Beyond the Golden Gate Research Symposium 2016

Host Institutions

Coastal and Marine Sciences Institute at UC Davis
Cordell Bank National Marine Sanctuary
Greater Farallones Association
Greater Farallones National Marine Sanctuary
Point Blue Conservation Science
Point Reyes National Seashore
Romberg Tiburon Center for Environmental Studies,
San Francisco State University
San Francisco Bay National Estuarine Research Reserve
San Francisco Bay and Outer Coast Sentinel Site Cooperative

If you did not receive an announcement of the workshop and wish to be added to the GFNMS research mailing list or if you have comments on this our future research symposia, please submit written request and suggestions to Jan Roletto, Jan.Roletto@noaa.gov, GFNMS, 991 Marine Dr., The Presidio, San Francisco, CA, 94129.

The Proceedings and PDFs of the presentations are available on the symposium web site at: http://www.sfbaynerr.org/goldengate2016/

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BEYOND THE GOLDEN GATE RESEARCH SYMPOSIUM

A symposium focused on the oceanography, geology, and ecology of the Gulf of the Farallones and adjacent waters between Point Arena and Point Año Nuevo – including Cordell Bank, Point Reyes and central San Francisco Bay

Tiburon, CA

1 December 2016

Preface

Coastal and Marine Sciences Institute at UC Davis (CMSI), Cordell Bank National Marine Sanctuary (CBNMS), Greater Farallones Association (GFA), Greater Farallones National Marine Sanctuary (GFNMS), Point Blue Conservation Science (Point Blue), Point Reyes National Seashore (PRNS), Romberg Tiburon Center for Environmental Studies at SF State University (SFSU), San Francisco Bay National Estuarine Research Reserve (SFBNERR), and NOAA's San Francisco Bay and Outer Coast Sentinel Site Cooperative (SFSCC) are pleased to convene a multidisciplinary symposium on research in the Gulf of the Farallones and adjacent waters between Point Arena and Point Año Nuevo – including Cordell Bank, Point Reyes, and central San Francisco Bay. After a five year hiatus since our last regional research symposium, we are excited to provide this forum for researchers to collaborate and exchange information about their projects within the region. Within the symposium you will hear about marine resource management, including climate change impacts and indicators, restoration and mitigation activities, defining and identifying ecological hotspots, oceanographic patterns, the integration of biological and physical observations, habitat characterization, and the importance of long-term monitoring of our marine and estuarine habitats and species. Our goal is to increase our understanding and protection of regional marine and estuarine ecosystems, because it is this understanding that will support and guide wise management of the environment.

Abstract requests were sent to the community of researchers and marine educators, private organizations, schools, and public agencies known to be investigating or educating the public about the ecosystem within the region. This year we received 62 abstracts from a broad range of disciplines including: geography and mapping, characterization and ecology of various habitats, oceanographic processes and influences on productivity, geology, sediment transport, marine debris, coastal erosion, predator-prey relationships, planning for climate change impacts, population assessments, and resource management issues, e.g. restoration, pressures, status and trends. The symposium is an opportunity for local managers, researchers, and educators to meet people working in other disciplines and to increase communication and collaboration between researchers, managers, policy makers, and the public.

The abstracts in these Proceedings include projects recently completed, in-progress reports, and projects planned to begin in the near future. We hope that you use this forum to critique and contribute to each other's work, as well as to develop new collaborations. Several investigators were not able to attend the workshop but their abstracts are included in the Proceedings. The data and information produced through the research and monitoring projects represented are vital to the continued wise management of the bay, coastal and pelagic sanctuaries, parks, and reserves.

The institutions sponsoring this symposium are leaders in the field of marine, coastal, and estuarine research and resource protection and each contributes to our regional collective efforts through research, teaching, or management. This year Greater Farallones National Marine Sanctuary celebrates 35-years of protecting our ocean wilderness just beyond the Golden Gate. Cordell Bank National Marine Sanctuary expanded in 2015, protecting 1,286 square miles of ocean off the coast of Point Reyes and is making strides in science for resource management. Point Reyes National Seashore is celebrating its 55th anniversary in 2017 and has ongoing commitment to marine science, conservation, and education. They lead the research and restoration of Drakes Estero and continue long-term monitoring of pinniped, seabird, rocky-intertidal and Marine Protected Areas along the PRNS coastline. The Romberg Tiburon Center for Environmental Studies will celebrate its 40th anniversary in 2018 and is dedicated to the scientific study of the sea through interdisciplinary research and educational programs that illuminate the vital connections between science, society and the sea, providing the foundation for resilient marine and coastal ecosystems. San Francisco Bay National Estuarine Research Reserve is one of 28 estuarine research reserves in the nation and protects two of the most pristine marshes in San Francisco Bay. San Francisco Bay and Outer Coast Sentinel Site Cooperative is one of five NOAA Sentinel Site Cooperatives in the country. Their goal is to enhance the capacity of Bay Area communities to plan for and adapt to changing coastal flood conditions by uniting partners and resources. The recent establishment of the Coastal Marine Sciences Institute at UC Davis has brought together marine scientists at Bodega Marine Laboratory (BML) and the main campus, continuing to strengthen research interests and education opportunities in this region, integrating across disciplines and combining discovery with formal through degree programs. In 2016 UC Davis celebrated the founding of BML 50 years ago. Point Blue Conservation Science celebrated 50 years in 2015 and is committed to advancing nature-based solutions to climate change, habitat loss, and other environmental threats for wildlife and people, through science, partnerships, and outreach. The protection of our ocean-based natural and cultural resources will be diminished without the research represented in these Proceedings.

We thank our colleagues at CMSI, CBNMS, GFA, GFNMS, Point Blue, PRNS, SFBNERR, SFSCC, and SFSU, as well as donations from Lagunitas Brewing Company and Whole Foods Market for funding and in-kind assistance to deliver this symposium.

Ben Becker
Point Reyes National Seashore

Jaime Jahncke
Point Blue Conservation Science

Jenna Judge
San Francisco Bay and Outer
Coast Sentinel Site Cooperative

John Largier
University of California Davis,
Coastal and Marine Sciences Institute
Bodega Marine Laboratory

Danielle Lipski
Cordell Bank National Marine Sanctuary

Karina Nielsen
Romberg Tiburon Center for Environmental
Studies, San Francisco State University

Rachel Rhodes
Greater Farallones Association

Jan Roletto
Greater Farallones National Marine Sanctuary

Michael Vasey
San Francisco Bay National Estuarine
Research Reserve

Program

0800-0900 Morning Reception and One-on-One Exchange of Introductions and Ideas

0900-0910 Welcome and Introductory Remarks – Karina Nielsen

Session A. Pelagic and Benthic Ecosystems, Moderator – John Largier

0910-1040 **North Central California ecosystem status update for 2014-2015.**
Jaime Jahncke, Meredith Elliott, Jan Roletto, and Danielle Lipski

Dissolved oxygen variability on the North-Central California shelf.
Kate Hewett, John Largier, and Danielle Lipski

Benthic science in Cordell Bank National Marine Sanctuary.
Danielle Lipski, Dan Howard, and Kaitlin Graiff

Characterization of fish- habitat interactions within the Greater Farallones National Marine Sanctuary (GFNMS).
Emily Aiken and James Lindholm

Developing marine food web models to evaluate blue whale, Cassin's auklet and salmon responses to long- and short-term changes in oceanography in the California Current.
Ryan J. Hartnett, Karina Nielsen, Frances Wilkerson, Meredith Elliott, Nadav Nur and Jaime Jahncke

***Pseudo-nitzschia* occurrence in the central California Current.**
Meredith L. Elliott, Gregg Langlois, Jan Roletto, Danielle Lipski and Jaime Jahncke

Marine debris monitoring and assessment program at Greater Farallones National Marine Sanctuary: an overview of methodology, data collection, and preliminary findings.
Kate L. Bimrose, Sherry Lippiatt, Kirsten Lindquist, and Jan Roletto

Microplastic contamination in San Francisco Bay.
Meg Sedlak, Rebecca Sutton, Carolynn Box, Sherri A. Mason, Shavonne K. Stanek, Ellen Willis-Norton, and Ian F. Wren

Fishermen-led derelict Dungeness crab gear recovery in GFNMS in 2015-16.
Jennifer Renzullo, Bob Maharry, Richard Ogg, Andy Giuliano, and Kirsten Gilardi

Deploying ROVs to assess Marine Protected Area effectiveness.
Dirk Rosen and Andrew Lauermann

1040-1110 ***Break – Coffee in the South Bay Room***

Session B. Coastal and Estuarine Ecosystems, Moderator – Danielle Lipski

1110-1240 **Intrusion of upwelled waters into San Francisco Bay.**
John Largier and Kate Hewett

Restoring *Fucus distichus* following an oil spill in the San Francisco Bay.
Laura M. Anderson, Pete T. Raimondi, Joao Neiva, and Ester Serrão

Water quality in Drakes Estero before and after oyster mariculture, a comparison of 2010 versus 2016.
Frances Wilkerson, Sarah Blaser, Megan Wood, Alex E Parker, Karina Nielsen, and Dick Dugdale

Incorporating the invertebrate grazer, *Phyllaplysia taylori*, into the eelgrass restoration framework: physiological and ecological investigations.
Richelle L. Tanner, Wayne P. Sousa, and Jonathon H. Stillman

Improving an ocean acidification observing system in support of Pacific Coast Shell Fish Growers.
Aric Bickel, David Anderson, Emilio Mayorga, Molly McCammon, Jan Newton, Julie Thomas

Pescadero Lagoon hypoxia.
John Largier and Robin Roettger

Snapshot Cal Coast: Mobilizing community members to document species ranges along the California coast.
Alison Young and Rebecca Johnson

Using youth-based citizen science to reveal ecological trends in California rocky intertidal.
Monika L. Krach and Abby Nickels

Reserves in reverse and back again: changing access status of Stornetta Ranch and the resulting effect on red abalone populations.
Karah Ammann, Pete Raimondi, Laura Anderson, Christy Bell, Melissa Douglas, Rani Gaddam, Maya George, Nathaniel Fletcher and David Lohse

The sediment connection: shrinking supplies in the face of growing needs.
Douglas George, John Largier, and Patrick Barnard

1240-1340 ***Lunch Provided in the South Bay Room and Poster Review in the Hearth Lounge and North Bay Room***

Session C. Biogenic Habitats, Bird Populations & Management, Moderator – Karina Nielsen

1340-1510 **Citizen science monitoring reveals kelp forest community changes in northern and central California.**
Jan Freiwald, Dan Abbott, and Anna Neumann

Reef Check California citizen scientist conduct first scuba kelp forest survey in Montara State Marine Reserve.
Jan Freiwald and Dan Abbott

The strength of kelp tissue depends on age, season, and herbivore activity.
Nicholas P. Burnett and Mimi A. R. Koehl

Common Raven depredation negatively affects reproductive success of Pelagic Cormorants at Año Nuevo State Park, central California.
Ryan D. Carle, David M. Calleri, Jessie N. Beck, and Michelle M. Hester

Population trends of Common Murres and Brandt's Cormorants in the Gulf of the Farallones, 1999-2016.
Gerard J. McChesney, Phillip J. Capitolo, Michael W. Parker, Harry R. Carter, Cassie M. Bednar, Pete M. Warzybok, Russell W. Bradley, and Richard T. Golightly

Aircraft disturbance to common murres (*Uria aalge*) at a central California breeding colony.
Allison Fuller, Gerry McChesney, and Rick Golightly

Recent demographic analysis of Ashy Storm-Petrels on the Farallon National Wildlife Impacts: Survival and population benefits from reduced numbers of Burrowing Owls.
Nadav Nur, Russell W. Bradley, Leo Salas, and Jaime Jahncke

Shedding light on the winter movements of Cassin's auklets.
Michael E. Johns, Pete Warzybok, Russell W. Bradley, Jaime Jahncke, Mark Lindberg, and Greg Breed

Clay nest modules for seabirds: a versatile and sustainable solution to diverse threats.
Michelle M. Hester, Nathan Lynch, Ryan D. Carle, Jessie N. Beck, and Matthew Passmore

Initial ROV characterization of the deepwater wreck of USS Independence, August 2016.
James Delgado, Michael Brennan, Kai Vetter, Christopher Figueroa, Kelley Elliott, and Jan Roletto

1510-1530 Break – Coffee in the South Bay Room

Session D. Marine Vertebrate Populations & Management, Moderator – Ben Becker

1530-1700 **Status of mapping in the area of the Greater Farallones National Marine Sanctuary.**
Guy R. Cochrane

Length-based estimates of survival of sub-adult and adult white sharks in California using photo id mark-recapture.
Paul E. Kanive, Jay J. Rotella, Sal J. Jorgensen, Taylor K. Chapple, Scot Anderson, and Barbara A. Block

Movements and diving behavior of juvenile California sea lions during the 2015/2016 El Niño event.
Elizabeth A. McHuron, Barbara Block, and Daniel P. Costa

Northern elephant seal population decline on South Farallon Islands as a result of habitat degradation.
Ryan Berger, Russ Bradley, Derek Lee, Sarah Codde, Melissa Carter, and Jaime Jahncke

Update on the status of humpback and blue whales along the US West Coast including the Gulf of the Farallones.
John Calambokidis

Insights into blue and humpback whale movements and diving behavior from archival tag deployments in relation to ship-strike risk in the Gulf of the Farallones. John Calambokidis, Angela Szesciorka, and James Fahlbusch

First observed foraging by humpback whales in San Francisco Bay.
William Keener, Isidore Szczepaniak, Marc A. Webber, S. Jonathan Stern, and Mary Jane Schramm

Coastal bottlenose dolphins move north to the San Francisco Bay Area and beyond.
Isidore Szczepaniak, William Keener, Marc A. Webber, S. Jonathan Stern, Daniela Maldini, Mark Cotter, R.H. Defran, Megan Rice, Gregory Campbell, Amanda Debich, Aimée R. Lang, Dennis L. Kelly, Alex Kesaris, Maddalena Bearzi, Kayla Causey, and David W. Weller

Applied science supporting place-based resource management: needs and opportunities within the Greater Farallones National Marine Sanctuary. Jan Roletto and Mitchel Tartt

Use the Sanctuary Integrated Monitoring Network (SIMoN) to link your science to resource management in sanctuaries.
Danielle Lipski

1700-1710 Closing Remarks – John Largier

1710-1830 Poster Session and Reception in the North Bay Room and Hearth Lounge

Plankton species diversity and abundance from the San Francisco Bay to the Greater Farallones National Marine Sanctuary.
Fadwa Bouhedda, Viktoria Kuehn, John Damascus, and Gretchen Coffman

Experience and contaminants in relation to incubation behavior of western gulls (*Larus occidentalis)* nesting at Farallon National Wildlife Refuge.
Lindsey J. Broadus, Pete Warzybok, Russell Bradley, Jaime Jahncke, and Scott A. Shaffer

Understanding harbor porpoise trauma cases in northern California through necropsy and dolphin sighting data.
Rachawadee Chantra, Claire Simeone, Padraig Duginan**,** William Keener, Isidore Szczepaniak, Marc A. Webber, S. Jonathan Stern, and Frances Gulland

Tag resight survey of northern elephant seals (*Mirounga angustirostris*) at Point Reyes National Seashore.
Megan Church, Luz Torres, Sheridan Wilner and Doreen Gurrola

The receptor binding assay as an alternative animal-free method for the detection and quantitation of paralytic shellfish toxins in oysters.
Chad Crain, Stephanie Abromaitis, Shiyamalie Ruberu, James Chithalen, and William Draper

Lessons learned during the 2015 Guadalupe fur seal Unusual Mortality Event with a focus on differentiating otariid species among similar sized pups and yearlings stranding in California.
Moe Flannery, Sue Pemberton, Denise Greig, and Tenaya Norris

Benthic community characterization of the upper reefs of Cordell Bank using still images and multiple habitat variables.
Kaitlin Graiff, Danielle Lipski, and Dan Howard

Connecting our community to the Golden Gate Biosphere.
Daphne Hatch, Karen Reyna, and Stephen Skartvedt

Long term trends in baleen whale sightings near the Farallon Islands.
Kaytlin Ingman, Ellen Hines, Ryan Berger, Nadav Nur, and Jaime Jahncke

