Bay Area Ecosystems Climate Change Consortium

Wednesday, January 30, 2014 10 AM – 2:00 PM
11th Floor Conference Room, California State Coastal Conservancy
1330 Broadway, Oakland, CA 94612

Meeting Summary

Attendees:

*Sarah Allen, *National Park Service*
*Patrick Barnard, *US Geological Survey*
Louis Blumberg, *The Nature Conservancy*
*Ryan Branciforte
*Erin Chappell, *CA DWR*
Ellie Cohen, *Point Blue Conservation Science*
Deanne DiPietro, *Point Blue/CA LCC*
Scott Dusterhoff, *SFEI*
*Jenn Fox, *Bay Area Open Space Council*
Matt Gerhart, *CA State Coastal Conservancy*
Wendy Goodfriend, *BCDC*
James Gregory, *ESA PWA*
*Daphne Hatch, *National Park Service*
Kelley Higgason, *Gulf of Farallones NMS*
Sara Hutto, *Gulf of Farallones NMS*
Andy Gunther, *BAECCC*
*Roger Leventhal, *Marin County*
David Loeb, *Bay Nature*
*Suzanne Marr, *EPA*
*Lisa Micheli, *Pepperwood Preserve*
*Cristina Milesi, *NASA*
Sara Moore, *Consultant/NBCAI*
Sarah Newkirk, *The Nature Conservancy*
Nadine Peterson, *CA State Coastal Conservancy*
David Revell, *ESA PWA*
Sarah Richmond, *BCDC*
John Rozum, *NOAA Coastal Services Center*
Eric Simons, *Bay Nature*
*Tom Suchanek, US Geological Survey
Linda Tandle, *CEMAR*
Alicia Torregrosa, *US Geological Survey*
Luisa Valiela, *US EPA*
Rebecca Verity, *URS*
Michael Vasey, *SF Bay NERR*
*Angela Whitney, *National Park Service*

* = via teleconference

1. **Introduction of participants and their BAECCC-related projects**

Participants introduced themselves and the interests of their organizations in BAECCC.

2. **Review Agenda**

No new items were added to the agenda.

3. **Updates**
   1. **EPA SF Bay Water Quality Improvement Fund Proposals.** Luisa Valiela announced that the request for proposals will be available in March. It covers nine San Francisco Bay counties.
   2. **Bayland Ecosystem Habitat Goals Update.** Matt Gerhart reported that the update is in final review after a major reorganization of the draft. It should be released mid to late summer. He added that funding is needed for report design and the web interface.

3. **North-central California Coast and Ocean Climate-Smart Adaptation Project.** Sara Hutto and Kelley Higgason announced a Focal Resources Workshop on February 11 that will help define a final list of resources that will be the subject of a vulnerability assessment at a second workshop. The goal of the project is to collaboratively develop and implement adaptation actions in response to, and in preparation for, climate change impacts on coast and ocean habitats, species and ecosystem services. The project also could use additional funding for planning and implementation of adaptation actions. The end goal is to design pilot resilient shoreline projects.
4. **Climate Smart Grant Program, California Coastal Conservancy.** Nadine Peterson reported the Conservancy received $13.3 million in proposals statewide. Funding for the program was increased from $1.5 million to $3 million. Five Bay Area projects were approved by the Board last week: (1) City of Benicia will assess vulnerability and create an adaptation plan to mitigate risks to shoreline and community assets associated with sea level rise, (2) San Francisco International Airport along with other agencies will study the vulnerability of a shoreline area northwest of the airport to sea level rise and prepare adaptation strategies, (3) East Bay Dischargers Authority will study strategies for changes to regional wastewater discharge to protect facilities from sea level rise and potentially use treated wastewater to enhance the growth of wetlands vegetation, (4) San Francisquito Creek JPA will design a pilot project to protect against flooding of a portion of the Bayfront Expressway (State Highway 84) between the Dumbarton Bridge and Ravenswood Slough; the project will incorporate restoration of wildlife habitat in adjacent former salt ponds as part of the flood-control measures, and (5) Bay Area Ridge Trail Council will work with the San Francisco Bay Trail Project to examine how public hiking and biking trails, together with mass transit, can be managed to reduce car usage and emissions of greenhouse gases.

