantitatively examine whether rugosity, surface aspect and orientation relative to incoming solar radiation, and/or complexity of the substrate within mid-upper rocky intertidal zones exhibited a predictable relationship with patterns in associated species diversities and abundances. I hypothesized that higher richness and species diversity of established rocky intertidal communities and greater abundances of selected species of interest were associated with lithologies containing characteristics expected to lower desiccation stresses. Examples of these properties include, but are not limited to, higher rugosity,

complexity, and surface orientation away from the dominant direction of incoming solar radiation. Preliminary results of data collection at three different sites around the Monterey Bay region from two study seasons were reported, including that from pilot studies testing the efficiency and feasibility of the methods used.

Pennington, J.Timothy, Monique Messié, Reiko Michisaki, and Francisco P. Chavez
Monterey Bay Aquarium Research Institute, Moss Landing, CA

CHANGE IN MONTEREY BAY: NONSEASONAL VARIABILITY ASSOCIATED WITH NORTH PACIFIC CLIMATE INDICES

Monterey Bay, California, has been sampled by ship at 2-3 week intervals since 1989. Here we examine time series of temperature, salt, sigma-t, spice, nitrate, chlorophyll and primary production over the 23 year record and correlate the nonseasonal variability with Pacific basin climate indices. Anomaly time series were constructed over 0-200m. The original data series are dominated by the seasonal cycle, but the anomalies highlight ENSO and additionally indicate that Monterey Bay has been cooler and saltier, with elevated subsurface nitrate and near-surface chlorophyll and primary production over the past decade. To explore, anomalies for 0, 60, 100 and 200m were correlated against each other and Pacific basin climate indices. Within-parameter physical and nitrate anomalies are coherent across depths with the largest variability near the surface; their cross-parameter correlations are also strong except for spice. The biological parameters are strongly intercorrelated, but are less strongly correlated to the physical variables with spice being the weakest predictor of biology. The 60 and 100m physical and particularly nitrate anomalies are better predictors of the biological variables than are the 0m anomalies. Climate indices representing ENSO, the Pacific Decadal Oscillation and the North Pacific Gyre Oscillation are strongly correlated to temperature, salinity, sigma-t and nitrate at all depths; El Niño Modoki is less strongly associated. The biological parameters are also less strongly but still significantly associated with ENSO and the PDO and NPGO. The analysis demonstrates connection between a Monterey Bay time series and North Pacific basin nonseasonal variability.

Perales, Brynn (1)**, Amelia Whitcomb** (2)**, and Kathleen O'Malley** (2)
1) California State University Monterey Bay
2) Hatfield Marine Science Center, Oregon State University

AN EVALUATION OF COHO SALMON (*ONCORHYNCHUS KISUTCH*) JACK MATE CHOICE BASED ON IMMUNE-RELEVANT GENES

It has been recently shown that when hatchery reared coho salmon spawn in the wild they have a lower reproductive success (RS) compared to wild fish. This decrease in RS may be driven by mate choice. In the wild, females select favorable males to mate with, but in the hatchery choice has been eliminated. However, hatchery coho jacks, small sexually mature 2 year old males, do not experience the same fitness decline as 3 year old males. Coho jacks employ a "sneaker" strategy suggesting they mate opportunistically. We therefore predict that jacks would not exhibit a mate choice. We tested for non-random mating by comparing observed mate pairs with randomly generated pairs and found significant evidence for non-random mating at four immune-relevant

gene linked markers. Immune-relevant genes can be used to test for mate choice because they can offer genetic benefits to offspring. However, we found no evidence for a preference type; genetically similar or dissimilar. Interestingly, we found a positive correlation between the greater number of shared alleles between mate pairs and increased RS at three of the markers. Our results suggest that some of the immune-relevant markers influence the RS of wild spawning coho mate pairs.

