

An aerial photograph of a beach and ocean. The ocean is a deep blue-green color with white-capped waves breaking onto a sandy beach. Numerous seabirds, likely albatrosses, are captured in flight over the water, their wings spread wide. The birds have brownish-tan upperparts and dark wings and tails. In the foreground, the sandy beach is visible, with a single person standing near the water's edge. The overall scene is dynamic and captures a natural coastal environment.

GULF OF THE FARALLONES  
NATIONAL MARINE SANCTUARY

**2013 Ocean Climate Summit Report:  
Strength Through Collaboration**

February 20, 2013, San Francisco, California

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Gulf of the Farallones National Marine Sanctuary  
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Cover Photo: Kelley Higgason, Gulf of the Farallones National Marine Sanctuary

## Table of Contents

|  |    |
|--|----|
| Introduction.....                                  | 1  |
| Summit Objectives.....                             | 1  |
| Summit Structure.....                              | 1  |
| Presentation Summaries.....                        | 1  |
| 1) Our Coast–Our Future.....                       | 1  |
| 2) Engaging the Community on Climate Change Panel  |    |
| a. Identifying the Need.....                       | 3  |
| b. Utilizing Social Media.....                     | 4  |
| c. Connecting with Teachers.....                   | 4  |
| d. Learning from the Public.....                   | 4  |
| 3) NOAA Sentinel Site Cooperative.....             | 5  |
| 4) Ocean Climate Indicators.....                   | 6  |
| 5) Climate Smart Conservation.....                 | 6  |
| Closing Remarks.....                               | 7  |
| 4 <sup>th</sup> Biennial Ocean Climate Summit..... | 7  |
| Appendix A: Summit Agenda.....                     | 9  |
| Appendix B: Poster Presentations.....              | 10 |
| Appendix C: Summit Participants.....               | 16 |

## Introduction

Gulf of the Farallones National Marine Sanctuary (GFNMS), in partnership with the Bay Area Ecosystems Climate Change Consortium, California Academy of Sciences, California Landscape Conservation Cooperative, Cordell Bank National Marine Sanctuary, Farallones Marine Sanctuary Association, NOAA Coastal Services Center, PRBO Conservation Science, and San Francisco Bay National Estuarine Research Reserve Coastal Training Program, held the "Third Biennial Ocean Climate Summit: Strength Through Collaboration" at the Golden Gate Club in the Presidio of San Francisco on February 20, 2013.

From the First Biennial Ocean Climate Summit held in 2008, to the third in 2013, San Francisco Bay Area partners have made great strides in building collaborative programs and projects to better understand and address the effects of climate change and ocean acidification on local coast and ocean ecosystems. As noted by Maria Brown, GFNMS Superintendent, in her opening remarks, our accomplishments have been made as a community, from increased partnerships and collaborative awareness campaigns, to providing accessible information and tools to local decision-makers.

## Summit Goal and Objectives

The goal of the Third Biennial Ocean Climate Summit was to connect information, resources, and people across disciplines to collaboratively sustain North-central California coast and ocean ecosystem health through fostering awareness, promoting action, and advocating climate smart conservation.

The objectives of the Summit were to provide a forum for managers, planners, scientists, educators, and public relations specialists involved in climate change and ocean acidification efforts in the greater GFNMS region to:

- Recognize collaborative partnerships and successes in addressing climate change and ocean acidification impacts
- Promote dialogue and share new

information and tools across disciplines on climate change and ocean acidification

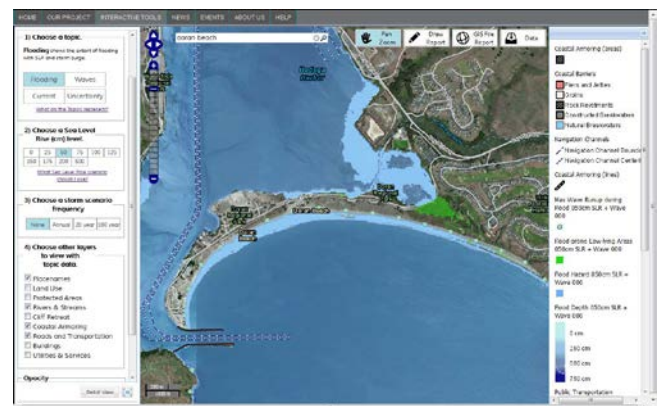
- Discuss climate change and ocean acidification education and outreach efforts that inspire action within the community, and lead to new collaborations
- Discuss local collaborations that provide resources for climate adaptation planning/ climate smart conservation
- Build upon existing collaborations and forge new partnerships

## Summit Structure

Networking and information sharing were encouraged throughout the day through informational presentations followed by 15 minute open discussion periods and an extended lunch, featuring a poster session highlighting collaborative Bay Area projects and programs focused on coastal climate change and ocean acidification.

## Presentation Summaries

All presentation titles link to pdfs.



## Launch: Our Coast–Our Future Beta Decision Support Tool for Sea Level Rise and Storms, part 1

**Kelley Higgason, Ocean Climate Initiative Coordinator, Gulf of the Farallones National Marine Sanctuary**

Our Coast–Our Future (OCOF) is a collaborative, user-driven project focused on providing San Francisco Bay Area coastal resource and land use managers and planners locally relevant, online

maps and tools to help understand, visualize, and anticipate vulnerabilities to sea level rise and storms within San Francisco Bay and on the outer coast, from Half Moon Bay to Bodega Bay. OCOF's three main objectives are to:

- Model vulnerabilities to sea level rise and storm hazards
- Assess stakeholder information needs
- Map infrastructure and ecosystem vulnerabilities at the scale needed for management action

Through extensive stakeholder scoping, the following management needs for sea level rise and storms decision support tools were defined:

- Identification of projected threats to infrastructure, recreation and habitats
- Identification of erosion impacts and highly vulnerable areas
- Prioritization of restoration sites
- Localized predictions and accurate visualizations
- Help with vulnerability analyses

The intended benefits to managers and planners include increased buy-in from stakeholders, the use of best available science in decision-making, efficient assessments, providing an "in house" planning process, and cost savings. The decision support tools can be applied to a variety of planning processes including species protection plans, habitat restoration plans, municipal plans (e.g., General Plans, Climate Action Plans, Local Coastal Plans), and infrastructure maintenance plans.