Partnering to meet the challenges of sea level rise: NOAA's San Francisco Bay and Outer Coast Sentinel Site Cooperative.
Jenna Judge, Jim Eckman, Adam Fullerton, Aimee Good, Wendy Goodfriend, Sara Hutto, Becky Lunde, Lisa Schiavinato, Becky Smyth, and Mike Vasey

Increases in Pacific mole crab abundance in Northern California correlates to strong El Niño.
Monika L. Krach and Abby Nickels

Advancing transition zone restoration: application of soil amendments to increase vegetation establishment.
Nissa Kreidler, Rachelle Cardona, Eva Malis, Dylan Chapple, Donna Ball

Biological mortality anomalies in the northern and central California ecosystem, 2014-2015.
Kirsten Lindquist, Jan Roletto, Taylor Nairn, and Dru Devlin

Listening in on Cordell Bank National Marine Sanctuary.
Danielle Lipski, Holger Klinck, Samara Haver, and Leila Hatch

Changes in seabird breeding population sizes in the north central coast region of California, 1989 to 2010-2012
Gerard J. McChesney, Harry R. Carter, Crystal A. Shore, Sandra J. Rhoades, Russell W. Bradley, Pete M. Warzybok, Richard T. Golightly, and Phillip J. Capitolo

Communication and compliance in California Coastal MPAs.
David McGuire, Viktoria Kuehn, and Brian Baird

Census of gray whales and other cetaceans off the Sonoma and Mendocino coasts of northern California.
Scott Mercer and Theresa Mercer

Where are the fish: identifying forage fish hotspots within Central California National Marine Sanctuaries using predictive modeling.
Corinne Ross, Michael Thayne, Julie Howar, Meredith Elliott, Nadav Nur, and Jaime Jahncke

Restoration monitoring of Drakes Estero: pre-restoration assessment of eelgrass, marine debris, and non-native species.
Amelia Ryan, Sarah Codde, and Ben Becker

Finding the Fish: Using school detection modules and single target algorithms to assess forage fish abundance off Central California.
Michael Thayne, Benjamin Saenz, Pete Warzybok, Jaime Jahncke

Drakes Estero Ecological Monitoring Study.
Andrew Weltz

Spatial analysis of chick-brooding rhinoceros auklets *Cerorhinca monocerata* breeding within the central California Current System.
Bradley Wilkinson, Jaime Jahncke, Pete Warzybok, Russ Bradley, and Scott Shaffer

Abstracts Not Presented

Experimental propagation methods for the Oro Loma Horizontal Levee Demonstration Project.
Jessie Olson, Donna Ball, Jason Warner, and Peter Baye

An overview of rocky intertidal monitoring for the North Central Coast MPA Baseline Program.
Pete Raimondi, Laura Anderson, Karah Ammann, Christy Bell, Melissa Douglas, Rani Gaddam, Maya George, Nathaniel Fletcher, and David Lohse

Biodiversity exploration and discovery – mesophotic and deep-sea coral and sponge diversity in the Cordell Bank and Greater Farallones National Marine Sanctuaries.
Gary C. Williams

Abstracts

Listed Alphabetically by First Author's Last Name

Characterization of fish- habitat interactions within the Greater Farallones National Marine Sanctuary (GFNMS).

Emily Aiken and James Lindholm

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The successful application of spatial approaches to management of marine ecosystems (including National Marine Sanctuaries) requires data on the distribution of key organisms and the habitats with which they associate. The marriage of remotely operated vehicle (ROV) imagery to high-resolution topographic maps of the seafloor can provide precisely these data for demersal fishes and their habitats. We analyzed 24 hours of ROV video collected along three sites within the Greater Farallones National Marine Sanctuary: Rittenburg Bank, Cochrane Bank, and the Farallon Escarpment. We identified all fish to the lowest taxonomic level possible (5,558 total fish from 42 species), quantified fish abundance and density, and precisely-georeferenced the occurrence of each individual fish. Videographic imagery was used to establish fine-scale fish-habitat interactions, while the georeferenced data were combined with high-resolution topographic maps of the seafloor (available for download through the USGS data catalog at http://pubs.usgs.gov/of/2014/1234/datacatalog.html) to determine the relative influence of benthic landscape attributes on the distribution of biological communities. We used binomial logistic general linear models from the marine geospatial ecology tool in ArcGIS to create efficient habitat-derived predictive distribution models for several selected rockfish species. These habitat suitability maps provide an opportunity to extrapolate necessary information beyond the surveyed areas to support spatially explicit management strategies throughout the Sanctuary and beyond.

Reserves in reverse and back again: Changing access status of Stornetta Ranch and the resulting effect on red abalone populations.

Karah Ammann, Pete Raimondi, Laura Anderson , Christy Bell, Melissa Douglas, Rani Gaddam, Maya George, Nathaniel Fletcher and David Lohse

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The Stornetta Ranch, just south of Point Arena in Mendocino County, CA, historically consisted of 1711 acres of private property including 2.5 miles of coastline. Prior to 2004, this coastline had virtually no public access or harvesting, making it a 'de facto' reserve. The area was opened to the public in June, 2004 and harvesting of red abalone (*Haliotis rufescens*) immediately began. In May, 2010 the Stornetta Lands were added to the existing Sea Lion Cove State Marine Conservation Area and were once again closed to abalone fishing.

Just prior to the area being opened to the public in 2004, the Multi-Agency Rocky Intertidal Network (MARINe) and Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) worked with the California Department of Fish and Wildlife (CDFW) to perform a preliminary intertidal survey of Stornetta. A large population of red abalone was found during the survey. Since then, annual monitoring of the intertidal abalone population has occurred to determine both the effects of harvesting, and, after 2010, it's subsequent response to the area's closure.

To accomplish this, in 2005 a number of permanent plots were established. Due to the influence of Sea Lion Rocks (essentially an offshore island) the plots differed in wave exposure and, therefore, the composition of intertidal algae and organisms. Initially the results suggested that the plot closest to the coastal access point was the most heavily impacted by harvesting. Specifically, there was a marked absence of individuals of legal size in the plot closest to the access point compared with those farther away. However, by year 2 virtually no legal sized individuals were found in any of the plots. Since the closure in 2010, there has been an overall increase in the number of individuals which appears to be due mostly to a large increase in numbers in the most wave exposed plots. This suggests that, in addition to the lack of harvesting, other environmental/ biological factors can influence population size.

These results suggest that changes in access status can have dramatic consequences on red abalone populations. As other privately owned coastal lands in California are changed to public access, monitoring programs such as described here may provide the insights needed to effectively manage these areas.

Restoring *Fucus distichus* following an oil spill in the San Francisco Bay.

Laura M. Anderson[1], Pete T. Raimondi[2], Joao Neiva[3], and Ester Serrão[4]

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Intertidal rockweed algae provide food and shelter to myriad organisms; damaging these important fucoid communities could cause cascading negative effects to rocky intertidal habitats. On Nov 7, 2007, the *Cosco Busan* freighter hit the San Francisco-Oakland Bay Bridge and spilled 53,569 gallons of Intermediate Fuel Oil. *Fucus distichus* populations in the San Francisco Bay were found to decline following this spill. Because *Fucus* plays an important ecological role and exhibits limited dispersal, restoration was proposed as an appropriate means of mitigation. One perplexing issue concerning restoration of marine habitats, however, is how to provide donor species to impacted areas without compromising the ecological or structural integrity of donor patches. In an attempt to avoid depletion of donor populations, pilot work was carried out. First, reproductive fronds of *Fucus* were collected non-lethally and put in mesh bags that were placed in the intertidal zone for "re-seeding" purposes. These mesh bags did not result in successful recruitment of *Fucus* juveniles. Next, *Fucus* juveniles were settled onto cobbles in the lab and outplanted into the intertidal zone; these outplants exhibited extremely low survival. Finally, translocation of a minimum number of adults from a healthy population to a site with very few *Fucus* (that was hot water power washed after the Cosco Busan Oil Spill) was then carried out. The intent was for transplanted adults to reproduce and for small scale relocation of resultant juveniles at the restoration site to further increase the spread and cover of *Fucus*. Translocation did not significantly increase recruitment at the restoration site in 2015, however, water temperatures were above average that year which could have affected algal recruitment. In 2016, more *Fucus* was transplanted and bare substrate was placed around transplants; there has since been an increase in *Fucus* recruitment. It is important to develop suitable manipulative restoration methods for marine environments as coastal anthropogenic disturbances are predicted to increase in the future.

Northern elephant seal population decline on South Farallon Islands as a result of habitat degradation.

Ryan Berger[1], Russ Bradley[1], Derek Lee[2], Sarah Codde[3], Melissa Carter[4], and Jaime Jahncke[1]

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Northern elephant seals (NES, *Mirounga angustirostris*) recolonized the South Farallon Islands (SFI), CA in 1972. The number of pups born increased at a rate of 56% per annum from 1973-1983, and declined at a rate of 5.5% per annum from 1984 to 2015. The change in population trajectory coincided with the first El Niño of the time series (1982/83) with major declines observed after the 1998 event. El Niño events are generally associated with southern swell that remove sandy deposits from SFI. In the 1980s, Shell Beach (SB) was the major breeding area capable of accommodating as many as 250 cows. From the 1998 El Niño to the 1999 breeding season, the SB colony declined 64% from 188 to 67 cows. In 2016 there was one cow that weaned one pup on SB. Mortality due to El Niño events and the disappearance of sandy habitats are probable causes for the dramatic decline in numbers over the years. Similar erosion effects have been documented at other areas on SFI. Furthermore, evidence of expansion at the adjacent Point Reyes, CA colony suggests high immigration from SFI. We modeled our population data relative to sea swell height and direction, wind speed and direction, Southern Oscillation Index (SOI) and sea level rise from 1972-2016 to examine whether an increase in storm frequency and intensity: a metric related to beach erosion, is correlated with the observed population decline. Preliminary examination comparing data from 1972 – 1997 vs 1998 – 2016 indicates that the frequency and intensity of storms increased in the later part of the time series consistent with the onset of observed decline. As we continue to face the effects of climate change, our data will assist managers in making decisions to help reduce the impacts of these effects on the wildlife inhabiting SFI.

Improving an ocean acidification observing system in support of Pacific Coast Shell Fish Growers.

Aric Bickel[1], David Anderson[1], Emilio Mayorga[2], Molly McCammon[3], Jan Newton[2], and Julie Thomas[4]

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The Pacific coast has seen the significant impacts of ocean acidification (OA) on regional shellfish industries. Rising atmospheric CO2 and accompanying changes in ocean chemistry, including a declining calcium carbonate saturation state in the ocean, make it more difficult for calcifying organisms (e.g., oysters, clams, mussels) to produce or maintain their calcium carbonate shells. Due to the seasonal upwelling of acidic water along the West Coast, shellfish in this region are already living in water that is close to harmful saturation thresholds, making them particularly vulnerable to decreases in the calcium carbonate saturation state. In 2014, the Central and Northern California Ocean Observing System (along with the three other IOOS Regional Associations on the West Coast) successfully proposed to strengthen the ocean acidification observing programs on the west coast with funding from the NOAA Ocean Acidification Program. This three year project, now in its second year, seeks to advance three main objectives: 1) Support BML to operate and maintain a research grade pCO2/DIC system capable of monitoring saturation state at the Hog Island Oyster Company in Tomales Bay, CA. 2) Develop lower cost and higher accuracy "weather grade" sensor technology that can measure pCO2, temperature (T) and salinity (S), and ultimately pH and dissolved O2 in a variety of deployment configurations (including small commercial fishing or tourist vessels, field moored locations, and autonomous free-drifting systems); these systems will provide a low-cost way to expand measurement capability to stakeholders operating in conditions where the research-grade equipment would be not be functional, while providing data of sufficient quality to resolve carbonate-chemistry at actionable levels. 3) Establish data handling and dissemination mechanisms that are user-friendly and developed in coordination with technical experts, shellfish growers, and other stakeholders. As we near the halfway point of the project, we see significant progress on all three objectives, including new sensor field testing results and the release of the publicly- accessible data explorer.

Marine debris monitoring and assessment program at Greater Farallones National Marine Sanctuary: an overview of methodology, data collection, and preliminary findings.

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The Marine Debris-Monitoring and Assessment Project (MDMAP) was developed by NOAA's Marine Debris Program to collect data on marine debris type, abundance, and distribution. Data are used to characterize and assess the scope of the marine debris problem, assist development of mitigation targets, and measure effectiveness of existing debris prevention efforts. In July 2012, Greater Farallones National Marine Sanctuary (GFNMS) joined MDMAP in partnership with Greater Farallones Association to begin collecting monthly baseline data on debris deposition at six sites along GFNMS and Monterey Bay National Marine Sanctuary (MBNMS) shores.

The program trains volunteers to execute NOAA designed protocol for two survey types, accumulation surveys and/or standing stock surveys, located within Año Nuevo State Park, Golden Gate National Recreation Area, and Point Reyes National Seashore. These state and federal managing agencies are critical partners for securing survey sites and supporting this ongoing research. In exchange, agency partners can access MDMAP data to inform resource conservation issues, such as beach clean ups and habitat management strategies, within their jurisdiction. When coupled with other shoreline monitoring programs such as Beach Watch and LiMPETS, data from this program can further inform the development of protection measures for at risk resources along our shores.

GFNMS participation in MDMAP also offers important regional and national applications. Comparison of local data with MDMAP sites in Washington and Oregon broadens understanding of the marine debris problem along the West Coast, developing opportunities for regional collaboration on debris mitigation and prevention efforts. Nationally, data from these surveys help determine and prioritize the most efficient use of limited funding for prevention and mitigation efforts, which are critical for developing sound national policy recommendations.

This presentation will discuss the nationwide MDMAP program as well as methodologies for the establishment and execution of standing stock and accumulation surveys within GFNMS and MBNMS. The presentation will also discuss preliminary findings on debris type, frequency, and deposition patterns, and how these findings may inform resource management issues and debris reduction strategies along sanctuary shores.

Plankton species diversity and abundance from the San Francisco Bay to the Greater Farallones National Marine Sanctuary.

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As part of the University of San Francisco California Ecosystems undergraduate and graduate class, we investigated species diversity and abundance of plankton from the San Francisco Bay estuary to the marine ecosystems of the Greater Farallons National Marine Sanctuary (GFNMS). We sampled plankton along a 30 mile transect from the San Francisco Bay through the GFNMS in October 2012, 2013, and 2015. In addition, we measured abiotic factors of temperature, salinity, conductivity, water clarity, pH, dissolved oxygen, air temperature, and wind speed at the same sites plankton were sampled. The objectives of our research were to train students how to sample marine and estuarine ecosystems and understand marine upwelling and management. Results of our two-way ANOVA showed that there was a significantly higher abundance of plankton in the open Ocean compared to the San Francisco Bay [$F_{(2,156)} = 6.138$; $P = 0.014$] and that zooplankton were significantly more abundant than phytoplankton [$F_{(2,156)} = 45.846$; $P < 0.001$]. Copepods were the most abundant phytoplankton species at all sites. Furthermore, plankton species diversity was highest around the Farallon Islands 27 miles offshore, significantly lower in the San Francisco Bay and even lower off the Continental shelf. A salinity gradient was observed from highest in the open Ocean (34.5 ppt) to lowest in the San Francisco Bay (32.1 ppt). Also, higher dissolved oxygen levels and pH levels were associated with high plankton abundance. Data collection by USF Environmental Science and Management students over the next 20 years will help elucidate basic relationships between plankton and physical factors from the San Francisco Bay through the GFNMS.

Experience and contaminants in relation to incubation behavior of western gulls (*Larus occidentalis)* nesting at Farallon National Wildlife Refuge.

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Most avian species turn their eggs during incubation, which is necessary for the proper progression of embryonic growth. In monogamous species, parents trade off egg turning responsibilities in order to allow one another to forage. Much is known about egg turning in the poultry industry, as being able to predict hatching success increases product numbers. However, little is known about egg turning in wild bird species. Western gulls are excellent candidate species to study egg turning behavior due to their multi-egg clutches and annual breeding attempts. Age and experience are factors that may influence this incubation behavior. Another element that may be affecting egg turning is lead contamination in gulls from the ingestion of paint chips. The objective of this study is to determine if age and lead contamination can independently have adverse effects on normal egg turning behavior. Having placed artificial eggs containing egg loggers into western gull clutches for part of the breeding season, we are now examining retrieved data on egg temperature and turning pattern consistencies, and comparing the data to egg lead levels, along with known ages and breeding experience of pairs of nesting gulls on Southeast Farallon Island. The data collected may emphasize a need for further application of egg loggers to address a variety of avian breeding behaviors influenced by experience and environmental factors.