Peterson, Mikayla and Lauren Smith
San Lorenzo Valley High School, Felton, CA

BIRD BIODIVERSITY: THE SEQUEL

The San Lorenzo Valley is a unique area for wildlife, birds in particular. One reason for this is the diverse habitats and the rich riparian corridors. In this project, we are continuing to compare the diversity and abundance of birds in four different types of habitats (meadow, river-meadow, river-redwood, and redwood) in Henry Cowell Redwoods State Park. Our hypothesis is that there will be seasonal differences in the biodiversity and abundance of birds between each type of habitat. We survey eight sites twice a month along a predetermined loop at Henry Cowell. We record all the birds we see and hear at each site over a 10 minute period and also record weather conditions. So far, our data has shown that the Meadow habitat has the highest Shannon Diversity Index (7.1) and a species count of 69. The River-Redwood has the second highest Diversity Index (6.7) and a species count of 56. The Redwood habitat is the third diverse with a Shannon Diversity Index of 6.5 and a species count of 55. The River-Meadow habitat has shown to be the least diverse with a Diversity Index of 6.2 and a species count of 46. Though the indices are different, the standard errors of each set of data show that there is no significant difference among the diversity in each habitat. We are still collecting data and analyzing our results to determine any data trends. We would like to thank our mentor, Dr. Jeff Smith.

Prambs, Johann
San Lorenzo Valley High School, Felton, CA

ONLY IN THE WATER

Will salmoniids thrive and reproduce again in the San Lorenzo River (SLR)? What human activities are preventing the historical returns of salmon? I have been collecting water quality data on 6 tributaries to the SLR to determine anthropogenic changes in water quality. I will be comparing the data I collect with historical data collected by Santa Cruz County Environmental Health Services (SCCEHS). For over twenty years, SCCEHS has been collecting water quality data on various streams along the San Lorenzo River; however, due to budget cuts the Service is unable to monitor as many factors or tributaries as in the past. Beginning in August 2012, I have monitored the dissolved oxygen, conductivity, pH, temperature, nitrates, and water flow of 6 streams flowing into the river from Ben Lomond through Felton. I am utilizing a Vernier LabQuest handheld data collector and probes to measure the above water quality factors. However, for nitrates I collect a water sample, freeze and deliver it to SCCEHS for testing using ion chromatography. I am currently comparing the results I have recorded to past data obtained from SCCEHS. While no significant

difference has been determined thus far, I have found that a few sites have abnormally high levels of conductivity and nitrates. With further analysis, I hope to determine what may be causing these unusual levels and possibly preventing the return of abundant salmoniids to the river. I would like to thank Steve Peters for the opportunity, data and guidance to pursue this project.

Reichert Amber N., Corey Garza, and Scott Toews
Science and Environmental Policy, California State University, Monterey Bay, Seaside, California

ANALYZING THE AGE DISTRIBUTION OF BLACK SURFPERCH (EMBIOTOCA JACKSONI) RELATIVE TO HABITAT STRUCTURE AND COMPOSITION

Characterizing fish species by habitat type is a useful strategy in the designation of marine protected areas (MPA's). In this study we examined if there is a relationship between different age classes of Embiotoca jacksoni (E. jacksoni) and their underlying subtidal habitat structure and composition. Our approach is to use the locations, habitat data, and fish age to produce a predictive habitat model. Fish were obtained from 4 locations in the Monterey Peninsula. Age was determined by counting concentric growth rings of otoliths. GIS landscape analysis and spatial statistics were employed to test and model the association of fish location and age with the habitat parameters derived from bathymetric data. This information may hold value in future monitoring of the life cycles of black surfperch and other ecologically vulnerable species.

Rhett, Gillian
Moss Landing Marine Laboratories, Moss Landing, CA

COMMUNITY COMPOSITION OF MEIOBENTHOS UNDER WHALE FALL IN MONTEREY BAY, CALIFORNIA

Most of the seafloor is bare sand or mud and is relatively nutrient-poor but there are localized habitats where the concentration of organic carbon is much greater, such as hydrothermal vents and cold seeps, and sunken whale skeletons called whale falls. Meiofauna, a taxonomically diverse group of microscopic invertebrates, are an important part of the ocean's ecosystems and they have been studied in many of the large variety of habitats where they are found, though they have never before been studied at whale falls. The purpose of this project is to characterize the community of meiofauna living under and around whale fall at four locations in the Monterey Bay, in terms of density (individuals per area), biomass, and taxonomic richness. I will test the hypothesis that these variables are affected by the presence of the whale skeleton. I will measure these three variables using two methods: visual identification and counts by microscopy, and metagenomics using universal eukaryotic PCR primers and 454 sequencing on the mixed DNA extracted from each sediment core. I expect density and biomass to be highest at the whale fall and decrease with distance from the bones, and I expect richness to be low at the whale fall due to competitive dominance, low at the furthest distance from the bones due to lack of nutrients, and high at an intermediate distance. I am a student pursuing a MS in Marine Science at MLML. For my poster, I intend to present preliminary data on one whale fall site.