The tool currently covers the outer coast, from Half Moon Bay to Bodega, and funding has allowed for expansion into San Francisco Bay. Tool developers expect to have the digital elevation model (DEM) of the Bay portion available in spring 2013 and the launch of the completed tool for the Bay in 2014.

## **Launch: Our Coast-Our Future Beta Decision Support Tool for Sea Level Rise and Storms, part 2**

**Michael Fitzgibbon, Chief Technology Officer, PRBO Conservation Science**

Michael Fitzgibbon provided a live demonstration of the OCOF decision support tools. He navigated through the website, demonstrating how to use the interactive map and community forum. Doran Beach was demonstrated as a case study, with visualizations of varying sea level scenarios and storm severity. The following topic areas and data layers are included with the mapping tool:

- Flooding
- Wave height
- Currents
- Place names
- Land use
- Protected areas
- Rivers and streams
- Cliff and shoreline retreat
- Shorebirds
- Coastal armoring
- Roads/transportation and trails
- Buildings and utilities and services

Users can produce and save a report for a selected area that includes area and elevation information, projected average flood depths, projected percent area flooded, and a map of the selected area. A brief overview video tutorial, as well as a detailed video tutorial guiding the user through the mapping tool, is available on the [OCOFC website](#). Webinar trainings will also be held in March and April 2013.

### **Open Discussion**

Questions/statements from Summit attendees and answered by OCOF project leads:

Is there a technical manual for modeling work?

- An open access DEM report is available through USGS. This can be found in the references link under Help on the OCOF website.
- A modeling fact sheet is also available under Help on the OCOF website.

Does flood modeling output consider existing flood protection structures (levees, etc.) or is it based on the DEM?

- The model is based on the DEM with a 1km footprint, interpolated to 2m. Back-flooding does take into account flood protection structures at this scale.

Has there been any collaboration with other federal, state, and/or local agencies?

- The advisory committee includes FEMA.
- We are working with Corps of Engineers to look at best practices, especially for south bay.
- We are still scoping for the bay, but plan to work with water districts, etc.

How far inland will OCOF go?

- The model includes all elevations expected to be impacted in the next 100 years.
- There is no cutoff distance from coast.

Will there be people who give in person presentations to groups?

- Yes, contact Kelley Higgason or Marina Psaros for presentations.
- We can also provide directed trainings to help groups apply the tool to their planning process.

Changes in near-shore bathymetry: when do you expect to be able to incorporate this into the product?

- We will be moving effort to Southern California to examine coastal evolution.
- At the time of this tool development, analysis and data weren't available. Funding and information will be available for Southern California as we move forward.

How often will updates happen?

- There is no plan to update the DEM any time soon, but the model encompasses a huge range of sea level rise scenarios.
- We would need funding to update the DEM, even on a site-specific basis.
- Audience comment: add capability for users to provide information on changes.

Is river discharge included?

- The model does not include river outflow along coast, but developers are seeking discharge data to incorporate for the bay.

Is it in the work plan to include the Sonoma coast?

- Additional funding is needed for this.
- There is interest in expanding north with the increased focus on the Russian River and proposed sanctuary boundary expansion.

### **Engaging the Community on Climate Change Panel**

Carol Preston, GFNMS Education Coordinator, opened the education panel by noting that educators are working hard to engage the community and encourage behavior change, and that rapid social change is needed to help deal with climate change impacts.

### ***Identifying the Need: Undergraduate Students' Conceptions and Misconceptions of Ocean Acidification*** **Kathryn Danielson, Graduate Student, San Francisco State University**

Kathryn discussed her work with undergraduate students to determine their understanding of ocean acidification. Data was collected through written assessments from 250 Biology, Chemistry, and Environmental Studies majors about students' conceptions of ocean acidification, and follow-up interviews with smaller subpopulations were conducted. Results indicate: 1) ocean acidification literacy is low among all three populations of advanced undergraduate science students, 2) Environmental Studies majors are more likely to have heard of ocean acidification, as well as provide scientifically accurate conceptions of the causes and effects of ocean acidification, and 3) newly documented student misconceptions about ocean acidification are present among all three populations of advanced undergraduate science students. Kathryn suggested that, before communicating these issues to an audience, understand their background knowledge so you can fully address any potential misconceptions.

## ***Utilizing Social Media: California King Tides Initiative***

**Heidi Nutters, Coastal Training Program Coordinator, San Francisco Bay National Estuarine Research Reserve**

The California King Tides Initiative (King Tides) uses extreme high tides to increase awareness of sea level rise and coastal hazards, document vulnerable areas along the California coast, and garner support for policy and adaptation efforts. Social media is the primary outreach strategy and reaches a broad distribution of people. Social media is an effective tool to engage all age groups, encourage participation, and is interactive, fun, and easy to use. Working collaboratively with non-governmental organizations, government agencies, and the public to document high tide impacts, King Tides helps build a catalogue of vulnerabilities, serves as a living record of sea level rise, and provides visuals that support mapping visualization of flooding events. King Tides hopes to increase the coastal and ocean management community's comfort and familiarity with social media, and better coordinate communications across this sector with the public.