4. Group discussion: Fog and Climate Change in the Bay Area

Alicia Torregrosa of the US Geological Survey presented on the recent work of a team of scientists studying fog in the Bay Area, including past trends, current measurements and challenges of projecting the future fog regime.

A simple definition of fog is a cloud that touches the ground. Key ecological characteristics of fog are its liquid water content, heat flux, and aerosol transport and composition. Fog brings water and nutrients to terrestrial ecosystems. It impacts stream flow because it lowers the evaporative demand of transpiring plants. It acts to lower stream temperature because it reflects solar energy that would otherwise heat the surface waters.

We really aren't sure how fog will be affected by climate change. Alicia's colleagues have examined fog records going back about100 years (mainly from airports), and these data show a 33% decrease in fog during that time. Additional data and analysis are needed to draw conclusions about the drivers of this trend.

There are three key questions that are the focus of the USGS fog research: (1) What are the main drivers that affect marine coastal fog (frequency and distribution)? (2) How might these drivers

change in the future? and, (3) What do we need to understand to project future trends in CA coastal fog?

Data sets have been developed regarding the spatial and temporal distribution of fog, but at present there are many variables that are too poorly understood to project future fog regimes. Scientists are starting with basic physical principles to understand fog dynamics in coastal California. Processes at the global scale such as anticyclones, and regional scale such as air pollution, will impact fog formation and distribution.

Alicia presented a video of the earth's wind patterns to emphasize the layered nature of the atmosphere. As the pressure decreases, the winds are faster, and there are consequently different circulation patterns at different elevations. Measuring the vertical structure of the atmosphere is also important because subsidence of upper atmospheric layers will trap the stratus cloud layer near the ocean.

Alicia discussed doctoral work of Travis O'Brien (UC Santa Cruz –now at Lawrence Berkeley Lab) in which a regional climate model was coupled to a turbulence model that simulates fog formation. The results showed long-term declines in fog driven by surface pressure changes that increase off-shore flow that then dries the marine boundary layer and lifts the fog deck. An increase in sea surface temperature would further reduce fog formation but would perhaps be offset by Central Valley warming that would draw fog further inland.

Ocean upwelling is another important driver of coastal fog. Alicia noted that the time of strongest upwelling does not coincide with the foggiest months. In the last decade the foggiest month is July, while May and June are strong upwelling months. Aerosols that can serve as cloud condensation nuclei are also important for fog formation. Aerosols coming from the ocean are highly diverse, and include organic and inorganic molecules, bacteria, and fungi. Conditions under which condensation occurs are influenced by the condensation nuclei. Fog droplets can condense at surprisingly low humidity (*e.g.*, calcium chloride particles can cause condensation at 20% relative humidity).

Alicia outlined the products generated through the California Landscape Conservation Cooperative and Terrestrial Biodiversity Climate Change Collaborative (TBC3):

- Fog low-cloud maps and derivatives. These are maps and data sets compiled from various satellite data: GOES (Geostationary Operational Environmental Satellite). MODIS (Moderate Resolution Imaging Spectroradiometer), Landsat, and AVHRR (Advanced Very High Resolution Radiometer). Products include:
  - a map of hourly data from 1999 to 2009 at 4km spatial resolution, (she showed an animated version of the map for a 10 day period of hourly fog data derived from GOES-derived low cloud-fog dataset). The hourly fog cover data were generated by Cindy Combs, CIRA [Cooperative Institute for Research in the Atmosphere]). Other derived data sets include monthly average fog hours per day, and monthly percent fog cover. These data are all for the summertime (JJAS) period for 1999-2009.
  - Site-based fog measurements. Many groups are collaborating together to gather on site-based measurements of fog (FogNet). Save the Redwoods League Redwoods and Climate Change Initiative is funding and partnering with UC Berkeley and Humboldt