Roeder, Kyle P. and Henrik Kibak
The Molecular Ecology Lab at California State University Monterey Bay

A PCR-BASED ASSAY FOR GENDER AND SPECIES IN THE GENUS *MYTILUS*

At the beginning of the twentieth century, the blue mussel *Mytilus trossulus* was thev dominant mussel of protected estuaries and harbors along the California coastline. However, recent studies have shown that *M. trossulus* has been displaced from San Diego to Monterey and in some cases beyond, by an invasive sibling species, the Mediterranean mussel *Mytilus galloprovincialis*. Invasions of this nature have been shown to alter offshore ecological communities, which makes positive identification of the invasive species paramount. The many morphological similarities between *Mytilus* species at all life stages make differentiation based on morphology difficult at best and DNA sequence analysis is required to determine species identity. Mussels in the genus *Mytilus* have a unique mode of genetic inheritance, wherein mitochondrial DNA is inherited from both parents, a phenomenon known as doubly uniparental inheritance. Many different biotechnological assays that involve the polymerase chain reaction have been developed to differentiate between the various *Mytilus* species, but to date no assay has been published that differentiates between species and gender. We used the phenomenon of gendered mitochondria to develop an assay based on PCR that differentiates between both gender and species in *Mytilus*. The primers Mytilusfor (5'-AACATAATAGGGCTGCTAAC-3') and Mytilusrev (5'-GGTATCTAATCCTGGTTTCTTC-3') amplify a ~6kB region of DNA from the mitochondrial genomes of four *Mytilus* species. These DNA samples are then digested with varying combinations of restriction enzymes to produce restriction fragment length polymorphisms (RFLPS) which are run on agarose gels in order to create a unique DNA fingerprint for gender in various *Mytilus* species.

Rosenfeld, Leslie K., Aric Bickel, Francisco Chavez, and Jason Adelaars
CeNCOOS, Monterey Bay Aquarium Research Institute, Moss Landing, CA

CENCOOS: MEASURING AND PREDICTING CHANGE IN THE MONTEREY BAY NATIONAL MARINE SANCTUARY AND BEYOND

The Central and Northern California Ocean Observing System (CeNCOOS) is one of 11 regional ocean observing systems that make up the Integrated Ocean Observing System (U.S. IOOS®), the U.S. contribution to the Global Ocean Observing System. The CeNCOOS region extends from Pt. Conception to the Oregon border, from the coast through the Exclusive Economic Zone; thereby encompassing the whole of the MBNMS. CeNCOOS is a consortium of 50 members, and currently provides support to 15 principal investigators at 13 institutions. Within the Sanctuary, CeNCOOS supports a number of automated shore stations, more than 15 high frequency (HF) radar stations, a continuously operating profiling glider, atmospheric and oceanic numerical models, and a data management system. Most importantly, CeNCOOS serves data and information products to aid in informed decision-making concerning ocean ecosystems, fisheries, water quality, and climate change. These data allow managers to base policy decisions in the context of long-term oceanographic changes. CeNCOOS data assists in the evaluation of Marine Protected Areas within the Sanctuary by characterizing the physical environment, including how winds, currents, temperature, and waves in these areas change over time. In the MBNMS region, CeNCOOS monitors water quality, harmful algal bloom concentrations, chlorophyll levels, and ocean pH at

stations in Monterey, Moss Landing, and Santa Cruz. CeNCOOS makes these data sets, as well as oceanic and atmospheric numerical model output, and other data products available to stakeholders and the wider public through an online data portal.