The strength of kelp tissue depends on age, season, and herbivore activity.

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Kelp in wave-swept coastal areas can be damaged or dislodged if the mechanical hydrodynamic forces they experience exceed the strength of their tissues. Although wave action and herbivore activity change with the seasons, little is known about how the strength, extensibility (how far it stretches before breaking), and stiffness of kelp tissues are affected by their age, herbivore damage, or season. We used fronds of *Egregia menziesii*, a large and abundant intertidal kelp along the coast of western North America, to examine how the mechanical properties of kelp tissue are affected by these factors. Frond tissue became stiffer and stronger as it aged but did not change extensibility. Although mechanical properties of the youngest tissue on a frond did not change throughout the year, older frond tissue was weakest in the summer and strongest in the winter. Shifts in frond strength were proportional to seasonal increases in wave action, and inversely proportion to the frond's growth rates. Mechanical properties of the kelp tissues did not change in response to herbivore damage, although as damaged tissue aged, they became stronger at the same rate as undamaged tissue sections of frond. In the summer, when waves are small and herbivores are prevalent, the fast growth rates and weaker mechanical properties permit the kelp to grow to a large size. In the late fall, growth rates slow and fronds tend to break. The kelp's smaller size, slower growth rates and stronger mechanical properties in winter allow the kelp to better survive the large hydrodynamic forces of winter storms.

Update on the status of humpback and blue whales along the US West Coast including the Gulf of the Farallones.

John Calambokidis

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Long term photo-identification research on humpback and blue whales along the US West Coast including the Gulf of the Farallones has been conducted annually since 1986 continuing through 2016. For both species, the catalog of identified individuals maintained by Cascadia Research now numbers about 3,000. These are based on both dedicated and opportunistic efforts including a recent partnership with Happywhale as a way to promote citizen-science contribution. Current estimates of abundance based on mark-recapture are now about 2,000 for both species (smaller than the catalog size since not all animals were alive at the same time) though the trends have been very different between the two species. Blue whale abundance has been relatively stable possibly due to their already having recovered from whaling. Humpback abundance increased steadily at about 7-8% per year through the 1990s and 2000s from about 500 to now closer to 2,000 as it recovered from whaling that continued through 1966 off California. This increase has leveled over the last few years or even reversed possibly indicating the population has reached carrying capacity. This increase in humpback whales and has also been accompanied by an expanded occurrence of animals into regions where they have not been common including several coastal areas off Washington, San Francisco Bay, and expanded areas in the southern portion of the California Bight.

In a related development, entanglements of humpback whales dramatically increased along the US West Coast in 2014-2016 and most dramatically off California where they went from 0-8/year prior to 2014 to >15 in both 2014 and 2015. While increased abundance of humpback whales would certainly create more opportunities for entanglements, more importantly, expanding areas and seasons of use also add to this potential overlap with the fishery. Additionally, humpback whales can switch between feeding on fish or krill based on prey abundance: when fish feeding they appear to use much more near-shore areas compared to feeding farther offshore along the continental shelf edge when targeting krill. The recent increase in humpback whale entanglement is at least partly the result of an increasing whale abundance expanding into more areas and a shift in consumption to near-shore fish prey in some of the same areas that the Dungeness crab fishery operates.

In 2016, NOAA recognized the existence of Distinct Population Segments for humpback whales worldwide include four DPS units based on breeding areas in the North Pacific. These DPS' were given different status' under the US Endangered Species Act with humpback whales breeding of Central America and in the Western North Pacific kept as Endangered, those breeding off Mexico down-listed to Threatened, and those from the largest breeding area around Hawaii delisted completely. While this more acknowledges the true population structure and their status, it also creates challenges in areas like US West Coast which serves as a feeding area for animals coming from Central America, Mexico, and to a limited degree Hawaii, all of which now have a different ESA status. This has made some of the population structure information from photo-ID and genetics all the more important.

Insights into blue and humpback whale movements and diving behavior from archival tag deployments in relation to ship-strike risk in the Gulf of the Farallones.

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The development of new tag designs and technologies have emerged in recent years that have dramatically increased the capabilities and uses of these instruments in whale research. Archival tags that record information on board the tag have become increasingly more capable in terms of types of sensors, sampling rates, and amount of data they can store. These high capacity multi-sensor tags have not only allowed a much better understanding of underwater behavior of whales but now serve as ideal tools for examining the impacts and response to anthropogenic activities. We report on results from deployments of archival tags in the Gulf of the Farallones area primarily since 2013 with the main objective of examining diving behavior and movements to examine risk of ship strikes and response to ship noise and ship close approaches. While archival tags have often been attached for short durations with suction cups, new attachment methods have also opened up the potential for longer duration attachments that have dramatically increased their capabilities but can also require considerable effort to recover. Previously longer duration monitoring was only possible with implant satellite tags where the small bandwidth available to transmit data has limited the amount of information that can be transmitted. With several new general medium-duration archival tags we achieved high resolution multi-sensor data for up to three weeks on blue whales and durations of a few days to a week on humpback whales. Deployments in 2016 were the first successful deployments on whales of a longer duration acoustic tag that also recorded digital sound. One of these deployments on a blue whale in the Gulf of the Farallones demonstrated the frequency of some of the ship close approaches some of these animals are exposed to with this one whale spending time in all three shipping lanes in and out of San Francisco (based on GPS quality position) and on at least 11 occasions experiencing a very close ship passage based on the clear acoustic signature of a ship on the tag. These longer deployments also demonstrated the important habitat and diving differences between humpback whales when they are in two different modes, near-shore shallow fish feeding versus more offshore deeper krill feeding.

Common Raven depredation negatively affects reproductive success of Pelagic Cormorants at Año Nuevo State Park, central California.

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Populations of many species of corvids (family *Corvidae*) have increased worldwide in response to anthropogenic subsidies. We studied egg depredation by Common Ravens (raven, *Corvus corax*) on nesting Pelagic Cormorants (*Phalocrocorax pelagicus*) at Año Nuevo State Park (ANSP), California, during 2014. We monitored a Pelagic Cormorant breeding sub-colony on the ANSP mainland (ANM) with an automated camera from April 28th- August 7th, 2014 to assess the extent of nest depredation by ravens. We compared reproductive success of a Pelagic Cormorant colony with high depredation rates (ANM) with a colony at Año Nuevo Island (ANI; ~1km distant) where no egg depredation was observed. We also monitored population and breeding success of Pelagic Cormorants at ANSP from 1999-2014 and used this time-series to inform conclusions about impacts of raven depredation on Pelagic Cormorants. In 2014, ravens visited the camera-monitored ANM sub-colony 165 times, averaging 1.6 ± 2.5 SD visits per day (N = 101 days). Ravens interacted with each nest 15.5 ± 8.5 times, flushed incubating cormorants from each nest 6.8 ± 5.5 times, and removed at least 3.3 ± 2.2 eggs from each nest (N = 13 nests). No ravens were observed interacting with Pelagic Cormorant nests on ANI during 2014. Pelagic Cormorant productivity in 2014 at ANI was 2.45 ± 0.2 SE chicks fledged per pair (n = 29 nests) compared with 0.48 ± 0.2 SE chicks per pair on ANM (n = 27 nests). From 1999-2014, annual Pelagic Cormorant productivity on ANI did not differ significantly from ANM productivity. However, Pelagic Cormorants at ANI were more likely to fledge at least one chick than those on ANM during six years of the 16-year time-series, including 2014 (P = <0.0001). In 2013 and 2014, years in which egg depredation was observed at ANM, also had strongly significant differences in hatching success between colonies (P = <0.0001). Overall population of Pelagic Cormorants at ANSP increased significantly from 1999-2014 (R^2 = 0.33, P = 0.02, β = 4.33). We speculate that egg depredation at ANM was carried out by one breeding pair of ravens with specialized predatory behavior. Our study illustrates the importance of baseline monitoring for unlisted species, so that well-informed management decisions can be made when novel threats occur.

Understanding harbor porpoise trauma cases in northern California through necropsy and dolphin sighting data.

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Harbor porpoise are commonly observed along the San Francisco Bay Area coast, and the non-migratory San Francisco-Russian River stock is estimated to have a stable population of approximately 10,000 animals. The coastal stock of bottlenose dolphins, with a population estimated at approximately 500 statewide, has been expanding its range north from southern and central California, and was first photographed in San Francisco Bay in 2007. Cases of 'porpicide,' in which bottlenose dolphins physically attack porpoises, have been recorded with suspected increasing frequency since that time. While previous data from northern California has linked some strandings with trauma, a better understanding of stranding demographics, along with dolphin sighting data, may provide additional insight into what is occurring in these cases. Harbor porpoise necropsies conducted by The Marine Mammal Center were analyzed. Of 240 cases, 56 indicated trauma (either bone fractures, tooth rake marks, hemorrhagic lesions or a combination of these findings) consistent with lethal injuries caused by bottlenose dolphin attacks. Porpicide victims analyzed by sex and age class revealed they were 50% male and 50% female, and 48% adults and 52% juveniles/calves. Local dolphin sightings compiled by Golden Gate Cetacean Research were analyzed, and harbor porpoise strandings showed a correlation with the occurrence of bottlenose dolphins. Of 38 porpicide cases in the San Francisco Bay Area, 12 occurred within 4 days of a dolphin sightings, and 31 occurred within 3 weeks. From 2008-2016, the highest frequency of porpicide strandings occurred in the months of August and September, which coincided with periods of frequent dolphin sightings. A peak in porpicides occurred in September 2013 when 5 stranded within a 2-week period, just before a large group of 30-35 bottlenose dolphins that contained 6 known porpoise aggressors was documented on 28 September on the San Francisco coast. The close association in time of porpicide cases with bottlenose dolphin sightings in the San Francisco Bay Area supports the premise that the dolphins are the perpetrators of lethal attacks on harbor porpoises. If this behavior continues as the coastal bottlenose dolphin stock extends its range farther north in California, direct mortality and habitat exclusion could negatively impact harbor porpoise populations. Future work includes the development of a standardized protocol for measuring external and internal wounds in stranded harbor porpoises, and the creation of a photo catalog of traumatic findings at necropsy for this species.

Tag resight survey of northern elephant seals (*Mirounga angustirostris*) at Point Reyes National Seashore.

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During the 2016-2017 breeding season, our team from Dominican University of California (DUC) will be observing the northern elephant seal (*Mirounga angustirostris*) colonies at Point Reyes National Seashore (PRNS). Seals were first seen at PRNS in the 1970's after being hunted down to about 1,000 in the 1800's. By the 1980's, the colony was re-established. PRNS researchers have been collecting data since this time. Seals haul out year round at several sites near the Chimney Rock Headland including Drakes Beach, Chimney Rock, Main Colony, and South Beach. Our research will focus during the breeding season of December through March. We will be working under PRNS permits. Through weekly observations, data will be collected on total number of seals at each haul out site, gender and age ratios, pup mortality, tag resights, and weather conditions. The rookeries will include: Drakes Beach, Fish Docks, Gus's Cove, Chimney Rock Cove and South Beach. The objective of this study is to determine site fidelity among elephant seals through tag resights. Using previous data from PRNS, we will be able to compare our results to previous observations. This collaborative research between DUC and PRNS will continue in future breeding seasons.

Status of mapping in the area of the Greater Farallones National Marine Sanctuary.

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Recent multibeam echo sounder (MBES) mapping in the area of the Greater Farallones National Marine Sanctuary (GFNMS) by Ocean Exploration Trust (OET) significantly increased the area on the outer shelf and upper slope that has been mapped with modern MBES data in the region. Previous mapping by NOAA on the *Okeanos Explorer* and by the USGS using the R/V *Snavely* mapped 1029 km^2 on the Farallon Escarpment, Rittenberg Bank, and around Bodega Canyon. The most recent mapping by OET adds 1600 km^2 of data collected at the deeper portions of Arena Canyon, Farallon Escarpment and Pioneer Canyon. In addition, the California Seafloor Mapping Program (https://walrus.wr.usgs.gov/mapping/csmp), a collaboration of the USGS, the California Ocean Protection Council, NOAA, CSUMB and other Federal and State agencies has mapped all the State Waters (out to three nautical miles).

Interpretation of the data in State waters includes a full suite of geologic and geo-habitat map products available online as PDF maps or geo-referenced data files. The MBES, video and photo data files are also available on the same website. The data outside State Waters are not as organized and have not been published for the most part. Seafloor Character rasters have been produced by USGS that show the distribution of basic substrate types: rugose rocky reef areas, sand and mud flat area, and hard-flat coarse sediment and bedrock areas. These substrate characterizations have been used to plan ROV operations to locate and sample deep water corals and verify the habitat and geologic mapping. Seafloor character and MBES data for the USGS area has been published online (http://pubs.usgs.gov/of/2014/1234/).

A cursory evaluation of all the data in the region shows that the inner shelf area is rich in rocky reef habitat relative to areas north of Mendocino and in southern California. Transform margin strike-slip faulting (TMSSF) located close to the coastline is the primary cause of this difference in rock outcrop area. North of Mendocino the plate boundary is convergent and located at the base of the slope. In Southern California the plate boundary is TMSSF but the fault is located inland of the coast. Strike-slip faulting in the coastal waters produces localized uplift of bedrock related to small restraining bends in the fault. Where the fault bends back in a releasing bend a graben forms, which acts as a sedimentary basin. Sediment supply and wave energy also impact the area of rocky reef; there are no major rivers supplying sediment directly onto the shelf as is seen in Northern California and wave energy in the region is higher than in Southern California. The GFNMS sits astride the plate boundary; rocky habitat on the outer shelf and slope are primarily related to erosion resistant rock from the southern Sierra region moving northwest on the oceanic plate.

The receptor binding assay as an alternative animal-free method for the detection and quantitation of paralytic shellfish toxins in oysters.

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Marine biotoxins, such as paralytic shellfish poisoning (PSP) toxins including saxitoxin and its analogs, pose a significant risk to public health through ingestion of contaminated commercially sold and recreationally harvested shellfish. Monitoring of the California coast for changes in PSP toxin levels is managed by the California Department of Public Health (CDPH). The current method for quantifying PSP toxins in shellfish is the AOAC mouse bioassay (MBA). The receptor binding assay (RBA) is an appealing alternative to the MBA which offers 1) greater sensitivity, 2) higher throughput, and 3) uses no live animals. The RBA method is currently approved by the Interstate Shellfish and Sanitation Conference (ISSC) for use in mussel tissues. This investigation expands the use of the RBA to oyster tissues, and investigates substitution of rat brain tissue with commercially available porcine brain tissue. Our findings establish that the RBA determines PSP toxins in STX spiked oyster tissue as well naturally-incurred PSP toxins in oysters from California growing areas. The RBA provided slightly higher estimates of toxin concentration than the MBA for a concentration range between ± 100% of the alert level (i.e. 80 µg STX eq./100g tissue), consistent with other analytical methods for STX quantitation, which affords a greater level of public health protection. Moreover, the lower limit of detection of the RBA (6.4 µg STX eq. /100g), compared to the MBA (37ug STX eq./100g), highlights the expanded utility of the RBA for monitoring fluctuations of PSP toxins during low seasonal periods that are less predictable. Commercially available synaptosomes prepared from porcine brain tissue exhibited comparable RBA assay performance to the rat membrane preparations across the linear range of the assay (i.e. IC_{30}-IC_{70}), as correlated to the internal assay standard curve. The comparative studies were conducted by different analysts with both membrane preparations and different material reagent lots. The final data comparisons agreed across experiments, exhibiting strong repeatability and robustness. In addition to showing similar behavior to the rat membrane in the RBA, the commercial membrane is an attractive substitute as it is derived from the by-product of meat production. Further, the results from this study demonstrated similar behavior in the RBA as mussel tissues. A matrix extension to expand the use of the RBA to monitor PST levels in oysters and inclusion of the porcine membrane would increase the universality of the RBA to be used for not only regulating commercial shellfish operations, but also to monitor the general health of marine environments. Application of the RBA to oysters is particularly important for commercial growers as this species represents the vast majority of the California shellfish grown for interstate commerce. The implementation of the RBA as a fully approved method for measuring PST concentrations in shellfish and other matrices would provide an improved, cost effective, animal model-independent replacement for the MBA.