## ***Connecting with Teachers: Our Changing Oceans and Estuaries Teacher Workshops***

**Jenny Stock, Education Coordinator, Cordell Bank National Marine Sanctuary**

Professional development workshops are an effective way to share science with teachers, increase their knowledge of sea level rise and ocean acidification, and assist with incorporation of these issues into teaching curricula. Our Changing Oceans and Estuaries Teacher Workshops addressed local impacts of climate change, ocean acidification and species adaptation, and included science lectures, field trips, reflection time and planning, and the creation of teacher resource guides. Pre-workshop surveys revealed that many teachers already incorporate these issues into their lesson plans, to some extent, but that many barriers prevent comprehensive climate change education in the classroom (i.e., disbelief by parents and students, low teacher confidence, lack

of engaging activities). Post workshop surveys indicated that a wide range of grade-level educators have an interest in teaching climate change science, and that hearing directly from scientists themselves was most valuable. The next step is to conduct a follow-up survey to see how information from the workshops has been incorporated into classes. All materials from these workshops can be accessed at [OER Commons](#).

## ***Learning from the Public: "Framed" Ocean Acidification Messaging***

**Aaron Pope, Manager of Sustainability Programs, California Academy of Sciences**

Ocean acidification messages were developed by Academy educators to use during coral tank dive shows. Ocean acidification has been identified as a key issue for the Academy, and a priority message for their staff to deliver. The general public has little to no awareness of ocean acidification, and the issue has not been politicized like climate change, so now is the time to take advantage of an audience willing to listen and learn. The Academy uses a simplified message and analogy approach; avoiding unloading too much information on visitors and using the "crisis" approach as this often overwhelms and turns away visitors. The Academy has sent staff to specialized training (through the National Network for Ocean and Climate Change Interpretation) to learn how to frame messages in a way that most effectively reaches Academy audiences, including the use of communal solutions and a value-based approach. After incorporating a 3-minute ocean acidification script into the coral tank dive show, 90% of visitors correctly identified ocean acidification and 74% were able to accurately describe the process. Academy staff plan to continue testing new language metaphors, test more specific and measurable "asks", conduct a more scientifically robust evaluation, and continue training staff and volunteers to frame climate change messages for visitors.

## Open Discussion

Carol Preston moderated an open discussion with the education panel, and began by expressing that now is an exciting time to work on collaborative climate change communication and education.

Questions/statements from Summit attendees, answered by the panel:

What is the new California Coast Tank public program at the Academy?

- Aaron: The Academy is developing a new public program at the California tank, bringing concepts of ocean acidification to the local area.

Are the teacher workshops one time or being repeated?

- Jennifer: We are currently looking for funding to continue them.

It would be great to have a website to model changes in the community with public awareness of the issue. OCOF is geared more towards a technically literate audience, so to have something more basic to show people what the area they love will look like in the future would be beneficial.

- Heidi: This is what all of us on the panel are trying to do. One resource is the [NOAA Coastal Services Center CanVis](#).
- Jennifer: One idea discussed is to take advantage of the new Nemo movie coming out by raising awareness of Nemo's future.
- Marina Psaros: OCOF and CanVis will be incorporating King Tides photos to help people visualize what the future will look like.

Was Kathryn able to identify the sources of students' misconceptions?

- Kathryn: Many students couldn't articulate the source of misconceptions. It would be useful to teach students to filter and conceptualize the messages they are getting.

How do we take metaphors to the more rigorous

science step? How can we help the audience understand that the ocean is basic and becoming less basic, not more acidic?

- Aaron: Audiences have different backgrounds, different capacity to understand, and different levels of scientific literacy. The key is to understand your audience so that you can frame and not go too deep if they aren't ready.
- Kathryn: You also can't go too deep with an audience if they have barriers to understanding. You may need to un-teach a misconception before you can teach them what is correct.
- Jennifer: Working with teachers provides an opportunity to reach thousands of students. Teachers can go deeper with students if they have access to the information and a more in-depth understanding.

Carol Preston concluded that the "Oceans in a High-CO<sub>2</sub> World" conference in Monterey helped build ocean acidification knowledge, and the following 2-day workshop, "[Effective Practices for Communicating Ocean Acidification](#)", discussed how best to communicate the issue, including information gaps, the urgency to act now, and social solutions.

### **NOAA San Francisco Bay Area Sentinel Site Cooperative for Sea Level Rise**

**Becky Smyth, Regional Coastal Services Division Chief, NOAA Coastal Services Center**

Becky Smyth introduced the San Francisco Bay Area as a new NOAA Sentinel Site Cooperative, and described the designation as a place-based, issue-driven effort to focus resources and leverage existing assets to address the impacts of sea level rise. San Francisco Bay is one of 5 sites in the Sentinel Site Program, whose primary goals are to: involve local partners and integrate capabilities across NOAA to collaborate and improve resilience; develop innovative new partnerships, data, tools, and information to inform decisions; develop strategies to address impacts; and raise community awareness of sea level rise impacts. The



Cooperative recently finalized an Implementation Plan and is currently identifying gaps in resources.

### **Announcement: Ocean Climate Indicators for the North-central California Coast and Ocean**

**Benet Duncan, Postdoctoral Ocean Climate Researcher, Gulf of the Farallones National Marine Sanctuary**

Benet Duncan announced climate change indicators for the North-Central coast of California that were developed with expert scientific input as part of a 2-year post doc with Gulf of the Farallones National Marine Sanctuary. The purpose of these indicators is to help managers determine when and where climate change impacts are occurring, and to inform monitoring and response plans for the region. Benet described the selection process, including a survey and workshop with local scientists, which led to a consensus decision of [10 physical and 13 biological indicators](#). The next steps for this project include the development of an indicator-based monitoring inventory and plan, an outreach report tailored to resource managers, and a detailed report for publishing in a peer-reviewed journal.