Saarman, Emily T., Daniel P. Malone, and Mark H. Carr
University of California Santa Cruz

KELP FOREST COMMUNITIES IN CALIFORNIA'S CENTRAL COAST MARINE PROTECTED AREAS: CHARACTERIZATION AND INITIAL CHANGES

Since 2007, when a network of marine protected areas (MPAs) were established along the central coast of California, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) has monitored kelp forest communities inside and outside of 15 coastal MPAs using SCUBA. The information gleaned from this monitoring effort allows us to characterize the geographic patterns of kelp forest communities, including fish, invertebrate and algal assemblages, along the central coast and relate those patterns to environmental features both inside and outside of MPAs. The monitoring data, which spans the six years since MPA implementation, also provides insights into initial changes in kelp forest populations and communities, including changes in the biomass and size of some fished species inside MPAs relative to nearby unprotected areas. Finally, we use the results from our monitoring to inform the design of longer-term efforts to track population and community responses to MPAs into the future.

Sanchez, Michaela and Adrian Miller
San Lorenzo Valley High School, Felton, CA

FECAL COLIFORM: A STUDY OF WATER CONTAMINATION IN THE SAN LORENZO RIVER

What is the main source of fecal coliform in the San Lorenzo River? We believe that animal waste is a contributing factor, as well as human waste from septic tank leaks. Fecal coliform is nonpathogenic, but is an indicator of fecal contamination from birds or mammals and therefore may indicate the presence of pathogenic microbial species. This is our second year of monitoring coliform levels in the San Lorenzo River. We have taken samples in two different locations in Felton: Covered Bridge Park before the horse stables and Henry Cowell State Park after the same stables. We use sterile whirl-pak bags to collect water samples, transport the samples to the high school lab and then isolate the bacteria using membrane filtration. We grow the bacteria on m-FC media and incubate at 44.5 degrees Celsius for 24 hours. We use *Escherichia coli* as a positive control, and run sterile phosphate buffer through the vacuum filtration system, as a blank, insuring sterile conditions. Last year, we found coliform contamination at our sites upstream and downstream of the horse stables. This year we are trying to isolate the cause of this contamination. We would like to thank our mentors Jennifer Slaughter, Water Quality Specialist, Santa Cruz County Environmental Health Services, and Jane Orbuch, Biology teacher, SLVHS.

Sedoryk, Maryna (1)**, Danielle M. Frechette** (2)**, Ann-Marie K. Osterback** (2,3)**, and Sean A. Hayes** (2)
1) Environmental Studies, University of California Santa Cruz
2) National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA
3) Ecology and Evolutionary Biology, University of California Santa Cruz

DIET ANALYSIS OF WESTERN GULLS ON AÑO NUEVO ISLAND

Generalist predators can have a significant top-down effect on their prey, especially when prey are threatened or endangered. Recently, a generalist predator, the western gull (*Larus occidentalis*), has been identified as an important predator of threatened juvenile salmonids (*Oncorhynchus spp.*) in central California (USA) watersheds. Initial estimates indicate that western gulls breeding on Año Nuevo Island (ANI) may consume up to 30% of salmonids originating in coastal California streams, however the contribution of salmonids to overall gull diet remains poorly understood. Here we analyze the diet of nesting western gulls by dissecting 46 pellets collected on ANI between June and August 2008 in a first attempt to better understand the importance of salmonids to gulls. Pellets were found to consist primarily of fish remains (identified in 68% of pellets collected), vegetative matter (41%), and bird remains (27%). Fish remains were further analyzed by identifying otoliths to the lowest possible taxonomic level, when feasible (many otoliths were unidentifiable due to mechanical damage and/or erosion). Four families were positively identified – Engraulidae, Gadidae, Salmonidae, and Pleuronectidae – with Northern Anchovies (family Engraulidae) the species most commonly encountered. Although preliminary results suggest that western gulls have low per capita predation rates on juvenile salmonids, the relatively large population of gulls may translate into substantial mortality of salmonids from predation. Our results provide an introductory look into the dietary habits of western gulls on Año Nuevo Island, and further supports previous findings that gulls may be an important predator of juvenile salmonids in central California.