Initial ROV characterization of the deepwater wreck of USS *Independence,* August 2016.

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The World War II aircraft carrier USS *Independence* (CVL22) was used as a target vessel in Operation Crossroads, the 1946 atomic bomb tests at Bikini Atoll. Damaged and irradiated, the vessel was towed to San Francisco for study and to serve as a platform for experimentation and training of naval personnel in radiological decontamination. In January 1951, the carrier was scuttled with explosive charges off San Francisco in deep water with an unspecified amount of "nuclear waste." Thought to be rediscovered in 1990 by a side scan sonar survey performed by USGS, the wreck was subsequently sonar mapped by NOAA's office of Ocean Exploration and Research in 2009 in the waters of Monterey Bay NMS, and again in 2015. In August 2016, a detailed mission working from the E/V *Nautilus*, operated by the Ocean Exploration Trust, in partnership with NOAA, undertook a series of dives with the remotely operated vehicles *Argus* and *Hercules*. We collected approximately 40-hours of detailed survey video and still photographic documentation to assess the condition of the wreck, atomic and post-blast damage and modifications, the presence of Bikini test materials and post-test "waste," and any residual radiological contamination.

Under the guidance of Professor Kai Vetter, students of the UC Berkeley RadWatch team collected eight sponge samples from the hull of *Independence* and two from Pioneer Canyon as a control, to measure for radiation. The sponges were dried and examined with a high purity germanium (HPGe) detector for 24 hours. The measurements did not find any Cs-137 or Co-60 that could be attributed to Operation Crossroads or nuclear waste. Only trace amounts of naturally-occurring radioisotopes in concentrations comparable with samples from the California mainland were measured.

Sample	Location	Type	Mass (g)	Cs-137 (Bq/kg-dry)	Co-60 (Bq/kg-dry)	K-40 (Bq/kg-dry)	Bi-214 (Bq/kg-dry)	Tl-208 (Bq/kg-dry)
NA077-012/13 (Avg.)	Independence	Goiter	50.8	< 0.30	< 72	383 (3)	6.5 (6)	1.0 (1)
NA077-014	Independence	Barrel	65.1	< 0.27	< 37	397 (2)	10.5 (5)	4.7 (3)
NA077-015	Independence	Barrel	31.0	< 0.52	< 54	141 (3)	4.2 (1.0)	< 0.68
NA077-016	Independence	Barrel	13.1	< 1.2	< 155	238 (7)	18 (2)	< 1.6
NA077-017	Independence	Barrel	25.9	< 0.63	< 149	113 (4)	8 (1)	2.4 (8)
NA077-018	Independence	Barrel	17.9	< 0.89	< 89	169 (5)	< 1.6	8.6 (1.2)
NA077-019	Independence	Barrel	19.8	< 0.80	< 212	218 (5)	4.8 (1.5)	< 1.1
NA0777-024	Pioneer Canyon	Goiter	21.9	< 0.74	< 153	184 (4)	11.1 (1.4)	6.0 (1.0)
NA077-033	Pioneer Canyon	Barrel	5.9	< 2.7	< 606	222 (15)	< 4.9	< 3.6

Pseudo-nitzschia occurrence in the central California Current.

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Data pertaining to the occurrence and relative abundance of phytoplankton species are available for the central California Current region for years 2010-2015 as part of the ACCESS (Applied California Current Ecosystem Studies; www.accessoceans.org) program and the California Department of Public Health's Biotoxin Monitoring Program. ACCESS conducts at-sea surveys in the Greater Farallones, Cordell Bank, and northern portion of Monterey Bay National Marine Sanctuaries, in collaboration with Point Blue Conservation Science. Phytoplankton samples are collected 3-5 times a year at 20-30 visited stations in the upper 9m of the water column using a hand-held 25cm diameter net with a 20µm mesh. Phytoplankton samples are analyzed by the Biotoxin Monitoring Program for relative abundances of different species of phytoplankton, providing a qualitative measure of phytoplankton species. Concurrent with phytoplankton collections were conductivity-temperature-depth (CTD) casts, surface nutrients samples, and water color. We also maintain data series on basin-scale, regional, and local climate and ocean indices. Of particular interest are species belonging to the *Pseudo-nitzschia: seriata* complex, as these diatoms are responsible for domoic acid production in our region. Preliminary findings suggest these toxin-producing species are found in cold, nutrient-depleted surface waters. Additional results showed that species in the *Pseudo-nitzschia: seriata* complex had increased abundances in warm, low ocean productivity periods which were preceded (by one to two months) by cold, high ocean productivity periods. More analysis is needed to understand the conditions under which these species produce toxins. Our results may further our knowledge of harmful algal blooms near the highly urbanized San Francisco Bay area, as well as what we may expect in future years with climate change.

Lessons learned during the 2015 Guadalupe fur seal Unusual Mortality Event with a focus on differentiating otariid species among similar sized pups and yearlings stranding in California.

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In 2015, the central and southern coasts of California experienced two Unusual Mortality Events (UME). The first began in 2013 with high numbers of California sea lion (*Zalophus californianus*) pups stranding along the coast. Between January and July 2015, the same area of coastline observed 12 times the average number of stranded Guadalupe fur seals (*Arctocephalus townsendi*), a threatened species under the US Endangered Species Act. A typical stranding year in California, between 2005 and 2014, averaged eight (± 4 SD) stranded Guadalupe fur seals of all age classes (range: 1 - 14 per year). In 2015, California stranding organizations responded to 97 stranded Guadalupe fur seals (43 live, 54 dead). The majority of the stranded fur seals (n=93) were aged as pups or yearlings with only four individuals considered adults. During these UMEs, the overlapping stranding seasons, the high numbers of individuals, and the smaller than usual body size, made it challenging to identify pup and yearling carcasses to species. We present key characteristics used to identify all four otariid species: California sea lion, Steller sea lion (*Eumetopias jubatus*), northern fur seal (*Callorhinus ursinus*), and Guadalupe fur seal. Additionally, prior to this UME, very little was known about the dispersal of Guadalupe fur seals. The post-release movements of 11 rehabilitated individuals were tracked using satellite transmitters. The estimated locations of these animals, from offshore of northern California to north of Vancouver Island, Canada, provided valuable information about a species whose behavior and occurrence was not well known. Due to the significant range overlap among species supported by satellite telemetry, the use of a key to differentiate species across the west coast of North America will be important as these UMEs continue into subsequent years.

Reef Check California citizen scientist conduct first scuba kelp forest survey in Montara State Marine Reserve.

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Reef Check California (RCCA) is a citizen science kelp forest monitoring program that has conducted marine protected area (MPA) monitoring since 2007. The program began monitoring reefs prior to the establishment of MPAs along the California central coast. However, most subtidal scuba monitoring of MPAs in the central coast is restricted to south of Santa Cruz, California. Here we report the early results of the first scuba kelp forest survey of the Montara State Marine Reserve located near Half Moon Bay, California. On November 3rd, 2016, RCCA divers conducted a survey of the fish, invertebrate and algal community of the rocky reefs in this MPA. This survey was motivated by a strong interest in the local community of ocean users to survey this MPA in order to better understand the species assemblage in this area. RCCA is collaborating with local divers and boat owners to survey this MPA as it had not been part of its state-wide MPA monitoring program in past years. Local initiatives like this can capitalize on RCCA's large network of divers and its state-wide program adding substantial value to the ongoing long-term MPA monitoring program. In the future, we hope to use local initiatives like this, in collaboration with the MPA Collaborative Network, to build on ongoing long-term MPA monitoring and to study MPAs that otherwise might not be included in a statewide program focused in the MPA network as a whole.

Citizen science monitoring reveals kelp forest community changes in northern and central California.

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Reef Check California (RCCA), a citizen science kelp forest monitoring program, has conducted marine protected area (MPA) monitoring since 2007 as MPAs were established in consecutive regions in California. Through this program, citizen scientists have established one of the geographically largest and temporally longest near-shore reef datasets in California. In recent years we have documented dramatic changes in the rocky reef communities. Along northern California's Sonoma county coast kelp forests that were historically dominated by *Nereocystis luetkeana* have turned into urchin barrens with urchin densities increasing a hundred-fold in many places. Similar dynamics have recently been documented in *Macrocystis pyrifera* forest in central California but the phenomenon is not as widespread and local kelp forest seem to vary in their responses to increasing urchin densities. These types of community changes cannot be detected by short baseline monitoring programs that provide a snapshot of ecological communities. Nevertheless, these long-term dynamics are essential to understanding community changes inside and out of MPAs. Only if we can put trends inside MPAs into context with long-term trends and their drivers – natural or anthropogenic – can we evaluate if MPAs are achieving their goals.

Aircraft disturbance to Common Murres (*Uria aalge*) at a central California breeding colony.

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A Common Murre (*Uria aalge*) breeding colony at Devil's Slide Rock (DSR), that was extirpated in the mid-1980s, was recently restored after several years of restoration efforts. Despite these efforts, the colony still faces threats, including human disturbance. One of the main human threats is from aircraft disturbance, which is relatively frequent because of the colony's proximity to San Francisco Bay and the Half Moon Bay airport. As part of the colony restoration and monitoring project, aircraft disturbance to the colony has been recorded during the breeding season for several years. To assess the effect of timing and aircraft attributes, we constructed and ranked several multinomial log-linear models that included data from 2008 to 2014. Our top model included seven variables: year, reproductive timing, start time, aircraft type, aircraft category, altitude, and distance; as well as the interactions between aircraft type and aircraft category, and between altitude and distance. The relative risk of disturbance varied from year to year, with 2010, 2011, 2013, and 2014 exhibiting a greater risk of disturbance than 2008. Disturbance was more likely during the pre-egg lay period and post-chick hatch period than during incubation. Helicopters were more likely to cause disturbance than fixed-wing aircraft. Flushing was more likely to occur at low altitudes and close distances. Our results will help to support outreach, education, and other efforts to reduce aircraft disturbance to the colony.

The sediment connection: shrinking supplies in the face of growing needs.

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The tidal flushing through the Golden Gate connects the sediment-laden estuarine waters of San Francisco Bay to the lower sediment concentrations of the coastal region north and south of the bay mouth. Sediment transport processes are well-studied but not largely understood. One example is the conundrum of coastal erosion along Ocean Beach while another is the challenge of beneficial reuse of dredged materials. This gap becomes more of a challenge as climate change impacts begin to become apparent and sediment emerges as a valuable resource to combat coastal erosion, higher sea levels, and subsiding coastal wetlands. This talk will present on the primary sediment sources to the coastal ocean (the Sierra Nevada and the coastal bluffs), alterations to those sources due to human activities, and the impacts to coastal environments. Examples will include sand mining inside San Francisco Bay, dredging the main shipping channel through the ebb-tide delta, erosion at Ocean Beach, and mud management in Bolinas Lagoon. A new state-funded effort to design a sediment management plan for the coasts of Marin and Sonoma counties will be described as a complement to recently completed companion studies along the outer coast of San Francisco and San Mateo counties and inside the bay. Together, these studies detail the connectivity of sediment pathways from inland and northern sources and recommend how best to utilize sediment in an era of more unpredictable needs.

Benthic community characterization of the upper reefs of Cordell Bank using still images and multiple habitat variables.

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Cordell Bank, the centerpiece of Cordell Bank National Marine Sanctuary (CBNMS), is an offshore underwater granitic formation located on the continental shelf approximately 20 nautical miles west of Point Reyes, northern California. The bank, about 7 km by 15 km, comes to within 35 m of the ocean surface and provides habitat for a thriving community of invertebrates, algae and fishes. In August 2014, staff from CBNMS used their Phantom HD2 Remotely Operated Vehicle (ROV) to conduct quantitative transects over the upper reef areas on Cordell Bank in depths less than 70 m. The main objective was to perform a fine scale survey of invertebrate and algal species abundance and distribution to inform a quantitative assessment of biota on the upper bank. This ROV survey used analysis methods new to CBNMS by estimating percent cover of invertebrates and algae from down facing still images using Coral Point Count with Excel extensions (CPCe 4.1). The CPCe software was developed by the National Coral Reef Institute to assess species coverage in warm-water coral reef ecosystems and we adapted the program's species and habitat codes to those characteristic of Cordell Bank. CPCe overlays a specified number of random points onto the image and the features underlying the points are user-identified. The software then calculates coverage statistics and displays them in Excel spreadsheets for data storage and subsequent analysis. Fifteen transects, each about 1 km in length, were surveyed by the ROV capturing a total of 1,932 still images. A subsample of 538 images was analyzed for species percent cover and georeferenced to the ROV tracking data to be associated with multiple habitat variables extracted from a digital elevation model (DEM) produced from multibeam and backscatter data. In addition, individuals of conspicuous species of interest were counted: *Stylaster* spp., red gorgonian corals, two sponge species, urchins, and sea stars. Image analysis revealed species from ten phyla. The greatest percent cover observed among transects was made up of an unidentified brown biological material (average 34%). Porifera (19%), Cnidaria (16%), habitat (rock or sand, 13%), and Rhodophyta (11%) were also significant contributors of average percent cover for all transects. Coral count data was used to validate a predictive habitat model and confirmed that *Stylaster* spp. and red gorgonians occupy different niches and spatial distribution across the bank as a result of their respective preferences for specific habitat variables. Average percent cover of the most abundant species of Porifera, Cnidaria and Rhodophyta and unknown organisms were related to depth, slope, aspect direction, and topographic position index (TPI) variables derived from the DEM and allowed us to look at how habitat influenced species distribution. This detailed characterization of Cordell Bank's benthic community provides a baseline for future comparative studies and will allow sanctuary researchers and managers to detect large changes in species abundance and composition driven by natural or anthropogenic causes.

Developing marine food web models to evaluate blue whale, Cassin's auklet and salmon responses to long- and short-term changes in oceanography in the California Current.

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Upwelling of deep water delivers nutrients to the surface that results in recurring blooms of phytoplankton, abundant zooplankton, and a diversity of pelagic predators in the Gulf of the Farallones (GOF), in the California Current. Anomalous ocean conditions are linked to fluctuations in predator populations. Nutrients presumably play a key role in driving abundances of predators but has not been directly examined. Using the ten-year multivariate ACCESS dataset from the GOF, we investigate mid- and high-trophic level responses to Pacific-basin scale climate, regional and local ocean conditions. Using path analysis we examine how environmental drivers affect nutrients and determine spatial and temporal patterns in distribution and abundance of lipid-rich copepods and krill. Similarly we analyze how drivers affect temporal abundance of blue whale, Cassin's auklet, and salmon. We find that krill and copepod abundance associates with strong upwelling near the shelf break during May-June, with direct and indirect climate influence. Cassin's auklet densities associated with environmental factors that regulate krill availability near the surface where they feed. Blue whale abundance reflects overall krill biomass, driven by phytoplankton stock and ocean temperature. Salmon abundance is influenced by krill and climate during smolting conditions. We find that zooplankton and top predators do not respond uniformly to conditions and changing resources due to the complexity of the food web, how they utilize the ecosystem, and the traits of the various organisms involved. This complexity needs to be included in any attempts to model top predators' responses to changing ocean conditions.

Connecting our community to the Golden Gate Biosphere.

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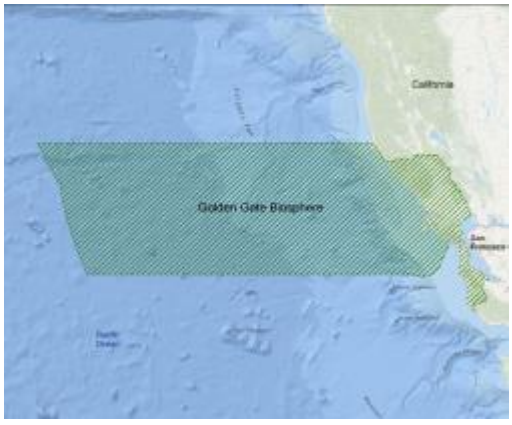
Situated in North-Central California with lands and waters in Sonoma, Marin, San Francisco, and San Mateo counties, the Golden Gate Biosphere represents a highly diverse complex of terrestrial, coastal, and marine environments, complemented by a rich cultural history, and the natural and intellectual resources of the San Francisco Bay Area. Since its designation in 1988, a network of federal, state, and local governmental entities, NGOs, universities, and public partners have worked in tandem to promote collaboration in scientific research, education, conservation, and sustainable development within this diverse and unique region.