### **Open Discussion**

Questions/statements from Summit attendees, answered by Benet:

How do we translate this to the general public and decision makers?

- Charismatic species, like seabirds, are something the public has invested interest in. We are seeking funding to make sure this data is accessible to decision makers, and are open to suggestions on how to do that.

Dissolved oxygen is not going to make it with the public- but a dead zone will. The indicator itself is about why we care about the measurement, and that's where scientists have to leap into that zone about making judgments about measurements – and that's how you make this connection with decision makers and the public.

Is there funding to monitor these indicators over time in a meaningful way?

- The monitoring inventory and plan will include what we need to be measuring, what is already being measured, and how it can be expanded. It will lay the groundwork for what is needed when funding opportunities arise.

### **Yes, There is Hope! Climate Smart Conservation**

**Ellie Cohen, President and CEO, PRBO Conservation Science**

Simultaneous mitigation and adaptation is needed; tipping points have been passed, but efforts can still reduce climate change impacts and allow more time for species and society to adapt. Ellie Cohen referred to this approach as “Climate Smart Conservation,” which has a set of defined principles:

- A future focus
- An ecosystem/watershed/landscape context
- Flexible and adaptive
- Prioritization of actions
- Collaboration and communication across sectors

Ellie emphasized that we cannot prevent ecological change, but we must figure out how to design management actions across multiple scenarios to address this change. Two examples of climate smart solutions include: 1) the modification of nesting boxes for Cassin's Auklets to protect the birds from more frequent extreme heat events, and 2) the creation of small islands to serve as windbreaks and to capture sediment in wetland restoration. Ellie also emphasized the need to reduce other stressors and manage for multiple benefits in a biosphere context rather than for individual species. She recommended that organizations begin “scenario planning” to address climate change in an uncertain future and encourage collaborative thinking amongst diverse stakeholders to develop a range of plausible scenarios. Ellie concluded that climate smart solutions are possible, can make a difference, and can provide for a greener future.

## Open Discussion

Questions/statements from Summit attendees, answered by Ellie:

An attendee commented that if you accept that the future is going to be different, you can talk about possibilities instead of the problems, with a focus on the future being better and not worse. The conversation can then open up to the science behind the solutions.

How do you take what we can do differently to regulators/ regulatory regimes? We don't see the flexibility; we see the rules that don't make sense. Have you had those conversations?

- I have not. At PRBO, we have not done a lot in the policy realm. I would love to give this presentation to regulators, so this kind of climate smart language is in everything they do.

Can we all use "Climate Smart"? Is there a way to reference it so we don't feel like we are plagiarizing?

- Everyone should feel free to use it, you won't be plagiarizing. Climate Smart Conservation literally means adaptation and mitigation.

## Closing Remarks

In closing, Maria Brown, GFNMS Superintendent, stated the first Ocean Climate Summit in 2008 brought the relationship between the oceans and climate change to the San Francisco Bay Area natural resource community to discuss and develop actions. Remarkable progress has been made because of the collaboration of many agencies and organizations, and the development of a community to tackle this issue. Highlights include:

- An exciting new tool was unveiled today – Our Coast–Our Future. The sanctuary will use this tool to assess species and habitat vulnerability to sea level rise for adaptation planning. Please contact Kelley Higgason if you are interested in expanding the OCOF model or would like specialized training.

- Opportunities to collaborate on engaging the public were explored today, ranging from social media to partnering scientists with teachers. Misconceptions and tools to effectively communicate about climate change and ocean acidification were shared.
- Since 2008, this community has garnered NOAA attention nationally by developing the first set of climate change indicators for the San Francisco Bay Area.

Maria expressed hope that this event may energize the community through collaborating and working across disciplines to tackle climate change. There is an urgency to act now to develop solutions and a tremendous opportunity to influence the direction we move as a community and a region to create a climate smart future. California and, in particular, the San Francisco Bay Area prides itself on being a leader in social and environmental change, and this community should continue to create positive change. Attendees are asked to send their ideas and vision for where the San Francisco Bay Area should be in two years for the next Biennial Ocean Climate Summit, perhaps sharing how as a community we are institutionalizing Climate Smart Conservation.

## 4<sup>th</sup> Biennial Ocean Climate Summit

Summit attendees completed a post event evaluation and were asked to provide their thoughts on what the 4<sup>th</sup> Biennial Ocean Climate Summit should include. These ideas are summarized here and will be taken into consideration when planning for the next summit:

Progress reports:

- Provide updates for all projects that were presented at this Summit, including concrete "next steps" to move towards adaptation and implementation of actions.
- Include case studies of how the OCOF tool has been implemented and any geographic expansion of the tool.
- Include an update on implementation of the Ocean Climate Indicators Monitoring Plan.

#### Education/outreach:

- Provide more focus on outreach to diverse audiences, from policy makers to school kids.
- Address common climate change misconceptions
- Provide more opportunities to learn best practices for communicating climate change science (e.g., “Don’t be Such a Scientist” by Randy Olson).

#### Summit Scope:

- Link climate change impacts on the coast to San Francisco Bay and vice versa.
- Bring in an outside case study and provide opportunities to learn from other regions.
- Include people from similar regions to the Bay Area to learn from work being done here.