Snyder, Alexander G., Rikk Kvitek, and Douglas Smith
California State University Monterey Bay

EMPLOYING LIDAR AND RTK GPS TO EVALUATE BEACH NOURISHMENT SUCCESS IN SOUTHERN MONTEREY BAY

An increasing number of coastal communities are considering beach nourishment as a coastal erosion mitigation method, particularly as erosion rates are quantified with increasing accuracy and consequences of sea level rise are realized. The southern region of Monterey Bay is eroding at rates of 0-0.8 m/year and small scale beach nourishment has been recommended as a possible mitigation technique. However, the absence of monitored pilot studies and calibrated models has prevented stakeholders from predicting the lifetime of this method. During the winter of 2012 - 2013, approximately 7,500 m3 Monterey Harbor dredge material was used to nourish a section of beach identified as a critical erosion area. To determine whether this method is feasible as long term mitigation strategy, we have collected geomorphological survey data of the nourishment area and control sites. Baseline beach profile data were collected using vessel based light detection and ranging (LIDAR) and real time kinematic (RTK) GPS prior to nourishment as well as

during the nourishment activities. Once nourishment activities are completed, we will continue morphological surveys and merge the data with multiple nearshore bathymetric surveys to evaluate the lifetime of the nourishment and its impact on overall nearshore sediment supply. Morphological survey data will be combined with regional wave climate buoy data and used to calibrate beach morphology models to the Southern Monterey Bay region for use in future coastal erosion decisions as well as establish a nourishment evaluation method that could be applied to other critical erosion areas.

Sprague, Robert M. and Henrik Kibak
California State University Monterey Bay

DEVELOPING A PROTOCOL FOR ROUTINE PATHOGEN AND HAB DETECTION IN MARINE MUSSELS

Mussels in the genus *Mytilus* are important filter feeders in coastal marine ecosystems. When mussels ingest pathogens or toxins, there are potential adverse effects on marine animals higher in the food chain. Sea otters (*Enhydra lutris*) are often observed feeding on mussels in the Monterey Bay, especially in Moss Landing Harbor. And since significant numbers of otters have been necropsied recently and found to be suffering from toxoplasmosis or poisoned by microcystin, we wondered if mussel digestive tract might contain detectable DNA from organisms that have been ingested, and could thereby provide insight into the potential presence of toxins or pathogens in marine ecosystems. Because the presence of degradative enzymes in the digestive tract can interfere with isolation as well as any subsequent amplification of DNA using the polymerase chain reaction (PCR), researchers conventionally use tissue from the gonad, gill, or mantle to isolate DNA from mussels. A primary goal of this project is to prepare an optimized protocol for successful DNA isolation from *Mytilus* digestive tract, and then to screen that DNA preparation for the presence of *Toxoplasma* and *Microcystis* genetic markers using PCR and primers specific for 18S rDNA, B1, and SAG1 genes in *Toxoplasma* and the mcyB locus of the cyanobacterial toxin synthesis operon. Once the protocol is perfected, the capacity to screen for additional pathogens such as Hepatitis A will be trivial.

Verga-Lagier, Annette, Mark E. Callaghan, Maren Mitch, and Henrik Kibak
California State University Monterey Bay

CHANGE? OBSERVATIONS ON THE SHIFTING *MYTILUS* POPULATION OF MOSS LANDING HARBOR, CALIFORNIA

Gene flow between species that hybridize in natural populations is important to monitor in regions sensitive to directional shift in overall species composition. Population dynamics of *Mytilus* spp. on the California coast are currently under surveillance due to total replacement of the native *Mytilus trossulus* in southern California by an invading Mediterranean sibling, *Mytilus galloprovincialis*. In central and northern California, Braby and Somero identified hybrid zones where the proportions of each species and their hybrids can vary dramatically from year-to-year. To follow up on their study, we sampled a floating dock in Moss Landing Harbor on the Monterey Bay in 2010, 2011, 2012, and 2013 to evaluate the allelic fluctuations in the *Mytilus* population there each year using PCR to amplify and resolve two nuclear and one mitochondrial marker. The agreement between diagnostic markers categorizes genotype and the level of hybridization, whereas the direction of the hybrid backcross and the extent of introgression can be determined by comparing the nuclear and mitochondrial markers. Individuals heterozygous for one nuclear marker and homozygous for the other must be hybrids that are the result of backcrosses or represent successful F2 generations. Given that these mussels have a pelagic larval stage and their hybrids seem to be persisting to the second generation and beyond, we propose these two species will eventually become one homogenous species, as is the case for *Mytilus californianus*.