The mission of the Golden Gate Biosphere is to protect the natural and cultural resources of the dynamic North-Central California coastal bioregion and to enhance their adaptive capacity through conservation, education, research and monitoring, and sustainable development. The foundation is built upon dedicated partnerships with communities adjacent to and within the boundaries, with the understanding that local engagement and initiative are key to long-term success. Our primary objective is to catalyze the communication and cooperation necessary to strengthen the community custodial interests in the key environmental services and issues of the Golden Gate Biosphere region. Combining the expertise and resources of 16 diverse protected areas including national and state parks, national marine sanctuaries, municipal water agencies, university research reserves, conservation NGOs, and a national wildlife refuge, the Golden Gate Biosphere enables a synthesis of our community's collective conservation, scientific, educational, and cultural values that surpasses the capacities of each individual entity. In keeping with this philosophy, the Golden Gate Biosphere's status as one of 669 sites within UNESCO's World Network of Biosphere Reserves, which spans 120 countries, expands the reach of our learning, research, and collaboration to a global scale.



Clay nest modules for seabirds: a versatile and sustainable solution to diverse threats.

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Burrow-nesting seabirds face diverse threats, including burrow trampling by humans or animals, soil erosion, habitat loss, and predators. Researchers have used artificial nests, most often made of wood and plastic, to monitor seabirds and to address some conservation needs (*e.g*. providing more nesting sites or protection from erosion), but common shortcomings include the need for frequent maintenance and replacement, problems with temperature regulation, flooding, and crushing by marine mammals. In a collaborative effort between a master ceramicist, designers, scientists, and wildlife managers, we created new artificial nest designs for seabirds, called "nest modules," out of durable clay. To date we have deployed clay nest modules on three California islands benefiting four seabird species. These clay nest modules simultaneously provide research access, resolve problems with previous wood and plastic designs, and address site-specific threats. Made of 100% clay, these nests require virtually no maintenance, are expected to last 50-100 years without replacement, and reduce the amount of trash abandoned/created by research activities. Importantly, clay provides great flexibility for adapting designs to species- and site-specific needs when designed/fabricated by experienced ceramicists. In 2010, we installed 90 clay modules designed for Rhinoceros Auklets (*Cerorhinca monocerata*) at Año Nuevo Island (ANI), California. Rhinoceros Auklet modules addressed the main threats on ANI of burrow trampling by sea lions and soil erosion. In addition to the target species, Cassin's Auklet (*Ptychoramphus aleuticus*) and Pigeon Guillemots (*Cepphus columba*) have also nested in these modules on ANI. At Orizaba Rock and Bat Cave, Channel Islands National Park (CINP), we created a design for cave-nesting Ashy Storm-petrels (*Oceanodroma homochroa*), to address problems with Common Raven (*Corvus corax*) predation. To produce the necessary weight to prevent ravens from flipping/dragging the modules and the stability to withstand extreme surge conditions in the caves, we created heavy triplexes with each module having three separate nesting entrances and chambers. In 2014-15, with CINP and other collaborators, a total of 45 nests were installed at two cave sites. Since 2015 we have prototyped nest modules designed specifically to protect Cassin's Auklets from extreme temperature events and gull disturbances. At all sites, Oikonos and partners are documenting the occupancy and breeding performance of pairs in clay nest modules and natural sites. In addition, currently we are testing the temperature performance of the modules designed for Cassin's Auklets to allow installations on the surface. These flexible, strong and sustainable clay designs have potential to be adapted and applied for burrow-nesting seabird conservation world-wide.

Dissolved oxygen variability on the North-Central California shelf.

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The five West Coast National Marine Sanctuaries are linked by the California Current System (CCS). Wind-driven coastal upwelling plays an important role for marine resources in each sanctuary, although the effects in vary across sites. Deep waters upwelled onto the shelf are typically enriched with nutrients that fuel productivity along the CCS, but these waters are also low in dissolved oxygen (DO) concentration and can be more corrosive than surface waters (low pH and saturation state). Yet, little is known about DO variability and its response to mechanisms (e.g., wind driven advection and respiration) over the North-Central California shelf. Here we report continuous bottom measurements of temperature, salinity, and DO collected at sites in the Gulf of the Farallones (30m and 54m) and on Cordell Bank (114m and 84m). We relate T, S and DO variability to forcing mechanisms to identify the importance of physical and biological drivers of DO. This is an important step in understanding past and predicting future low-DO events on our shelf.

Long term trends in baleen whale sightings near the Farallon Islands.

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We examined temporal trends in arrival time, peak abundance, duration of presence, and departure time of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) near the Farallon Islands, Central California. We used daily counts of whales collected from Southeast Farallon Island (SEFI; 37°34'N, 123°00'W) from 1987 to 2016, and detailed data collected using the Spotter Pro app from 2013 to 2016. We hypothesized that the timing of whale migration responds to basin scale oceanographic changes. Preliminary analysis of the data shows that blue and humpback whales are most commonly seen near the Farallones during the fall and summer months. Humpbacks were most commonly observed from July to November until the early 2000s. In the last 5 to 7 years humpbacks have been observed in high numbers as early as April, and were present year round in 2014-2015. Blue whales showed a similar pattern in which they were most commonly observed from August to October, but have been observed as early as January in 2014. This work is important for officials that manage the Marine Sanctuaries and commercial shipping vessels that frequent the shipping lanes near the Farallones. If whales are utilizing the area at different times of the year, then seasonal management practices must be adjusted as well to accommodate the new migration times. This analysis will be important for the future conservation of both blue and humpback whales that visit and inhabit the waters near the Farallon Islands.

North-central California ecosystem status update for 2014-2015.

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The Applied California Current Ecosystem Studies (ACCESS) program is a collaborative partnership of Point Blue Conservation Science, Cordell Bank and Greater Farallones National Marine Sanctuaries, and it provides ecosystem information for management. ACCESS has been investigating the spatial and temporal relationships between oceanographic processes, phytoplankton, zooplankton, and marine birds and mammals in the north central California region since 2004. Alongshore winds responsible for upwelling in the region were strong in early 2014, then relaxed mid-year and remained weak for the remainder of the year and most of 2015. On a local scale, sea surface temperature measured by the NOAA buoy (46013) near Bodega Bay showed warm temperatures for most months in 2014 and 2015. Zooplankton community composition results are not yet available for 2014-2015; however, large volumes of doliolid salps dominated samples collected in the upper 50 m of the water column from July 2014 and largely decreased in abundance by September 2015. Adult krill dominated Tucker trawl samples in June 2014, but the remaining cruises of the 2014 and most of 2015 caught mostly smaller, younger stages of krill. Relatively high abundances of adult krill were caught in periods of cold water conditions and strong upwelling (e.g. 2007-08, late 2010, early cruises of most years). The Cassin's auklet, a zooplanktivorous seabird, mainly ate euphausiids (krill) in most years, including 2014 and 2015. Mysids were the dominant prey in 2005-06 (poor ocean condition years), and the Cassin's auklet experienced unprecedented breeding failure. Increased amounts of krill in the diet since those years has coincided with improved productivity on the Farallon Islands. Acoustic measurements of krill in the upper 30 m of the water column and down to 200 m have shown low abundances overall from 2004 through 2008, an increase in krill biomass through 2011, followed by a decline observed in 2012-14.The blue whale, a main krill predator, follows very similar patterns to the krill abundance. Years of lower krill abundance (2004-08) have corresponded to low abundance of blue whales in the region. Signs of increasing blue whale abundance began in late 2009, and almost five times as many whales were sighted in the summer and fall of 2010 compared to the first four years of the study. This rise in whale abundance coincided with the great krill biomass observed in 2010; since then, blue whale abundances have been declining along with their prey in the region.

Shedding light on the winter movements of Cassin's auklets.

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For many seabird populations, conditions experienced during the non-breeding winter season are most limiting. Understanding the distribution and habitat needs of individuals once they depart the breeding colony is therefore essential for effective management. Cassin's auklets breeding on Southeast Farallon Island (SEFI), part of the Farallon National Wildlife Refuge, exhibit a strong reproductive response to local environmental variability, yet little attention has been paid to the conditions that shape their non-breeding distribution. To begin to quantify the winter range and habitat use of this population, 26 adults breeding in nest boxes on SEFI were outfitted with miniature archival global light sensing devices, or geolocators, in the summer of 2015; 16 of which were recovered during the 2016 season. An additional 33 geolocators were deployed in 2016, with recovery planned for the summer of 2017. Twilight events from raw light level data were identified in R with the package GeoLight, and position estimates were calculated using a hidden Markov chain model in the package FlightR. Preliminary results indicate these birds spend the majority of the non-breeding season in the productive California Current System off the continental shelf of California, with some movement north of Cape Mendocino and south of Point Conception. To characterize winter habitat use, remotely sensed oceanographic variables including sea surface temperature and chlorophyll a concentrations were overlaid with position estimates in R. These findings will help to better understand the stressors Cassin's auklets face while at sea, information that is particularly relevant for a population utilizing resources within an increasingly unstable marine system.

Partnering to meet the challenges of sea level rise: NOAA's San Francisco Bay and Outer Coast Sentinel Site Cooperative.

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To enhance sea level rise adaptation, NOAA's San Francisco Bay Area Sentinel Site Cooperative focuses on bridging natural and built adaptation planning, supporting development of a regional network for early detection and forecasting of marsh ecosystem changes, and fostering resilience efforts that incorporate connections between the ocean and bay. The San Francisco Bay and Outer Coast Sentinel Site Cooperative is one of five NOAA Sentinel Site Cooperatives. The Cooperative Management Team is made up of representatives from the San Francisco Bay Conservation and Development Commission (BCDC), NOAA's Office for Coastal Management, NOAA's Greater Farallones National Marine Sanctuary (GFNMS), the San Francisco Bay National Estuarine Research Reserve (SF Bay NERR), and California Sea Grant. The overarching goal of the Cooperative is to enhance the capacity of Bay Area communities to plan for and adapt to changing coastal flood conditions. We foster partnerships and facilitate collaboration to leverage the wealth of knowledge, programs, and resources that already exist in our region, and link these with national NOAA resources.

We present ongoing efforts related to the Cooperative's three focus areas:

1. Bridging natural and built adaptation planning
2. Supporting development of a regional network for early detection and forecasting of marsh ecosystem changes
3. Fostering resilience efforts that incorporate connections between the ocean and bay

Length-based estimates of survival of sub-adult and adult white sharks in California using photo id mark-recapture.

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Though understanding species' vital rates is imperative for developing reasonable conservation strategies, unbiased estimation of these rates can be challenging, especially with marine species such as the white shark (*Carcharodon carcharias*). Furthermore, inherent characteristics such as sex, length or age can have considerable influences on these rates. Our goal was to determine if survival of sub-adult and adult white sharks off California is affected by length and/or sex differences. We used the unique fin morphology of the dorsal fin to 'mark' individual sharks over a 9-year period. Sex assignment was not always achieved when sharks were 'marked'. However, the software program LOLASURVIV has been developed to accommodate imperfect sex assignment. In this framework we use models that allow length as a covariate to create unbiased estimates for survival, detection probability and the sex ratio for the sampled population. We found a length effect on survival, with substantially lower survival in smaller size classes, and no evident difference between sexes. We also found a lower detection probability for females with a sex ratio heavily weighted towards males. This is an important step towards assessing the status of the population of white sharks off central California.

First observed foraging by humpback whales in San Francisco Bay

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In the spring/summer of 2016, we observed an unprecedented influx of humpback whales (*Megaptera novaeangliae*) into San Francisco Bay (SF Bay). In contrast to previous sightings of a few humpback whales in the bay east of the Golden Gate Bridge, including disoriented individuals, in 2016 multiple humpback whales entered the bay to feed, apparently on a large biomass of northern anchovy (*Engraulis mordax*). Whales were first sighted in SF Bay on 28 April and were last sighted on 24 August, and recorded by several observers either in the bay or entrance to the bay on 44 days. The whales were not resident in the bay during this four-month time span, rather they transited to and from the coast in a tidally-dependent pattern, usually entering the bay on the flood and leaving on the ebb. Of the 32 sightings in the central bay with reliable times, 21 occurred during a flood/high tide, 13 at ebb/low. Peak numbers were 24 sighted in the entrance west of the bridge to Pt. Bonita (10 July) and 15 inside the bay east of the Golden Gate Bridge (12 July). Preliminary comparisons of fluke photo-ID images from San Francisco Bay with the North Pacific catalog matched at least 4 individuals. Photos also showed the same individual whales using the bay in successive months. Feeding behavior was noted on 7 days from 7 May until 30 July, including lunge feeding, and echelons of up to 3 whales feeding at depth. The cessation of humpback whale activity in SF Bay in August coincided with an increase in their numbers on the continental shelf/Farallon Islands area where they had access to krill. Should the whales return annually, intensively-feeding humpback whales may play a significant role in the bay ecosystem. Conservation implications include the potential for human interactions. As the whales enter the narrow congested Golden Gate Strait, the risk of ship strikes increase, as well as disturbance by recreational users, including windsurfers and kiteboarders who were seen on several occasions making close approaches to whales in the bay.

Increases in Pacific mole crab abundance in Northern California correlates to strong El Niño.

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The Pacific mole crab, *Emerita analoga*, is a denizen of sandy beach ecosystems. We will examine the population of the Pacific mole crab at Ocean Beach in San Francisco where high school students have collected abundance and size-frequency data over the past 15 years. LiMPETS (Long-term Monitoring Program and Experiential Training for Students) is a citizen science program in which students monitor ecological changes along the coast and participate in a hands-on, scientific endeavor that increases their knowledge of the marine environment.

Pacific mole crab populations are highly influenced by oceanographic conditions, as crabs spend the first 4-5 months as planktonic larvae. Only a small proportion of the larvae survive and settle on a beach. Sorte *et al*. (2001) revealed that fluctuating mole crab populations off the Oregon coast was linked to the presence of El Niño. Mole crab populations in Oregon are replenished by larvae drifting north from California, and because an El Niño period results in an increased northward transport of water, larval populations in Oregon are higher during El Niño.

After strong El Niño periods, LiMPETS observed sharp increase in the mole crab population at Ocean Beach and other Northern California beaches. The population increase was due to high amounts of young of the year crabs. In this poster, we will show the correlation between the intensity of El Niño and mole crab abundance from 2001 to 2016.

Reference:

Sorte, C. J., Peterson, W. T., Morgan, C. A., & Emmett, R. L. (2001). Larval dynamics of the sand crab, *Emerita analoga*, off the central Oregon coast during a strong El Niño period. *Journal of Plankton Research*, 23(9), 939-944.

Using youth-based citizen science to reveal ecological trends in California rocky intertidal.

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LiMPETS (Long-term Monitoring Program and Experiential Training for Students) is a citizen science program in which students, educators and volunteer groups monitor ecological changes along the coast of California's National Marine Sanctuaries. Through this statewide program, over 6,000 citizens annually participate in a hands-on, scientific endeavor that increases their knowledge of the marine environment, creating a new generation of informed and engaged ocean stewards.

Beyond the educational value of the program, the power of LiMPETS lies in the large quantity of data collected along rocky intertidal areas of the Greater Farallones and Monterey Bay National Marine Sanctuaries. By consistent and frequent monitoring, LiMPETS has established a baseline from which we can better address current and future environmental impacts.

LiMPETS collects abundance data on 27 rocky intertidal taxa. Data from the past 10 years reveal regular seasonal fluctuations in algal abundances, massive declines in ochre sea stars, expansions of mussel beds, boom and bust patterns of storm-sensitive algae. Like most monitoring programs, the value of the LiMPETS rocky intertidal dataset will grow over time. LiMPETS has the power to reveal shifting zonation patterns with sea-level rise, geographic expansion of species northward due to warming sea-surface temperatures, intense animal and algal abundance fluctuations with increased storminess, and patterns of disease like sea star wasting syndrome.