#### Summit Structure:

- Have lunch table discussions where people in similar fields/organizations can connect to provide more time for interaction with other attendees.
- Include time to talk in small themed groups, such as education, technology, social media/outreach, research, citizen science, etc.
- Include a dedicated time for posters.
- Structure the discussion portions to be more open, free-flowing and accessible.

#### State of the Science update:

- Provide a summary of the current science on aspects of climate change affecting the marine ecosystem, such as ocean warming and ocean acidification.
- Include a panel of experts on the current state of knowledge to discuss what is happening now, not only predictions.
- Provide new research about climate change and impacts on biological communities other than ocean acidification.

#### Climate Smart Conservation:

- Provide an opportunity to seek creative ideas and solutions for a sustainable and healthy ocean.
- Provide information on funding opportunities for climate smart conservation.
- Include presentations on project design and implementation processes.

- Provide information on integrating climate change into policy analysis and planning.

## APPENDIX A: 2013 Ocean Climate Summit Agenda

- 9:45 **Registration, Coffee and Refreshments**  
Hawthorn Room
- 10:15 **Welcome**  
Maria Brown, Gulf of the Farallones National Marine Sanctuary
- 10:25 **Summit Agenda and Logistics Review**  
Kelley Higgason, Gulf of the Farallones National Marine Sanctuary
- 10:30 **Launch: Our Coast-Our Future Beta Decision Support Tool for Sea Level Rise and Storms**  
Kelley Higgason, Gulf of the Farallones National Marine Sanctuary  
Michael Fitzgibbon, PRBO Conservation Science
- 11:00 **OCOF Open Discussion with Attendees**  
Moderator: Kelley Higgason, Gulf of the Farallones National Marine Sanctuary
- 11:20 **Engaging the Community in Climate Panel**  
Moderator: Carol Preston, Gulf of the Farallones National Marine Sanctuary  
**Identifying the Need:** Kathryn Danielson, San Francisco State University  
**Utilizing Social Media:** California King Tides Initiative, Heidi Nutters, San Francisco Bay National Estuarine Research Reserve  
**Connecting with Teachers:** Our Changing Oceans and Estuaries Teacher Workshops, Jenny Stock, Cordell Bank National Marine Sanctuary  
**Learning from the Public:** Exhibit and Program Evaluation, Aaron Pope, California Academy of Sciences
- 12:10 **Engaging the Community Open Discussion with Attendees**  
Moderator: Carol Preston, Gulf of the Farallones National Marine Sanctuary
- 12:30 **Lunch and Poster Session, Hawthorn Room**  
**King Tides Slide Show, Ventana Room**
- 1:40 **Attendees Reconvene in Ventana Room**
- 1:45 **NOAA San Francisco Bay Area Sentinel Site Cooperative for Sea Level Rise**  
Becky Smyth, NOAA Coastal Services Center
- 2:00 **Sentinel Site Open Discussion with Attendees**  
Moderator: Becky Smyth, NOAA Coastal Services Center
- 2:20 **Announcement: Ocean Climate Indicators for the North-central California Coast and Ocean**  
Benet Duncan, Gulf of the Farallones National Marine Sanctuary
- 2:35 **Climate Indicators Open Discussion**  
Moderator: Benet Duncan, Gulf of the Farallones National Marine Sanctuary
- 2:55 **Yes, There is Hope!**  
Climate Smart Conservation, Ellie Cohen, PRBO Conservation Science
- 3:10 **Climate Smart Conservation Open Discussion with Attendees**  
Moderator: Ellie Cohen, PRBO Conservation Science
- 3:25 **Closing and Next Steps**  
Maria Brown, Gulf of the Farallones National Marine Sanctuary
- 3:30 **Adjourn**

## APPENDIX B: 2013 Ocean Climate Summit Poster Presentations

### **Applied California Current Ecosystem Studies (ACCESS)**

Meredith Elliott, MSc, Senior Scientist / ACCESS Program, PRBO Conservation Science

*Abstract:* The Applied California Current Ecosystem Studies (ACCESS) is a partnership that supports marine wildlife conservation and healthy marine ecosystems in northern and central California by conducting ocean research to inform resource managers, policy makers and conservation partners. ACCESS was formed by PRBO Conservation Science, Cordell Bank National Marine Sanctuary, and Gulf of the Farallones National Marine Sanctuary. Partners include several federal and state agencies, non-profits and academic institutions. ACCESS members jointly conduct integrated, collaborative, and multi-disciplinary research to monitor distribution, abundance and demography of marine wildlife in the context of underlying physical oceanographic processes and inform managers, policy-makers and conservation partners about wildlife responses to changes in ocean conditions and human threats to mobilize public support for marine conservation. ACCESS focuses on the oceanic habitats in Federal and State waters of northern and central California, encompassing NOAA – National Marine Sanctuary waters (Cordell Bank, Gulf of the Farallones and Monterey Bay) and the potential expansion area south of Point Arena. ACCESS objectives include: 1) conservation of top predators and their food webs, 2) guide human uses to provide protection of the marine ecosystem, 3) document effects of climate change and ocean acidification on the marine ecosystem, 4) contribute to ecosystem-based management approaches, and 5) assess ecosystem effects of freshwater outflow. The information we collect is available upon request to collaborators by means of a simple data sharing agreement. In addition, we produce and disseminate an annual ‘Northern and Central California Pelagic Ecosystem Status Report’ to inform managers, policy-makers and conservation partners about wildlife responses to changes in ocean conditions and human threats to mobilize public support for marine conservation. We share our information with the public and different user groups through various web sites, including the ACCESS Home (<http://www.accessoceans.org>) and project pages on the Sanctuary Integrated Monitoring Network (SIMoN <http://www.sanctuarysimon.org>).