Weigel, Adela and Anna Maxwell
San Lorenzo Valley High School, Felton, CA

SUDDEN OAK DEATH: PART 2

Our goal is to monitor the progression of Sudden Oak Death (SOD) at two locations in the San Lorenzo Valley. We are 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 microorganism that has been rapidly infecting and killing oak trees in California and Oregon. Oak trees are key components of their ecosystem as they provide shelter and food resources for other species. Oak trees are dying at such a rapid pace that fallen trees can 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 air and germinates in water. Our hypothesis is that our wetter Fall Creek site will see a higher incidence of SOD than our drier Quail Hollow Ranch site. Our procedures include recording infected trees at both sites and confirming our diagnosis with ImmunoStrips. We are also collecting air temperature, soil temperature, soil moisture, relative humidity, and light exposure with a Vernier LabQuest along a transect at each site. We are looking for a correlation between these abiotic factors and the number of infected trees. This is the second year of our study and we are in the midst of statistically analyzing our data. We would like to thank our mentor, Dr. Michael Loik, UCSC.

Williams, Rachael (1)**, Melissa Redfield** (1)**, Nathaniel Fletcher** (1)**, Maya George** (1)**, Gernot Friederich** (2)**, Jeremy Rose** (3)**, Peter Raimondi** (1)**, Margaret McManus** (1)**, and Bruce Menge** (3)
1) University of California Santa Cruz
2) Monterey Bay Aquarium research Institute, Moss Landing, CA
3) Oregon State University

OMEGAS: INVESTIGATING THE ROLE OF OCEAN ACIDIFICATION IN NEARSHORE HABITATS WITHIN THE CALIFORNIA CURRENT

Anthropogenic carbon dioxide (CO2) in our atmosphere is a global stressor with implications for the marine environment. One repercussion of this change to our environment is Ocean Acidification (OA), the process by which oceanic pH drops in response to increasing CO2 assimilation by the ocean. The Ocean Margin Ecosystems Group for Acidification Studies (OMEGAS) formed in 2011 to explore effects of OA on coastal environments within the California Current upwelling system. This NFS-funded research consortium includes biologists and oceanographers from Oregon State University, University of California (UC)-Davis, UC- Santa Cruz, Monterey Bay Aquarium Research Institute, Stanford University, and UC-Santa Barbara with the goal of establishing an OA monitoring network extending from central Oregon to south of Pt. Conception with oceanographic and biological components. Each region (So. CA, Cen. CA, No. CA and Oregon) has two sets of paired intertidal and inner-shelf monitoring sites designed to capture the mosaic of coastal upwelling intensity and pH and assess the implications for key calcifying intertidal organisms *Mytilus californianus* and *Strongylocentrotus purpuratus*. OMEGAS data show that surf zone organisms experience the low pH waters upwelled just off-shore and that, although the trend relating average growth of *M. californianus* and mean pH contradicts prevailing OA hypothesis, further analysis demonstrates that pH plays an import role in the mussel growth story. Data collected for OMEGAS help fortify the baseline data for the region in an OA context and allow for further investigations into how organisms cope with influxes of reduced-pH waters.