Advancing transition zone restoration: application of soil amendments to increase vegetation establishment.

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Transition zones between brackish marsh and upland areas of San Francisco Bay are critical habitat for hundreds of species, some of which are threatened or endangered. This habitat is integral for wildlife seeking high tide refugia as well as flood protection during storms. The Baylands Goals Update prioritizes the need to create, restore, and protect this habitat, particularly in anticipation of sea level rise. However, the restoration and creation of large transition zones (10-30 acres) is a relatively new endeavor and restoration practitioners are just beginning to consider how to implement these projects. There is an urgent need for pilot projects to develop methods to cost-effectively revegetate and restore these areas at a large scale.

This study focuses on the challenges of restoring transition zone vegetation on a levee adjacent to marshes in the Palo Alto Baylands. The site is comprised of heavily disturbed, low-nutrient soils from a variety of sources. Standard restoration practices of removing invasive species and planting native plants demonstrated low survivorship after planting in 2011. Subsequently, in 2012 a soil amendment experiment was conducted to explore alternative methods. This ongoing experiment assesses the efficacy of (1) soil tilling, (2) compost addition, and (3) a combination of both to in improve vegetation establishment at a site with low quality soils.

Our results show the highest native plant cover in the compost treatment plot (57.1%), followed by the till and compost treatment plot (34.1%). Both the tilled-only treatment and control showed lower percent cover (3.8% and 23.9%, respectively). While the experiment is ongoing, these results influence our work in adjacent transition zone restoration projects. Looking forward to the future of transition zone restoration in the San Francisco Bay, continued monitoring at this site and these results can inform similar projects to maximize restoration efforts.

Intrusion of upwelled waters into San Francisco Bay.

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Given the value of freshwater, studies of San Francisco Bay have emphasized the role of river inflow and the majority of attention has been on inner estuary regions. In upwelling areas the ocean can deliver major nutrient or plankton subsidies to estuaries, which have largely been overlooked in San Francisco Bay. Specifically, there are few data on currents and water properties at depth. In recent collaborative work, we have collated and collected data to address the intrusion of upwelled waters into the Bay at depth. The coldest, densest water represents a significant flux of nitrate – and with acidification and deoxygenation of ocean waters, these intrusions may also expose bay environments to hypoxic and low-saturation-state water. Preliminary results indicate the important interplay of winds that drive upwelling, tides that drive exchange, and freshwater that modulates stratification in the outer estuary. The multiple dimensions of this problem offer diverse future scenarios for changes in San Francisco Bay due to shifting ocean influences under climate change.

Pescadero Lagoon hypoxia.

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The Pescadero Lagoon is a bar-built estuary that provides critical habitat for federally threatened steelhead (*Oncorhynchus mykiss*) and several other fish species. Closed lagoon conditions develop when a sandbar builds across the mouth of the estuary, most typically in late summer. After sandbar closure, the water level slowly rises in Pescadero Lagoon and in time lower-layer hypoxia develops. Nevertheless, rapid growth of steelhead is observed, consistent with other lagoons in the region – supporting the value given to Pescadero Lagoon as important nursery habitat for *O. mykiss*. At the end of the closure season, however, when the mouth breaches and the lagoon connects again to the ocean, fish mortality events have occurred almost every year since the mid-1990s. We report on new monitoring of hydrology and water quality in the lagoon, with a view identifying the controls on extreme oxygen levels that occur following (and immediately before) breach events – and links to the altered hydrology of Butano Creek and marsh-channel exchanges. Following another large fish kill in November 2016, there is newfound urgency in developing science quickly to support solutions.

Biological mortality anomalies in the northern and central California ecosystem, 2014-2015.

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Beach Watch ecosystem monitoring project is a partnership of Greater Farallones National Marine Sanctuary and Farallones Marine Sanctuary Association. Established in 1993, Beach Watch (BW) engages citizen scientists in bi-monthly surveys for live and beach cast birds and mammals on sanctuary beaches from Año Nuevo State Reserve, San Mateo County to Bodega Bay, Sonoma County. In November 2014 additional surveys were added to the project, extending north to Manchester Beach, Mendocino County. Currently, over 1300 surveys are performed annually, spanning 280 km of coastline. The Beach Watch project provides over 22 years of status and trend data for over 300 species of coastal wildlife. The most abundant beach cast species are Common Murres (*Uria aalge*), Northern Fulmar *(Fulmarus glacialis)*, Western Gull *(Larus occidentalis)*, Brandt's Cormorants *(Phalacrocorax penicillatus)* and California Sea Lions (*Zalophus californianus*). All beach cast birds and mammals are documented with measurements and photographs. Species identification, age, and sex are reviewed and confirmed by seabird and marine mammal experts on staff.

In 2014 and 2015 BW surveys documented unusual mortality events in two seabird species, Cassin's Auklets *(Ptychoramphus aleuticus)* and Common Murres and one pinniped species, the threatened Guadalupe Fur Seal (*Arctocephalus townsendi*). Cassin's Auklets are zooplanktivores feeding nearly exclusively on krill. Murres and Fur Seals are piscavores. BW collected specimens of each species for necropsy to determine cause of death.

Cassin's Auklets, a pelagic species, are historically rare on beached bird surveys in north central CA typically found at a rate of 0.017 birds/km surveyed. In July 2014 through February 2015 emaciated Cassin's washed ashore in above average numbers. During November and December Cassin's were observed at a rate of 2.82 birds/km an increase of over 166 times baseline rates. Guadalupe Fur Seals are uncommon in the north central coast of CA and rarely found on beach surveys typically found at a rate of 0.0002 mammals/km. In March through July 2015 Guadalupe Fur Seals were documented at a rate of 0.025 mammals/km, an increase 124 times baseline. Common Murres are the most common species of beach cast bird documented on BW surveys typically at a rate of 0.28 birds/km. In September through November of 2015 Common Murres were documented at a rate of 5.95 birds/km, an increase of over 20 times baseline.

BW data clearly show three anomalous mortality events in 2014-2015 including multiple trophic levels. Necropsies, performed by multiple agencies, suggest emaciation as the cause of death for all three species. During these mortality events, a prolonged period of unusually high sea surface temperature occurred, including the "Warm Water Blob" and El Niño. These environmental conditions appear to have affected prey availability. We continue to investigate the warm water impacts on seabirds and marine mammals in central and northern CA.

Use the Sanctuary Integrated Monitoring Network (SIMoN) to link your science to resource management in sanctuaries.

Danielle Lipski

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The Sanctuary Integrated Monitoring Network (SIMoN) is an integrated, long-term program that takes an ecosystem approach to identify and understand changes within sanctuaries managed by the Office of National Marine Sanctuaries. SIMoN provides information to resource managers for effective decision-making and provides an introductory understanding of the complex and unique marine processes within the California Current ecosystem. By gathering summary metadata from on-going, recently completed and historic monitoring and research projects within sanctuaries, SIMoN facilitates the critical but often overlooked communication between researchers, resource managers, educators and the public.

SIMoN, and in particular the SIMoN web site, was designed as a powerful tool for sanctuary staff to quickly access summary information on hundreds of monitoring and research programs. Sanctuary staff also seeks to increase the effective use of scientific research by integrating existing programs and identifying gaps in information. To avoid duplicating programs and leverage available resources, managers and their staff must first know what has been done in the past and which programs continue to collect data. With this knowledge, managers can more effectively target their limited resources on surveying and characterizing under-studied habitats, assessing the impact of natural processes or human activities on specific resources, and implement relevant, long-term monitoring programs.

The SIMoN web site also offers a variety of tools to access basic and advanced data characterizing the west coast sanctuaries and the natural resources and processes protected by sanctuaries. Among the more popular tools are the Photo Library, with over 5000 digital images of marine organisms, habitats, and activities; the Species Database, with natural history information on 172 species commonly occurring within the west coast sanctuaries; and Interactive Maps that allow users to manipulate a Google map interface to better visualize where research and monitoring projects are taking place in sanctuaries.

Finally, SIMoN not only provides information to managers, decision makers, the research community, but also to the general public. SIMoN serves as a hub for initiating and integrating data collecting efforts and disseminating information.

Benthic science in Cordell Bank National Marine Sanctuary.

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Cordell Bank National Marine Sanctuary (CBNMS) protects about 1286 square miles of ocean off the coast of Point Reyes, California and includes benthic habitat on the continental shelf, continental slope, Bodega Canyon, and Cordell Bank. The goal of the CBNMS benthic science program is to ensure that benthic communities in the sanctuary are well characterized and monitored so that changes can be detected and information is available to make recommendations to support management. Management concerns for this habitat include climate change, ocean acidification, invasive species, disease, and fishing impacts. Modern exploration and characterization of CBNMS dates back to the late 1970's and has included surveys using scuba, remotely operated vehicles (ROV), autonomous underwater vehicles (AUV), manned submersibles, drop cameras, and camera sleds. Our current benthic science priorities are: conduct ROV surveys, develop a long term sampling plan, and build collaborations for research projects.

Our most recent surveys were conducted using the sanctuary-owned Phantom HD2 ROV in 2014. One survey was conducted on shallow areas of Cordell Bank within the 70 meter isobaths to develop a fine-scale characterization of benthic communities in areas of high percent cover (see Graiff et al. poster). Another survey in partnership with Greater Farallones National Marine Sanctuary, National Center for Coastal Ocean Sciences, and California Academy of Sciences explored areas near the head of Bodega Canyon characterizing the mud and rock habitats and associated fish and invertebrate community. Our next planned ROV surveys are targeted for summer 2017 and will focus on 1) intermediate depths on Cordell Bank and 2) potential surveys in deep areas of the continental slope and Bodega Canyon in partnership with NOAA's Office of Exploration and Research and Ocean Exploration Trust.

Building on historic and recent efforts, CBNMS is developing a long term sampling strategy to systematically characterize and monitor benthic habitats in the sanctuary. In 2016 we held a workshop with experts to provide advice on sampling strategies in the variety of habitats in the sanctuary which resulted in a workshop report. A long term sampling strategy is in development, targeted for completion in 2017, and will include characterization and monitoring for biological communities, physical parameters, and education and outreach goals.

In addition to characterization and monitoring, we have targeted research questions about changes in species abundance and distribution since fishing closures were implemented, comparisons of survey results using different technologies coral habitat model validation, and effects of climate change and ocean acidification on benthic biota. We invite collaboration on these and other questions, in an effort to better understand, characterize, and ultimately manage benthic habitats in CBNMS.

Listening in on Cordell Bank National Marine Sanctuary.

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Underwater ocean noise has increased dramatically over the past several decades and can reduce habitat quality and interfere with marine animal communication, foraging, and locomotive behavior. Cordell Bank National Marine Sanctuary (CBNMS) protects 1286 square miles of ocean off the coast of Point Reyes, California and is home to vocalizing marine mammals and shipping lanes for commercial ship traffic to and from the ports of San Francisco. The lack of information about the type and magnitude of anthropogenic sound limits our ability to understand the impacts to sanctuary resources. CBNMS and NOAA's Pacific Marine Environmental Lab partnered to deploy a passive acoustic hydrophone mooring as part of NOAA's Ocean Noise Reference Station (NRS) Network to characterize the sanctuary soundscape. The NRS network now includes eleven buoys deployed in US waters. The hydrophones are standardized and calibrated so data can be compared among locations and over time. The CBNMS buoy was deployed in October 2015 and is recording sound in the 15-2200 Hz range, which includes the range vocalizing whales and ships. The buoy will be recovered in September 2017 and analysis will include identifying sound levels and sources to describe the soundscape of the sanctuary.

Population trends of Common Murres and Brandt's Cormorants in the Gulf of the Farallones, 1999-2016.

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The Common Murre (*Uria aalge*) and Brandt's Cormorant (*Phalacrocorax penicillatus*) are two of the most abundant breeding seabirds in the Gulf of the Farallones, with globally important populations. Both species can be sensitive to both natural and human factors. In this region, Common Murres declined dramatically following an extensive commercial egging industry in the latter half of the 19th century. Following partial recovery in the mid-20th century, this population again declined rapidly in the mid-1980s as a result of gill-net and oil spill mortality. The Brandt's Cormorant can be especially sensitive to changes in prey. The regional population declined following the strong 1982-83 El Niño and took several years to begin recovering. We examined trends in Gulf of the Farallones breeding populations of Common Murres and Brandt's Cormorants for the period 1999-2016, the years following the strong 1997-98 El Niño event and beginning with the oceanographic regime shift of 1999. Data used were from annual aerial photographic surveys of most breeding colonies and other surveys at the South Farallon Islands.

Common Murre annual breeding population sizes ranged from about 128,000 to about 415,000 birds. Significant population increases ranging 4.0%-19% per annum were found at all but one of seven colonies, while the overall population increased at a rate of nearly 6% per annum. Increases can be attributed to greatly reduced fishery-related and oil spill mortality as well as relatively high survivorship and recruitment resulting from productive forage conditions. Numbers showed signs of stabilizing at the latter end of the time series.

Brandt's Cormorant annual breeding population sizes ranged from about 2,600 to about 40,000 breeding birds. Although no significant trends were found for the whole period, nearly all colonies showed a consistent pattern of strong increase between 1999 and 2007 followed by an abrupt decline. After 2010, numbers began recovering at most colonies to levels recorded in the earlier part of the time series. However at the South Farallon Islands, which formerly hosted the world's largest Brandt's Cormorant colony, numbers are still fairly depleted. The increase and rapid decline of the region's Brandt's Cormorants has been linked to changes in northern anchovy (*Engraulis mordax*) abundance. Since a crash in the anchovy population that began in 2008, cormorants have switched largely to other prey items.

Changes in seabird breeding population sizes in the north central coast region of California, 1989 to 2010-2012

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Seabird breeding colony surveys were conducted in the North Central Coast region of California between Point Arena and Pigeon Point in 2010-2012 to update population sizes and provide baseline data for monitoring newly established state marine protected areas. Numbers of breeding birds were estimated from counts of nests (or birds for certain species) from boats, mainland or island vantage points, or aerial photographs; in some cases, recent literature was substituted. In 2010-2012, over 500,000 breeding birds of 13 species were found at 68 active colonies. By far the largest breeding colony was at the South Farallon Islands within the Farallon National Wildlife Refuge, with about 328,500 breeding birds (over 80% of the regional total), including all 13 species. The most abundant species was the Common Murre (*Uria aalge*), with nearly 440,000 breeding birds. Since the last region-wide survey in 1989, regional populations of five species increased (Double-crested Cormorant [*Phalacrocorax auritus*], Black Oystercatcher [*Haematopus bachmani*], Common Murre, Pigeon Guillemot [*Cepphus columba*], and Rhinoceros Auklet [*Cerorhinca monocerata*]), one new breeding species was added to the region (California Gull [*Larus californicus*]), four species declined (Leach's Storm-Petrel [*Oceanodroma leucorhoa*], Pelagic Cormorant [*P. pelagicus*], Cassin's Auklet [*Ptychoramphus aleuticus*] and Tufted Puffin [*Fratercula cirrhata*]), and three species fluctuated or remained relatively stable (Ashy Storm-Petrel [*O. homochroa*], Brandt's Cormorant [*P. penicillatus*], and Western Gull [*L. occidentalis*]).

Communication and compliance in California Coastal MPAs.

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In 2012, California implemented a world class system of 124 marine protected areas created through a comprehensive stakeholder-led public process with the Department of Fish and Wildlife and the Ocean protection Council. Facilitating the evolution of local collaboratives is an effective, transparent, grassroots method of stewardship of California's marine protected areas. Collaboratives provide a localized, comprehensive approach to ocean resource management by bringing together local experts and authorities in the areas of Outreach & Education, Enforcement & Compliance, and Research & Monitoring. The north central California marine protected areas (MPAs), from Alder Creek (near Point Arena) to Pigeon Point, are one component of a statewide MPA network. The 25 protected areas in this region (22 MPAs and three marine recreational management areas) cover approximately 154 square miles, or about 20 percent of north central California state waters. Six special closures are also managed as part of the region's complement of MPAs.