### **Copepods as indicators of climate in northern and central California**

Meredith Elliott, MSc, Senior Scientist / ACCESS Program, PRBO Conservation Science

*Abstract:* Copepods are small marine invertebrates at the base of the food chain that comprise a large and diverse group of species. These crustaceans can respond to short-term and seasonal changes in environmental conditions, making them useful indicators in studying ecosystem response to climate variability. In six years (2004-09) of zooplankton sampling in the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries, we found that the copepod species composition correlated with several environmental measurements at different scales, including alongshore wind stress, surface current flow past Point Reyes, and salinity measurements. In particular, boreal species (i.e., species common to northern latitudes) became more abundant when strong upwelling conditions prevailed (2007-09), and their abundances remained low in years when upwelling was weak (2004-06). These boreal species tend to be larger and bioenergetically richer than copepods from lower latitudes, making them better prey items than other species of copepods. Tracking copepods provides information about changes occurring in the marine food web that fuels the upper trophic levels. When the copepod community largely consists of boreal species, the marine ecosystem is far more productive than when southern species dominate. This was observed when the Cassin’s auklet (*Ptychoramphus aleuticus*), a zooplanktivorous seabird

breeding on the Farallon Islands, experienced unprecedented breeding failure during weak upwelling years (e.g. 2005-06) and recovered to above-average productivity in strong upwelling years (e.g. 2009). In other parts of the California Current, copepod populations have been used to give a one-year advance warning of major changes in oceans conditions. For instance, copepod indices have proven useful for forecasting salmon survival in Washington and Oregon. These lower trophic level organisms can provide important information to managers and scientists about the health of the marine ecosystem, and the potential to use copepods for future predictions on ocean conditions in the Gulf of the Farallones region should be explored.

### **Corps of Engineers Guidance on Planning for Sea Level Change**

Thomas R. Kendall, P.E., Chief of Planning, U.S. Army Corps of Engineers, San Francisco District

*Abstract:* A recent policy statement of the US Army Corps of Engineers states: “Mainstreaming climate change adaptation means that it will be considered at every step in the project life cycle for all USACE projects, both existing and planned... to reduce vulnerabilities and enhance the resilience of our water-resource infrastructure.” One of the variables that must be addressed in resilient coastal planning and design with a changing climate is sea level. This poster focuses on evolving Corps policy and guidance on how to plan for this key climatic variable.

### **Effects of sea-level rise on northern elephant seals at Point Reyes peninsula, California**

Ellen Hines, PhD, Professor of Geography, Marine & Coastal Conservation and Spatial Planning Lab, Romberg Tiburon Center for Environmental Studies

*Abstract:* Northern elephant seals (*Mirounga angustirostris*) historically experienced a significant population decrease to the brink of extinction, but have since recovered and re-colonized former breeding/haul-out sites. Point Reyes Peninsula, California, is one location where population increase has resulted in colony expansion. Sea level rise (SLR) models were built for three scenarios, which indicated that current haul-out sites and high suitability areas would mostly be inundated by 2050. As the Point Reyes coast possesses limited suitable habitat for the seals to colonize, critical conservation measures are needed in response to SLR. We used Maxent to build species distribution models from occurrence data and environmental variables. Models identified suitable habitats and suggested that human disturbance, geomorphology, mean wave height, and slope were important explanatory variables. The resulting analyses can be used to better understand marine mammal responses to SLR and contribute to effective management of pinnipeds within Point Reyes National Seashore and elsewhere.

### **Farallon Islands Program: Monitoring the restoration of a unique island ecosystem**

Russell Bradley, MSc, Farallon Program Leader, PRBO Conservation Science

*Abstract:* The Farallon Islands Program operates through a unique ongoing collaboration between PRBO Conservation Science (PRBO) and the USFWS Farallon National Wildlife Refuge. For more than 45 years, PRBO has been conducting research on the population dynamics, diet composition, and reproductive success of 13 seabird, five seal and sea lion species, and white sharks at the Farallon Islands. The goal of this long-term monitoring program is to improve conservation of marine birds, mammals and their food supply through the application of rigorous scientific research. The information gained from these studies provides timely data and puts them into the context of the long-term trends to allow us to detect changes, predict ecosystem responses, develop

adaptive management strategies and evaluate the success of management actions. Linking this information to environmental variables further enables the development of ecosystem indicators which can be used to inform ecosystem-based fisheries management.

### **Managing for Resilience in the Face of Climate Change: A Scientific Approach to Targeted Oyster Restoration in San Francisco Bay and Elkhorn Slough, CA**

Marilyn Latta, Project Manager, State Coastal Conservancy

*Abstract:* Coastal managers and decision-makers are faced with the challenge of designing conservation and restoration strategies that enhance the resilience of valued coastal resources to climate change. To design effective strategies, they need restoration-planning tools based on robust science. Critical questions include: What is the impact of climate-related stressors on valued resources relative to other anthropogenic stressors? How will climate-related stressors interact with other anthropogenic stressors? How does population connectivity influence resilience to climate change? We are addressing these three questions for native Olympia oysters (*Ostrea lurida*) in San Francisco Bay and Elkhorn Slough. Our ultimate goal is to increase the resilience of oyster populations by improving restoration planning in light of climate change. We are taking a collaborative, joint fact-finding approach to this work, involving restoration practitioners and resource managers in the development and implementation of the research and in the creation of data products and management recommendations. Initial measurements of both climate change-related stressors and other anthropogenic stressors at multiple sites in each estuary reveal significant geographic variation in the mean and range of most stressors. Field surveys of oyster recruitment, density, size distribution and fecundity also indicate existing differences among study sites. We will combine these data with information about oyster responses to multiple stressors in the laboratory and emerging assessments of population connectivity via trace element microchemistry to generate predictions about which sites and source populations are best suited for restoration efforts. We then will produce restoration planning tools to aid practitioners and policy-makers in the selection of sites where oyster restoration is most likely to be successful under projected future conditions.