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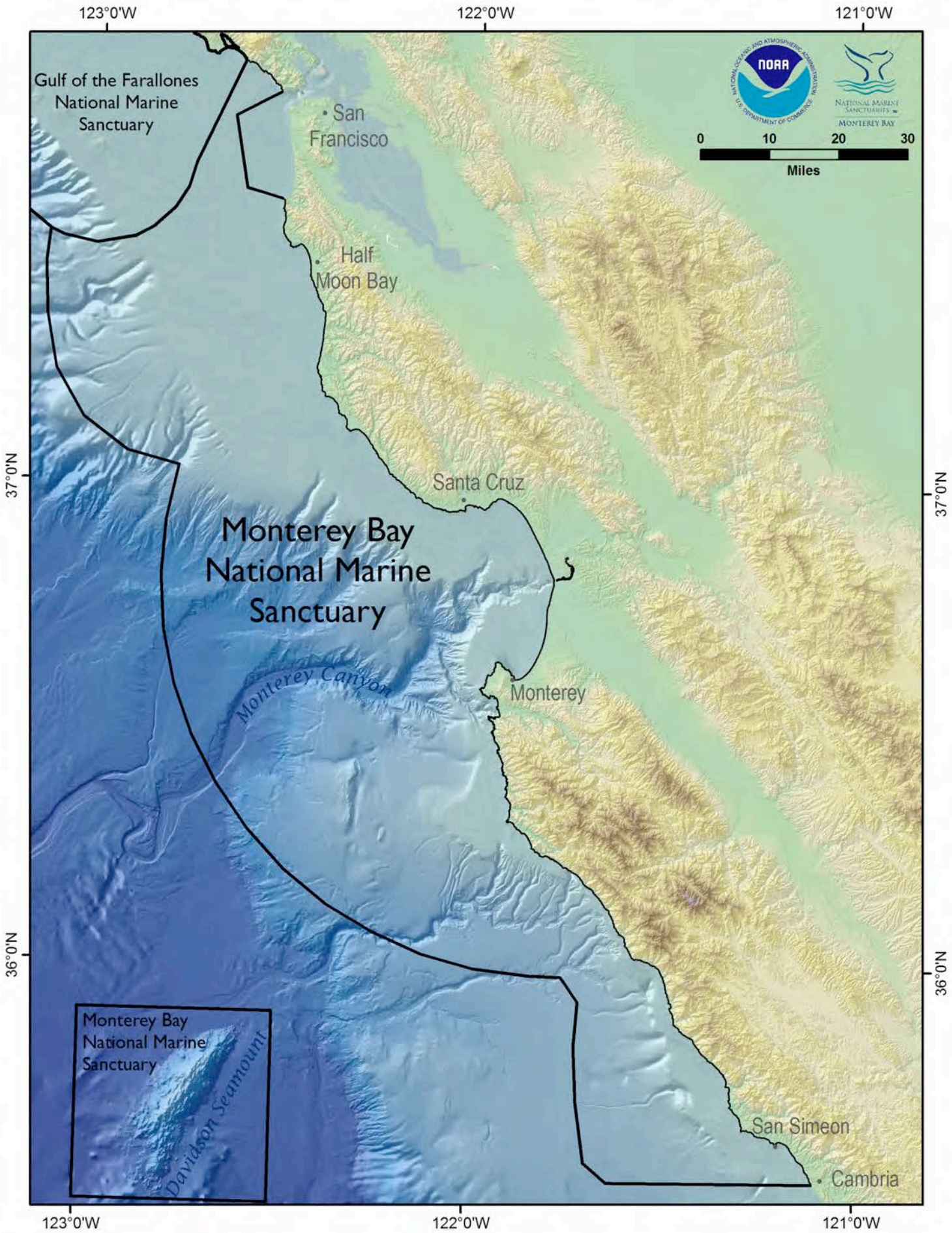
WIND TURBINE IMPACTS ON AVIFAUNA AT THE SANTA CRUZ MUNICIPAL WHARF

In 2011, the California Coastal Commission issued a conditional permit for the installation of a vertical axis wind turbine (VAWT) at the Santa Cruz Municipal Wharf, the first off-shore wind turbine to be deployed along California's coast. The permit was conditioned upon daily observation and reporting of bird mortality. The broader avifauna-wind turbine dynamics literature concentrates on effects from *horizontal* axis wind turbines (HAWTs) but contains no published studies on the emerging trend toward VAWTs, which are often considered more architectural and aesthetically pleasing. Because of VAWTs' design and operational visibility, it is hypothesized that VAWTs may reduce bird mortality when compared to similarly sized HAWTs. Expanding upon the observations and reporting required by the conditional permit, this research aims to fill a void in the current literature on the impacts of VAWTs on avifauna populations by using two novel methods of assessing those dynamics: (1) a geospatial analysis of avian species abundance, diversity,

and behaviors at the Wharf relative to VAWT location when the turbine is both in operation and stationary, and (2) an observational study of bird behaviors in the proximite VAWT location. We present the preliminary findings of this research, which includes evidence demonstrating avoidance of the VAWT and the adaptation of bird behaviors to mitigate adverse impacts on avifauna.


123°0'W
122°0'W
121°0'W
37°0'N
36°0'N
Gulf of the Farallones
National Marine
Sanctuary
San
Francisco
Half
Moon Bay
Santa Cruz
Monterey Bay
National Marine
Sanctuary
Monterey Canyon
Monterey
San Simeon
Cambria
Monterey Bay
National Marine
Sanctuary
Davidson Seamount
NOAA
National Marine
Sanctuaries
Monterey Bay
0 10 20 30
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