In the San Francisco Bay region, the Golden Gate MPA Collaborative, comprised of fishermen, NGOS, Museums and Aquaria, Universities and the general public are working to educate boaters, tide-poolers and shore fishers at MPAs between Bodega Bay and Pillar Point, including the Farallon Islands. The Golden Gate MPA Collaborative has successfully brought together environmental NGOs, agencies, fishermen, scientists, aquaria and vessel captains interested in raising awareness of marine protected areas in Marin and San Francisco counties, including the Farallon Islands. Collaborative members are engaging boat captains and docents in an ambassador program targeting visitors to Point Reyes and the Farallones. Working with these ambassadors, the collaborative has developed a map-based brochure that will be used as an outreach tool, with the goal of increasing awareness and compliance of local marine protected areas. A series of public events with Bay.org called the Coast and Oceans is reaching and recruiting hundreds of public volunteers. In a separate vessel ambassador program we are taking the public and students from the University of San Francisco to these remote marine protected areas observing wildlife and human interactions, sampling plankton, dissolved oxygen and salinity as well as contributing to baseline monitoring in a citizen science program.

Movements and diving behavior of juvenile California sea lions during the 2015/2016 El Niño event.

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California sea lions (*Zalophus californianus*) are an abundant predator in the California Current Ecosystem whose movements and diet are known to vary in response to fluctuations in prey availability at multiple temporal scales. Despite their abundance, very little is known about the habitat use and diving behavior of juvenile sea lions, a demographic group that may be particularly susceptible to reduced foraging success and high mortality during periods of reduced prey availability, such as El Niño events. The objectives of this study were to provide a preliminary investigation of the movements and diving behavior of juvenile sea lions at Año Nuevo Island, an important central California haul-out site that also supports a small breeding population. Bio-logging instruments were deployed on seven juvenile sea lions (1 - 3 years) in October 2015, which coincided with the strong El Niño event of 2014-2015. Sea lions instrumented at Año Nuevo Island ranged from southern to northern California, but the home range (90% UD) and core areas (50% UD) were generally concentrated to a much smaller area in central California between the Farallon Islands and Monterey Bay. Movements were largely restricted to the continental shelf and the majority of dives were from 10 - 50 m and <2.5 min, which is generally consistent with the behavior of adult sea lions during non-El Niño conditions. Adult sea lions have a greater dependence on deep dives in offshore areas during periods of increased sea surface temperatures, suggesting that juveniles and adults may differ in their response to environmental variation. Although juveniles did exhibit dives that were generally deeper and longer than average adult dive behavior, their maximum dive depths and durations were still only approximately 70% of adult maximum values. This indicates that juveniles may experience physiological limitations associated with incomplete development of total oxygen stores and a smaller body size, restricting foraging to on or just off the continental shelf and limiting their behavioral responses during periods of reduced prey availability largely to north-south movements.

Recent demographic analysis of Ashy Storm-Petrels on the Farallon National Wildlife Impacts: Survival and population benefits from reduced numbers of Burrowing Owls.

Nadav Nur, **Russell W. Bradley**, Leo Salas, and Jaime Jahncke

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We analyzed survival of Farallon ashy storm-petrel in recent years and estimated population trends. Burrowing owl occurrence and activity at the Farallon National Wildlife Refuge reached a peak in 2010/2011. During that same year, ashy storm-petrel survival reached its lowest level in the last decade, having shown a multi-year decline; population size was also declining during this same period that show a steep increase in burrowing owl attendance, 2007 to 2011. Thus, the evidence clearly points to the increased abundance and activity of burrowing owl leading to predation of ashy storm-petrels, thus decreasing survival and contributing to the observed population decline. However, since 2011, fall/winter burrowing owl numbers have been 40% lower in recent years (2011/2012 to 2014/2015) compared to the previous 2 years (2009/2010 and 2010/2011). Average storm-petrel survival for the four most recent year period (2011/2012 to 2014/2015) was greater than the estimate of survival for 2010/2011 by 6.0%. However, survival of ashy storm-petrels for 2014/2015, the year of markedly low burrowing owl attendance, was indistinguishable from survival observed in the previous 3 years, when burrowing owl attendance was on average 68% higher than it was in 2014/2015 We found that ashy storm petrel population trend in recent years has indeed evidenced a change, concomitant with the reduction in burrowing owl attendance. Looking at a longer time series, from 2001 to 2007, the population displayed a strong increase in population size (increasing at 17.5% per year, $P < 0.015$), confirming results from our earlier analysis. However, from 2007 to 2012 the population decreased by 7.0% per year ($P < 0.1$), this decrease coinciding with the period of increase in burrowing owl overwinter attendance. However, from 2012 to 2015 the population showed stability: the estimated change in size is less than 0.1% per year. Thus, the time series indicates that, after 2011 (the year of peak burrowing owl attendance), the population trend changed from decline to stability, just as the level of burrowing owl changed from high to moderate. This change in trend was consistent with the observed pattern of survival for the storm petrels over this time period. It is important to note that results of the statistical analysis provided low confidence in the estimates for any single year. The power of the results of our statistical analysis lies in estimates based on multiple years of data, rather than basing comparison on any single year. These results provide support for proceeding with efforts to reduce burrowing owl numbers on the Farallon National Wildlife Refuge as a means to aid a species of conservation concern and facilitate recovery in the future.

Experimental propagation methods for the Oro Loma Horizontal Levee Demonstration Project.

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The Oro Loma Horizontal Levee Demonstration Project is constructing an ecotone slope at the Oro Loma Sanitary District facilities in San Lorenzo. The ecotone slope is designed to serve as a buffer to impending sea level rise, test nutrient removal from wastewater discharge, and restore upland habitat. The plant palette for the project was chosen to mimic historic moist grassland/bayland ecotone habitat that has been largely eradicated from the bay.

The native plant propagation methods for the project are designed to reduce the cost of growing large numbers of plants in a nursery setting. Approximately 70,000 plants were grown to vegetate the ecotone slope utilizing various methods including bare root division propagation of rhizomatous species and annual seed increase, as well as nursery container plants. Propagules were sourced locally from remnant plant communities, well-adapted to the climate and sea level fluctuations of the East Bay. The majority of plants were grown in a large scale and low-maintenance method at a division bed nursery constructed at the project site. This approach utilized these species ability to propagate rhizomatously, thereby reducing the labor and cost necessary for container plant maintenance in a nursery environment. The entirety of the propagation, including seed collection, was completed in a compressed timeline of roughly one year, reducing what is generally a two to three year process of planning and collection.

Expected outcomes for the plant propagation component of the demonstration project include healthy, rooted stock that is able to thrive and compete when outplanted into the newly constructed slope. Native annual seed mix will develop a cover crop, excluding annual invasive species as the rhizomatous species establish. The Oro Loma horizontal levee demonstration project demonstrates a low-cost and lower-intensive labor method for large-scale plant propagation and can inform propagation methods for future ecotone/transition zone restoration projects.

An overview of rocky intertidal monitoring for the North Central Coast MPA Baseline Program.

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The Multi-Agency Rocky Intertidal Network (MARINe) monitors over 200 intertidal sites along the west coast of North America from Alaska to Mexico. Two survey types are implemented: Long-Term Monitoring (LTM) and Biodiversity. Long-Term Monitoring Surveys use fixed plots to document changes in percent cover, or abundance of targeted species or species assemblages. This fixed-plot approach allows the dynamics of rocky intertidal species to be monitored with reasonable sampling effort and provides sufficient statistical power to detect changes over space or time. The Biodiversity Surveys provide detailed information about biodiversity and community structure. These surveys were designed to measure diversity and abundance of algae and invertebrates found within rocky intertidal communities on the western coast of temperate North America. These monitoring data have been used in many capacities including assessing Areas of Special Biological Significance, Natural Resource Damage Assessment, and Marine Protected Area Monitoring.

The Marine Life Protection Act mandated the establishment of a network of Marine Protected Areas (MPAs) along the California coast. Our monitoring group at UC Santa Cruz has been involved in monitoring throughout the network, including the North Central Coast Study Region (NCCSR). This region includes 25 MPAs spanning the north central coast from Point Arena to Pigeon Point. The collection of baseline data was an important part of evaluating their effectiveness and informing adaptive management. These data were collected by the North Central Coast MPA Baseline Program, a collaboration of 11 monitoring groups working in diverse marine habitats and on socioeconomic issues. The rocky intertidal was among these diverse habitats assessed and is arguably the most sensitive area to land-based and human activities. Prior to the establishment of the MPAs, four Long-Term Monitoring sites have been monitored annually for 10+ years and nine Biodiversity sites existed within the NCCSR. In addition to these existing monitoring sites, 10 new intertidal monitoring sites were established and sampled in 2010 within the NCCSR. Resampling of some of the NCCSR intertidal sites is slated to occur in 2017, in addition to the four LTM sites sampled yearly.

Fishermen-led derelict Dungeness crab gear recovery in GFNMS in 2015-16.

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The California Lost Fishing Gear Recovery Project, started by the SeaDoc Society at the UC Davis School of Veterinary Medicine, has been conducting lost and abandoned fishing gear recovery in California coastal waters since 2006. In 2013, the Project partnered with commercial Dungeness crab fishermen on the North Coast to address the problem of lost and abandoned gear that littered legal fishing grounds and presented an entanglement hazard to vessels and marine wildlife. Partnering with the Humboldt Fishermen's Marketing Association (HFMA; Eureka, CA) to build financial sustainability into derelict gear recovery, three HFMA members collected 665 lost and abandoned Dungeness traps from the Del Norte, Humboldt and Mendocino County coasts in just 20 days of on-water work. The HFMA used Project funds to pay these fishermen for the derelict gear they collected, and then "sold" that gear back to original owners, placing the "profit" in an escrow account for future gear recovery. News of HFMA's success spread down the coast; starting in fall 2015 and with funding from the NOAA Marine Debris Program, the Project continued to conduct lost crab gear recovery work on the North Coast (310 traps recovered in 9 days), and also engaged three new fishermen (members of the Crab Boat Owner's Association of San Francisco and the Commercial Fishing Association of Bodega Bay) to conduct Dungeness gear recovery in Gulf of the Farallones National Marine Sanctuary and surrounding waters. More than 260 crab traps and lines have been recovered in 2015-16 in just nine days of gear recovery work. Concurrently, the Dungeness Crab Task Force initiated the drafting of new legislation to establish a permanent program for derelict Dungeness crab gear recovery (SB 1287, McGuire), signed by Governor Brown on September 23, 2016. This new program, a direct result of the Project's successes to date in facilitating commercial Dungeness crab fishermen in derelict gear recovery, will create a funding mechanism for gear recovery work by imposing a fee to permitted fishermen whose traps are recovered from the ocean after the close of the season.

Applied science supporting place-based resource management: needs and opportunities within the Greater Farallones National Marine Sanctuary.

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In 2015, Greater Farallones National Marine Sanctuary (GFNMS, formerly named Gulf of the Farallones National Marine Sanctuary) expanded north to Point Arena in Mendocino County, which now encompasses 3,295 square miles and has a new name to reflect our northern constituents. A new management plan was developed to include new habitats, such as kelp forest, and identified current, ongoing and new management issues associated with the entire sanctuary (http://farallones.noaa.gov/manage/management_plan.html). As part of the expansion process, we have identified additional science information needs to aid in resource protection, education and outreach efforts, and to identify impacts from climate change.

Science needs documents provide targeted information on the science requirements of the sanctuary based on the priority management issues defined in the GFNMS Management Plan, Condition Report, the staff's project work plans, and reports identifying existing and emerging issues in ocean conservation. GFNMS staff also administers the northern portion of Monterey Bay National Marine Sanctuary; therefore all of our science, education, outreach, and resource protection programs include needs for MBNMS from Rocky Point in Marin County south to the San Mateo-Santa Cruz County borders. Science needs documents are is designed to identify management information needs and to communicate these information needs to potential partners and interested organizations, such as professors and their students, federal and state agency researchers, and research institutions.

The information presented in each science needs assessment provides an overview of the management issue and the related scientific requirements. Sufficient information is provided to educate potential partners and interested parties and facilitate initial discussions on how the requirements might best be addressed. The information in these documents is not intended to be detailed enough to develop project plans or define specific roles and responsibilities of partnering organizations, but are designed to promote new and vital research and monitoring efforts. Detailed discussions with sanctuary staff will be necessary to develop, design and implement a research need, as well as identify potential funding sources to implement studies and analyses.

GFNMS science needs documents are posted on our Office of National Marine Sanctuaries web site at: http://sanctuaries.noaa.gov/science/assessment/gfnms.html. Most of our science needs pertain to science studies or analyses that we are not currently or may only partially be implementing. Projects to fulfill our science needs encompass research, monitoring, modeling, mapping, characterization, and/or inventory disciplines:

1) Characterization of Estero Americano and Estero de San Antonio;
2) Climate change threats to rocky intertidal and kelp forests;
3) Mapping and quantification of invasive species throughout the sanctuary;
4) Identifying, mapping and quantification of sensitive seafloor communities and threats to these communities;
5) Ship strikes and vulnerability to baleen whales;
6) Threats of oil pollution and baseline information for improved damage assessment of sandy beach habitat, benthic epifauna, water column impacts, and drift algae as a biogenic habitat; and
7) Human Dimensions and Socioeconomics

Deploying ROVs to assess Marine Protected Area effectiveness.

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The North Central Coast Marine Protected Areas (MPAs) were implemented in 2010, from Alder Creek (near Point Arena) to Pigeon Point. Historically, these marine habitats were well surveyed by scuba divers to depths of 20 meters, but the deeper waters remained poorly studied. Together, Cal State Monterey Bay and Marine Applied Research and Exploration (MARE) performed the baseline Remotely Operated Vehicle (ROV) surveys of this region. Subsequently, MARE performed further surveys for the Point Reyes National Seashore and the California Department of Fish and Wildlife (CDFW) employing Department developed survey design and protocols, as well as data post processing and analysis techniques, to evaluate how marine populations respond to the establishment of a network of MPAs over time.

To capture the ecological condition of North Central Coast MPAs, the ROV was configured to record both fish and invertebrate data concurrently. The ROV was equipped with both forward and downward facing video cameras and a digital still camera. Ranging sonars aligned with both video cameras were used to calculate video transect width and an ultra-long baseline tracking system was used to calculate transect length. This allowed us to geo-reference flora and fauna, and calculate species densities and relative abundance.

ROV surveys were conducted between 2010-2015 at sites identified and selected from acoustic bottom maps. More than thirty reserve and fished reference sites were evaluated. For the majority of the locations, inside-outside site pairs were selected for survey based upon similarity in the types and amounts of habitat present, proximity to one another, and depth.

More than 65% of California's MPA protection falls within water depths exceeding 20 meters. Understanding how these deepsea ecosystems respond to a network approach of protection is critical in evaluating not only the effectiveness of California's MPAs, but also for understanding the spatial and temporal scale at which these networks respond. Future comparisons of species abundance of the North Coast will assist in evaluating the effect networked MPAs have on local populations, and how these areas work cooperatively to rebuild and protect critical marine populations.

Where are the fish: identifying forage fish hotspots within Central California National Marine Sanctuaries using predictive modeling.

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We used acoustic abundance data on anchovy and young-of-year (YOY) rockfish to identify predictable and persistent locations of these species in Central California's National Marine Sanctuaries. The data was collected from May 2004 to September 2015 during ACCESS (Applied California Current Ecosystem Studies; www.accessoceans.org) cruises. ACCESS is a collaboration between Point Blue Conservation Science, the Greater Farallones National Marine Sanctuary, and Cordell Bank National Marine Sanctuary. We hypothesize that anchovy and YOY rockfish congregate in predictable locations as determined by bathymetric and oceanographic features. To test this hypothesis, we aggregated the acoustic fish data and associated environmental covariate data into three kilometer bins and used general linear models for analysis. We used negative binomial regression to identify important environmental variables and used these variables to develop predictive models of anchovy and YOY rockfish. We used ArcGIS to map predictive model outputs of anchovy and YOY rockfish abundance, and to identify high use areas. We found that anchovy associated with colder temperatures near the edge of the continental shelf. YOY rockfish associated with stratified waters (as indicated by temperature, salinity, and fluorescence) outside of the influence of the newly-upwelled waters of the Point Reyes Plume. Our study contributes to a better understanding of ecological drivers and habitat of keystone species within Central California's national marine sanctuaries.

Restoration monitoring of Drakes Estero: pre-restoration assessment of eelgrass, marine debris, and non-native species.