### **Modeling Sea Level Rise in San Francisco Bay Salt Marshes**

Kat Powelson, Biological Technician, U.S. Geological Survey, WERC

*Abstract:* Coastal salt marshes and estuaries are projected to be disproportionately impacted by climate change; in particular from sea-level rise. Although the San Francisco Bay (SFB) estuary salt marshes are severely fragmented and modified, it is one of the largest tidal marsh complexes in California and contains important habitat for federal and state-listed wildlife species. The maintenance and expansion of habitat is crucial to the successful recovery of these endangered species, but it remains unknown how much of an effect sea-level rise may have on the amount and quality of available habitat. The objective of this interdisciplinary study is to evaluate sea-level rise impacts to salt marshes by synthesizing field data and modeling in order to develop and evaluate habitat impact models and provide sites specific sea level rise predictions for land managers. Our work illustrates the variable impact to SFB salt marshes and identifies critical sea-level rise thresholds for wildlife species. For this study, elevation, vegetation and water level data was collected. In addition, sediment modeling, vegetation characteristics relative to elevation and tidal inundation patterns were also established for all marsh sites to better understand potential future habitat changes. Our models project that 96% (1,942 ha) of marsh area in our study transitioned to mudflat by 2100, which will likely render it unsuitable for current wildlife species. The results from this study are available in a USGS open-file report [www.werc.usgs.gov/SFBaySLR](http://www.werc.usgs.gov/SFBaySLR). This project is

ongoing in the San Francisco Bay estuary and has recently been expanded to 13 sites in Washington, Oregon and throughout California. This program provides resource managers with sea-level rise modeling to 2100, but also provides detailed baseline data that can be used to inform restoration efforts.

### **Nearshore linkages: the roles of native oysters and eelgrass as living shorelines in the San Francisco Estuary**

Marilyn Latta, Project Manager, State Coastal Conservancy

*Abstract:* The San Francisco Bay Living Shorelines: Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. This project builds on previous work by members of our team that advanced restoration methodologies and understanding of constraints and opportunities for both eelgrass and native oysters. Such habitat features, if scaled up beyond previous projects, have the potential to positively influence physical processes (such as waves and sediment transport) that determine shoreline morphology. In this project, we are further testing restoration methods, restoring critical eelgrass and oyster habitat, testing the individual and interactive effects of restoration techniques on habitat values, and beginning to evaluate effects on shoreline processes. Plots (32 x 10 m) of oyster substrate alone, eelgrass alone, or the two together in an additive design, are being compared to un-manipulated control plots along the San Rafael shoreline in the first phase of the project. Preliminary data show that restored habitat structure promotes increased abundance of numerous organisms relative to bare substrate, and that oyster settlement substrate (Pacific oyster shell bag mounds) in combination with eelgrass plantings alters the invertebrate community composition relative to either habitat alone. Small plots (1-m<sup>2</sup>, n=5) at San Rafael and along the Hayward shoreline (near Eden Landing Ecological Reserve) testing various oyster restoration substrates (including SF Bay-derived “baycrete” reef balls and interlocking blocks) are resulting in differences in native oyster recruitment by substrate and by site. This project will advance our understanding of restoration methodologies with an eye towards both habitat creation and shoreline protection in an era of rising seas and increasing storm surges.

### **Ocean Beach Master Plan: Coastal Mgmt + Transportation Implementation Studies**

Shannon Fiala, Ocean Beach Master Plan Assistant Project Manager and Shilpi Chhotray, Ocean Beach Master Plan Intern, San Francisco Planning and Urban Research Association (SPUR)

*Abstract:* The Ocean Beach Master Plan (OBMP) was developed by SPUR through an intensive, two-year interagency and public process. It lays out an ambitious and proactive vision to adapt to rising seas, protect infrastructure, restore coastal ecosystems, and improve public access to this unique open space. SPUR has been leading the OBMP process and will continue, throughout implementation, to serve as an outside entity, facilitating communication and coordination between City, State, and Federal agencies while keeping the long view in focus. The plan presents a series of recommendations designed to improve and restore conditions at Ocean Beach – even as coastal hazards worsen – by adapting proactively to the changing coastline. SPUR has been awarded additional funds from the California State Coastal Conservancy, the San Francisco Public Utilities Commission (SFPUC) and the National Park Service (NPS) to develop implementation studies that will help agencies translate the plan’s recommendations into implementable projects, develop more detailed technical analysis, and prepare for environmental and regulatory review. These studies will include a coastal management framework, transportation analysis, and open space planning.