State University on 10-year study that used assorted techniques/instruments included fog drip collector, leaf wetness sensors, and harp collector. Other partnership efforts (USGS, UC Davis, CSU Monterey Bay, UC Santa Barbara, NOAA, and others,) are putting out mesh fog collectors, fogcams, and instruments to measure fog droplet size and number to collect fog water for isotopic studies. Site-specific data Alicia presented included: total hours of cloud cover by site (June-Sept); total cloud hours by month by site, and quantifying fog impact on monthly temperature. These data show that the inverse correlation between maximum temperature and presence of fog is extraordinarily high at Cotati, Tomales Bay, and Napa, but not at Jenner. It is thought that an open coast location like Jenner is cooler to begin with, so the presence fog won't make as much of a difference in the maximum daily temperature.

To gather comments and suggestions from those present, Alicia distributed a "Matrix of Coastal Fog-related Natural Resource Decisions (or Questions) by Data Type":

- Decadal: What data units work best for you? 1) % fog cover as shown, 2) hours of fog, either total or as an average over a 24 hours period, 3) other?
- Annual: These data are JJAS (June/July/August/September) representing annual summertime fog. 1) Do these 4 months give you the info you need? 2) Other issues?
- Monthly: What format do you prefer? 1) GIS-ready map layer, B) an excel-ready flat data file with data for a single point, 3) other?
- Daily: 1) Which is more useful—a monthly map of average fog hours per day or a suite of 30 daily maps? 2) Is diurnal data useful to you? 3) Other?

Questions

- Scott Dusterhoff noted that a post-doc at Cal is studying fog as a relatively recent phenomenon, *i.e.*, last 5,000 years. Alicia answered that John Barron at USGS studied this issue and concluded that fog existed earlier than the Holocene period. Mike Vasey commented that ocean upwelling has been occurring for a couple of million years, increasing the probability that fog has been around, though there may have been different dynamics during glacial periods.
- Andy commented on the importance of the fog boundary on inland temperatures based on the site-specific data. It would be helpful to have data at a finer spatial scale to understand changes in fog at the inland boundary of the fog layer, as these are locations that might see large changes in temperature if fog were to become less prevalent.
- Mike Vasey commented that the interior delta region gets really hot; even though there may not be fog, delta breezes from the marine layer may still take heat out on a regional scale. Better deployment of different instruments is needed to assess points of vulnerability at transition boundaries.
- Sarah Allen asked about the relevance of the depth of the fog layer to ecosystems. Alicia responded that one of the derivatives from the GOES product (developed by Cindy Combs) used the topographic elevation of the surface overlaid by fog. Fog cameras are helpful as well; they have used the Golden Gate Bridge as a "measuring stick" to gauge fog depth. Hawk monitors are also recording thermals and fog cover.
- Rebecca Verity added that in habitat planning and managing restoration it would be helpful to have contour maps at a finer scale to enable design of specific habitats for water loving plans and animals.

5. Group Discussion: Innovative Coastal Resilience Planning in Ventura, CA

Sarah Newkirk of The Nature Conservancy (TNC) introduced the session by commenting on the potential increase in global annual flood losses---from $6 billion in 1995 to $52 billion by 2050. If sea level rise is added, the figure reaches $1 trillion. Billions will be spent on managing and protecting coastlines, (*e.g.*, walls, levees, green/nature infrastructure such as restoration of wetlands). TNC started its work on Coastal Resilience in 2005. Downscaled climate models were used to project coastal changes to encourage the addressing of sea level rise in general plans, LCPs (local coastal program updates), zoning code updates, and permitting activities, but local and regional decision makers didn't use them. TNC hypothesized that in order to enhance use more local ownership of the tools needed to be fostered by directly involving the decision/policy makers in developing tools based on best available science that incorporates economic impacts.