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The National Park Service is currently removing approximately 500 tons of wooden racks and debris from Drakes Estero, a Federally designated Wilderness and State Marine Conservation Area within Point Reyes National Seashore. These racks and debris are unnatural substrates that generally preclude eelgrass growth and support fouling invasive species such as the colonial tunicate *Didemnum vexillum*. We established a before-after control-impact study to assess pre and post-restoration community composition. During the pre-restoration monitoring we assessed percent cover of 564 estuary floor quadrats within 55 transects (treatments and controls) for species community assemblage, substrate, and marine debris. Non-metric Multi-Dimensional Scaling showed that the estuary floor beneath wooden racks with little debris underneath were dominated by sediment, while racks associated with extensive wood, shell and plastic debris on the estuary floor clustered with a non-native fouling organisms and algae community. Eelgrass cover was 40 ± 28 % (x ± sd) below racks without debris and 5 ± 4 % below racks with extensive debris, compared to 72 ± 20 % in control areas. Post-restoration monitoring will continue in the spring and summer of 2017, with annual surveys until restored areas converge to natural community composition.

Microplastic contamination in San Francisco Bay.

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Microplastic is a term used to describe fragments of plastic 5 mm or smaller. Sources of aquatic microplastic pollution include microbeads used in personal care products such as facial scrubs and toothpastes, pellets used as precursors for industrial products, plastic fibers derived from washing clothes made with synthetic materials, and fragments of larger plastic items. Motivated by recent state and federal efforts to ban microbeads in personal care products, the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) characterized ambient Bay surface waters and wastewater treatment plant (WWTP) effluents for microplastic contaminants. Nine Central and South Bay surface water samples were collected using a manta trawl. Two-hour sieved samples of effluent were collected from eight WWTPs discharging to the Bay. Particles in samples were characterized by size, type, and abundance. With an average abundance of 700,000 particles/km^2, Bay surface water appears to have higher microplastic levels than other urban waterbodies sampled in North America such as Cheaspeake Bay and the Great Lakes. The majority of particles in the Bay surface water were classified as fragments; interestingly, the majority of microparticles detected in wastewater were fibers. Secondary polymer confirmation using spectroscopy was not conducted on these samples, so it is possible that not all of the particles visually identified are plastic. Nevertheless, the different ratios of particle types between the effluent and the Bay suggest that there may be multiple sources of microplastics to the San Francisco Bay.

Coastal bottlenose dolphins move north to the San Francisco Bay Area and beyond.

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Although bottlenose dolphin skulls have been dredged from San Francisco Bay (SF Bay), and their bones discovered in baysore middens, this species has not been part of the northern California marine fauna in recent history. The presumed northern range limit of Pt. Conception was surpassed by a range extension into Central California, including a northernmost sighting off Pescadero Point, San Mateo County (37° 14' N), coincident with the 1982-83 El Niño event. Bottlenose dolphins have continued to move north along the coast to SF Bay (37° 49' N), where they now occur regularly, and we have compiled approximately 400 sightings north of Pescadero Point. Since 2010, our shore-based research efforts in SF Bay and nearby coastal waters resulted in photo-identification of 90 uniquely marked individuals. These dolphins, together with the portion of unmarked individuals observed, comprise about 18% of the estimated coastal stock. Of the 66 SF Bay dolphins of known or presumed sex, 35 were females and 31were males. Using a
subset of 71 SF Bay dolphins, comparisons with photo-identification catalogs from Monterey Bay and other locations in the Southern California Bight from 1981-2013 show that 93% (n = 66) of these dolphins have been matched to other study areas, including Monterey Bay, Santa Barbara, Santa Monica Bay, Orange County, San Diego, and Ensenada, Baja California Mexico. The oldest sighting record for a known SF Bay dolphin was 1981 in San Diego. The longest travel distance observed was by "Smootch," a dolphin seen off Ensenada in 2000 and in Bodega Bay, California (85 km north of SF Bay) in 2012. This represents a new longshore movement record of approximately 1000 km, and confirms previous research suggesting high mobility of the stock. Its northernmost point along the coast was reached at Little River, Mendocino County, in April 2016 during the most recent El Niño event. Ecological effects of the northward range extension include re-occupation of the Oregon Marine Biogeographical Province that brings access to new resources. For example, in SF Bay we witnessed predation on chinook salmon, previously unreported as prey for coastal bottlenose dolphins. The range extension also increases the likelihood of conflicts with harbor porpoises. On 4 June 2016, off the San Francisco coast, we documented the first instance of porpicide by a dolphin known to be porpoise aggressor in Monterey Bay.

Incorporating the invertebrate grazer, *Phyllaplysia taylori,* into the eelgrass restoration framework: physiological and ecological investigations.

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Nearshore eelgrass habitats along the Pacific coast of North America play an important role in erosion control, fish and invertebrate development, and local biogeochemical processes. A key grazer in these ecosystems is *Phyllaplysia taylori*, a sea hare living on the *Zostera marina* eelgrass blades that feeds on epiphytic algae, diatoms, and bryozoans, keeping blades clean for increased photosynthesis and growth. In San Francisco Bay, eelgrass restoration areas have not seen recruitment of this significant grazer, most likely due to limited dispersal potential dictated by direct development. Through ecological monitoring of eelgrass beds with and without this organism, we see that epiphyte coverage decreases dramatically with *P. taylori* presence, however, high variance in other metrics of eelgrass health clouds the signal of *P. taylori* presence. This should not downplay the importance of *P. taylori*, as results show that effects may be largely seasonal. *P. taylori* have two generations per year that differ in size and lifespan, usually correlated with times of high eelgrass growth. Shifts in their phenology based on local environmental stressors such as temperature and salinity have profound implications for the ecosystem services that they provide to their host plant. The effects of acute and chronic temperature exposure on embryo development are largely based on parental origin; current studies are investigating how parental and embryo temperature exposures can influence hatching success in times of acute thermal stress. Therefore, transplanting *Z. marina* and *P. taylori* that have complementary phenology based on microclimates within the bay is of the upmost importance when considering successful eelgrass habitat restoration. Multiple *P. taylori* populations on the latitudinal and local scale display a range of thermal tolerance limits and vary in the plasticity of this trait vary as widely within San Francisco Bay as they do within 750 miles of coastline. This is strong evidence for local adaptation, which can inform restoration efforts and direct *P. taylori* population inclusion for eelgrass transplanting based on local environmental conditions. This work aims to inform how associated fauna can best be incorporated into the eelgrass restoration framework under ocean warming.

Finding the Fish: Using school detection modules and single target algorithms to assess forage fish abundance off Central California.

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Forage fish are a crucial link between primary producers and the success of many top marine predators in pelagic ecosystems around the world. In upwelling systems such as the California Current Ecosystem (CCE), forage fish availability can be the central determining factor in the survival and reproductive success of upper trophic level species. Northern anchovy (*Engraulis mordax*) and juvenile rockfish (*Sebastes spp.*) serve as a critical conduit for the transfer of energy to top marine predators in the CCE. Traditional detection and quantification of forage fish by trawling is time consuming and expensive, and may not provide the resolution needed to examine ecological relationships in fast-changing marine environments. In an effort to accurately sample forage fish with less expense and higher resolution, this study used acoustic descriptors to identify and quantify anchovy schools and juvenile rockfish in hydroacoustic data collected from 2004 to 2015 in the Greater Farallones and Cordell Bank National Marine Sanctuaries, located in central California. Anchovy-like schools were detected using a volume backscattering strength (S_v) range of -42.9 to -47.6 dB. Juvenile rockfish-like single targets were detected using a target strength (TS) range between -52.8 to -50.9 dB, calculated from a TS model using lengths of juvenile rockfish consumed locally by three piscivorous seabirds. The results of the acoustic analysis were used to derive time series of acoustic abundance indices of both forage fish species. To verify the acoustic methods, the acoustic indices were compared to trawl data and the prey abundance data collected from local piscivorous seabirds the common murre (*Uria aalge)*, rhinoceros auklet (*Cerorhinca monocerata*), and Brandt's cormorant (*Phalacrocorax penicillatus*). The results indicate that acoustic methodologies can be used to accurately track changes in distributions and abundance of these forage fish species.

Drakes Estero Ecological Monitoring Study.

Andrew Weltz

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The California Department of Fish and Wildlife's (CDFW) Aquaculture and Bay Management Project (ABMP), in collaboration with CDFW's statewide Marine Protected Area (MPA) Management Project, is conducting a two-year ecological monitoring study in Drakes Estero, Marin County, California. Given the long history of marine aquaculture activity in Drakes Estero, the recent abandonment of the operations presents a unique opportunity for ABMP to study the potential long-term impacts of shellfish aquaculture on the estuarine ecosystem. Additionally, the MPA Project's involvement will take advantage of the opportunity inherent in this study to characterize baseline conditions in the two MPAs that have been established within Drakes Estero in accordance with California's Marine Life Protection Act. Here, we present preliminary data from two seasons of sampling. Staff scientists surveyed 16 permanent 30m transects (eight at current oyster rack sites and eight adjacent control transects) in summer and fall 2015 via SCUBA. Both ecological assemblages and anthropogenic physical debris (including oyster shell from the abandoned mariculture operation) were inventoried by divers. As this is an ongoing study, formal analysis is pending. Preliminary data, however, allow characterization of rack vs. control sites prior to the National Parks Service's planned restoration of the estuary.

Water quality in Drakes Estero before and after oyster mariculture, a comparison of 2010 versus 2016.

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Oyster mariculture is well established in estuaries along the U.S. West Coast, supported by high primary production fueled by coastal upwelled nutrients. It is often identified as a promoter of ecosystem health because of the high suspension feeding capacity of oysters that enhance water quality, a trait that supports them as ecosystem engineers. However, the ecosystem level consequences of oyster introductions or removals are not well understood. The recent removal of the 80-year old oyster mariculture in Drakes Estero, CA (in the Point Reyes National Seashore), mandated to meet a wilderness designation, provides an unprecedented opportunity to study such impacts in one of California's low inflow estuaries.

There are limited published studies that describe the ecology of the Drakes Estero to provide a baseline condition for understanding the impact of oyster removal. Funded by CA Sea Grant, we have begun to measure water quality (nutrient and chlorophyll concentrations) and phytoplankton productivity monthly in Drakes Estero for comparison with baseline data collected in 2010 prior to removal of the cultured shellfish. With removal of oyster grazing, upwelled nutrients will continue to be supplied and we hypothesize that phytoplankton will grow and accumulate biomass, in the absence of any compensatory effects by other suspension feeders. An interesting result was high chlorophyll concentration (i.e. phytoplankton biomass) in the Estero in October 2016 reaching 35 µg/L – higher than any values measured during 2010. Another unknown is how the sediment biogeochemistry of the Estero was altered by all the years of mariculture and presence of oysters and if any chemical equilibrium will become unbalanced since their removal. It is likely that loss of oysters will decrease sediment denitrification rates and increase the concentration of nitrate. Additional basin-scale observations of the Estero are being made by others that include monitoring of harbor seals by the National Park Service; assessment of eelgrass, marine debris, and non-natives by California Department of Fish and Wildlife and Marine Protected Area monitoring by the State. Thus, the scope of our study, that includes water quality, nutrients and primary producers, represents a powerful synergy with these other state and federally funded projects. Our research project will be described and preliminary data collected since June 2016 will be presented.

Spatial analysis of chick-brooding rhinoceros auklets *Cerorhinca monocerata* breeding within the central California Current System.

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Understanding how organisms interact with their environment is essential to making sound conservation and managerial decisions. Of particular importance is assessing where and how species acquire critical food resources. In complex and dynamic marine ecosystems, obtaining this information can be especially challenging. Emerging technologies have recently facilitated the remote sensing of animal movement, including miniaturized GPS data logging devices, which were attached to chick-brooding rhinoceros auklets (*Cerorhinca monocerata*) (n=16) breeding on Southeast Farallon Island during the 2015 and 2016 reproductive seasons. Each tracked bird undertook an average of 2.9 foraging trips (n=47) lasting 17.7 hours (3.5-27h), at maximal distances of 19.8 km (3-41km). Three large-scale patterns were observed in foraging behavior. The first and least common involved making short-distance (<8 km) trips to areas along the continental shelf characterized by shallow (<200m) bathymetry, typically to the north and west. The second and most common pattern involved longer-distance (9-20 km) trips west to the southern Farallon Escarpment, generally characterized by strong upwelling, steep bathymetric gradients, and decreasing SSTs compared to shelf waters. Of particular interest was the widespread use of submarine canyon features, a possible artifact of further increased advection and mixing processes leading to local forage hyper-abundance. The final pattern involved long-distance (21-41km) trips to the south, targeting waters around the Gumdrop and Pioneer Seamounts, as well as the mouth of Pioneer Canyon. These results underscore the variability in foraging strategies undertaken by breeding seabirds, and the need to maintain current MPA status for the Greater Farallones National Marine Sanctuary.

Biodiversity exploration and discovery – mesophotic and deep-sea coral and sponge diversity in the Cordell Bank and Greater Farallones National Marine Sanctuaries.

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Exploration of benthic environments in the Cordell Bank and Greater Farallones National Marine Sanctuaries has recently taken place during three research and bottom survey cruises using Remotely Operated Vehicles (ROVs). The immediate goals of the ongoing field study are to survey the deep-water benthic topography, geology, and biotic communities of the offshore region, to accumulate still and video imagery of the remotely accessible region, and to and collect samples of living material – corals, sponges, and associated marine fauna – for preservation, identification, and permanent curation at the California Academy of Sciences as well as the Harvard Museum of Comparative Zoology. The long-term overall objectives are to assess the extent of natural resources and biotic diversity regarding fisheries and benthic habitats of these federally protected offshore regions of central California. Successful exploratory cruises took place on board the National Marine Sanctuaries *Research Vessel (R/V Fulmar*) in October 2012 and September 2014, and the Ocean Exploration Trust Exploration Vessel (E/V *Nautilus*) in August 2016. The bottom depths surveyed varied from 79-432 m in 2012, 97-282 m in 2014, and 286-1868 m in 2016. Overall, these surveys covered a wide bathymetric range between 79 and 1868 m (259 to 6127 feet). The collections made by robotic arm on the ROVs have yielded approximately 45-50 species of sponges and corals and other invertebrates. Some of the noteworthy taxonomic discoveries made to date include designation of a new genus for the sea fan coral *Chromophyton marki (formerly Euplexaua marki)*; a new species of sea whip octocoral *Swiftia farallonesica*; four octocoral species not previously known from the sanctuaries – a deep-sea primnoid gorgonian *Parastenella ramosa* and three species of sea pens (pennatulaceans) *Halipteris californica*, *Acanthoptilum* cf. *gracile*, and *Umbellula* sp.; fresh material of the little known and recently described black coral *Antipathes denrochristos*; and several previously unidentified and poorly known species of glass sponges (Porifera: Hexactinellida).

Snapshot Cal Coast: Mobilizing community members to document species ranges along the California coast.

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In early 2016, the citizen science team at the California Academy of Sciences (CAS) worked with the California Marine Protected Area (MPA) Collaborative Network to coordinate Snapshot Cal Coast, a series of community-led bioblitzes along California's coast. This initiative was the first Network-wide project and an unprecedented effort to link a series of bioblitz events across one region to scale collective impact and the ability collect species range data. Each of the 14 community collaboratives is made up of scientists, educators, managers, nonprofits, state and federal agencies, fishermen, tribal representatives, and other MPA users working together to promote and further understanding of California's State MPAs. A bioblitz brings people together to document biodiversity in one place at one time, recording observations of plants and animals using smartphones or digital cameras and uploading results to the iNaturalist platform. Together CAS and the MPA Collaborative Network trained, supported, and mobilized volunteers and staff in documenting intertidal biodiversity along our coast from June 1st-12th, 2016. Working with the network and partners, we mobilized 385 people from Del Norte to San Diego who made 7101 observations of 943 species, with more than 3000 of those observations being made within the Greater Farallones National Marine Sanctuary and its administrative jurisdictional area. Snapshot Cal Coast participants also documented dozens of species that had not previously been recorded on iNaturalist from the California coast. We will discuss results, interesting findings, and lessons learned. We are now planning for Snapshot Cal Coast 2017 and welcome your input and participation.