## **Our Changing Estuaries: A Professional Development Series for Educators**

Erin Blackwood, M.Ed., Outreach Coordinator, Romberg Tiburon Center for Environmental Studies

*Abstract:* The Our Changing Ocean and Estuaries workshop series consisted of two one-day (spring and fall) and one two-day (summer) professional development workshops specifically addressing the impact of climate change on the ocean and estuaries, including ocean acidification. The series trained educators to teach their students about the impacts of climate change on the ocean. Workshops combined presentations by leading marine scientists with hands-on activities to implement in the classroom. This method gives teachers access to cutting-edge marine science research and will result in widespread awareness of ocean acidification. The project goals of the Our Changing Ocean and Estuaries workshop series are: provide a facilitated avenue for scientists to share their relevant scientific research about our changing ocean and estuaries due to climate change and ocean acidification; increase knowledge about ocean and climate literacy; increase implementation of ocean acidification and climate change lessons in middle and high school classrooms. The series reached over 50 educators, 36 at the 6-12 grade levels, as well as 17 college and informal educators. It is expected that each teacher will then pass the knowledge gained on to the approximately 75 students attending their classes. As a result, the workshop series will bring urgent information about climate change and ocean acidification to over 3,750 students in just one year. This number will grow exponentially as teachers continue to implement ocean acidification content in their classroom during future years. 50% of the educators attended more than one workshop in the series, and these multiple contacts with scientists and staff from the leading marine science education organizations in the Bay Area will develop a deeper connection and commitment to teaching the material. In addition, ties between the NOAA-supported Sanctuaries and NERR and scientists at local universities were strengthened through the collaborative process that made the workshops a success.

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

Louis White, Coastal Engineer, ESA PWA |Environmental Hydrology

*Abstract:* Coastal erosion poses challenges to land use and resource conservation in California and is particularly acute in southern Monterey Bay<sup>1,2,3</sup>. Sea level rise will exacerbate this challenge by raising the elevation of wave breaking and runoff<sup>4</sup>. Predictions of the potential extent of erosion over time are needed to assess vulnerabilities and evaluate adaptation strategies. ESA PWA (formerly Philip Williams & Associates, Ltd. (PWA)) has developed a methodology to approximately model sandy shore response to waves, sea level, sand supply and typical adaptation strategies (retreat, beach nourishment and armoring). The methodology uses simplified representations of key processes to provide an approximate but reasonably precise, efficient and transparent means of evaluating alternative scenarios. The methodology divides the shore into reaches represented by typical profiles, similar to a shoreline evolution model. Changes to shoreline position are determined using the concept of an equilibrium profile, incorporating sand supply changes (e.g. beach nourishment or sand mining) and sea level changes. Backshore conditions, defined by the adaptation strategy, are then set to allow or prevent shore recession, and are adjusted at discrete time steps for which the cross-shore widths of elevation zones of interest (e.g. dry beach) are measured. Ecologic, recreation and damage models, dependent on the width of each elevation zone, compares the economic impact associated with the landward migration of the profile. The modeling has shown promise in southern Monterey Bay<sup>5</sup> and Ocean Beach, San Francisco<sup>6</sup>, although still under development and testing. Methods and results of these applications will be presented.

## **Sea Level Rise and the California Coastal Act: A Framework for Action**

Hilary Papendick, NOAA Coastal Fellow, California Coastal Commission

*Abstract:* The Coastal Act mandates the California Coastal Commission (CCC) to “protect, conserve, restore, and enhance coastal and ocean resources for current and future generations.” To ensure coastal resources are protected for the future, the CCC is developing sea level rise (SLR) and climate change guidance for use by staff and local governments. The Guidance is based on existing Coastal Act regulations and statewide sea level rise policy recommendations. This poster explains the key components of the CCC’s Draft SLR Policy Guidance, how it relates to statewide SLR efforts, and gives an example of existing SLR policies.

## **The Challenge of Seabird Restoration in a Warming World**

Russell Bradley, MSc, Farallon Program Leader, PRBO Conservation Science

*Abstract:* While artificial nesting habitat can be crucial to effective seabird restoration, increased temperatures from climate change can cause serious negative impacts. Cassin’s Auklet (CAAU, *Ptychoramphus aleuticus*) is a small cavity nesting alcid which has been studied by PRBO Conservation Science in partnership with the Farallon National Wildlife Refuge (USFWS) on Southeast Farallon Island, California (SEFI) for over 40 years. This population has declined dramatically since the early 1970s. CAAU show high site fidelity to nesting boxes that allow monitoring of individuals without disturbing natural habitat. We assessed increases in air temperature at SEFI over the last 4 decades and recently explored the utility of mitigation measures to reduce temperatures in auklet nesting boxes, compared to uncovered boxes and natural burrow sites.

## **The San Francisco Littoral Cell Coastal Regional Sediment Management Plan**

Doug George, Oceanographer, ESA PWA |Environmental Hydrology

*Abstract:* The San Francisco Littoral Cell Coastal Regional Sediment Management Plan (CRSMP) covers 17 miles of Pacific coast shoreline from Fort Point, San Francisco, to Point San Pedro, Pacifica. The goals of the CRSMP are to preserve and maintain beaches as well as sustain recreation, enhance public safety and access, and restore beach habitats. An essential piece of the CRSMP is identifying cost-effective opportunities for beach nourishment and performing a cost-benefit analysis of the alternative solutions in the face of sea level rise. A multi-disciplinary approach is being used to satisfy the goals of the CRSMP, which is being completed for the US Army Corps of Engineers and the State of California. This includes assessment of geological and geomorphic processes, habitats and species of concern (terrestrial and marine), infrastructure at risk, economic costs/benefits, public access, and policies that may affect sediment management. Alongshore sediment transport budgets are calculated based on nearshore dynamics and sediment inputs from coastal watersheds. In addition, the CRSMP is considering the impacts of projected sea level rise over the planning horizon of 50 years based on curves supplied by the USACE. Extensive geospatial data were compiled, including preliminary data from the California Coastal Mapping Program (seafloor and shoreline), coastal armor, city infrastructure, historical and current habitat regions, and landslide susceptibility. The database forms the foundation for future coastal and marine spatial planning in the region. This poster documents the coastal hazards and damage potential, presents the available geospatial data and remaining data gaps, and identifies stakeholder-supported solutions.

## APPENDIX C: 2013 Ocean Climate Summit Participants

### **Sarah Allen**

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Fisherman

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