They decided to test this hypothesis on the coast of Ventura County, as it contains a variety of land use elements and a wide range of stakeholders willing to make a two-year commitment to the project. Modeling was conducted for the County's coastline and the lower floodplains of the Santa Clara River (1,600 square miles) and the Ventura River (227 square miles). Costs and benefits of two alternative management scenarios (one with more green infrastructure and one with less) will be presented to promote thinking about actual strategies and economic implications. The project is now in its third year.

Sarah then turned the presentation over to staff from ESA-PWA to describe the modeling; David Revell, a coastal geomorphologist, and James Gregory, a fluvial hydrologist. Three key elements were used to develop scenarios that were modeled to investigate hazards along the Ventura County coast:

1. Sea Level Rise: low: 0.44 meters by 2100; medium 0.93 meters by 2100; high 1.47 meters by 2100.
2. Wave Climate: existing conditions; doubling of El Niño frequencies; a 500-year or an Arkstorm event in 2060 with a doubling of El Niño frequencies.
3. Flooding: historic coastal storms; 100 year river events from climate models. A range of projected flood magnitude and frequency estimates were developed for two GHG emissions scenarios at three different time horizons for both watersheds.

Model outputs include (1) erosion hazard zones (integrated with coastal flooding) - future erosion increases hydraulic connection and risk of flooding; (2) coastal wave run-up hazard zone, (3) coastal flooding – inundation during extreme events and during monthly extreme tides; and (4) fluvial flooding from the Ventura and Santa Clara Rivers. Maps were produced of hazard zones for each scenario.

Dave noted that the model results can be queried using tools that are being used as part of a flood hazards analysis for City of Ventura. The tools help show the range of uncertainties by comparing multiple scenarios at different planning horizons to present relative risk. The spatial aggregation approach adds overlapping hazard zones, pixel by pixel, to show relative probability of impacts for each planning horizon.

Additional project elements included SLAMM (Sea Level Affecting Marsh Migration) wetland evolution modeling, GHG (greenhouse gas) accounting of management measures, and cost/benefit analysis of various adaptation strategies. SLAMM models the processes of inundation and accretion using the Great Diurnal Tide Range. Results show the evolution of mud flat, regular flooding extent, and irregular flood marsh/tidal fresh marsh.

SLAMM was also used as an example to investigate management alternatives including allowing marshes to transgress compared to protecting developed dry land between 2010 and 2100. They also used recently released IPCC guidelines for greenhouse gas sequestration to estimate the difference in sequestration rates over time with various management alternatives that had more or fewer marshes. Total sequestration was very sensitive to freshwater pond management.

Sarah Newkirk concluded the presentation by noting that there are now similar projects around the state. An immediate goal of TNC's Coastal Resilience initiative is to make sure other local adaptation projects, and the state agencies supporting them, can benefit from information about Coastal Resilience Ventura and other similar projects through a shared network. A long term goal is that state agencies get ground-level insight on how to meet local planning needs. Looking at a number of studies offers comparisons of approaches to modeling seal level rise and coastal hazards, economic assessment approaches, decision-support tool development, and lessons learned from stakeholder engagement. She asked, "What can TNC do to support nature-based adaptation projects in the Bay Area?"

Discussion

Mike Vasey commented that as the atmosphere warms it holds more moisture. There is a lot of variability in precipitation and episodic events with more frequent, larger events in the future but that tails off after 2030. Downscaled data may not be accurate that far into the future.

Patrick Barnard of USGS noted that their research in the Bay area indicates that for individual watersheds, flood stages are uncorrelated with Bay water levels. On the open coast the relationship is more tightly coupled; most large events are associated with El Niños.

Roger Leventhal commented that it would be good to keep track of projects that didn't work as we can learn from them.

Andy announced that the next quarterly meeting is April 24.

6. Adjourn

The meeting was adjourned at 2 p.m.