KEY COASTAL AND BIODIVERSITY NOTES FROM
CA CLIMATE CHANGE CONFERENCE SEP 8-10, 2008
Notes by Abe Doherty, California Ocean Protection Council

CEC Vice Chairman Jim Boyd said that CA is the 12th largest emitter of GHG in the world and is the 3rd largest gasoline consumer in the world (behind US and China). Boyd said that mitigation and adaptation decisions should consider: organizations and individuals, multiple scales, different decision making stages, vulnerability hotspots and potential social barriers to implementation.

ARB Board member Daniel Sperling said that the AB32 Final Scoping Plan will be released in October 2008 and adopted by ARB in November 2008. He emphasized the need to leverage co-benefits, form strong partnerships with NGOs and industry, stimulate innovation in technology, behavior and institutions and create a price signal for carbon through the cap-and-trade program and offset projects.

Secretary Chrisman stated that the state needs to look at how to adjust planning and expenditures to address climate change and highlighted SCC revising the project selection criteria to "protect terrestrial and aquatic species". Sec. Chrisman said that the key gap is how to translate scientific information into useable information and a "real adaptation plan". He said that we need to identify areas most at risk from hazards, identify cost effective solutions and how to communicate threats and solutions to public. (Announced Resources Agency was changing name to Natural Resources Agency in Jan 2009.)

Lester Snow, Executive Director for the Department of Water Resources, gave a presentation on the adaptation plan for water resources for the state. He said that the state needs to change the system of water rights, but said that he was uncertain how to do it and acknowledged that past attempts have failed. He said that DWR has selected arbitrary targets of planning for 20% worse floods, 20% worse droughts and improving water efficiency 20% by 2020. He said that it was important to have interim planning standards and a process for updating the targets (esp. for sea level rise). He recommended making management changes based on the vector for change, even though we may not understand the magnitude of the environmental changes. He emphasized the need to fully develop the potential for integrated water management and to implement a more diverse water supply portfolio, including reuse, desalinization, and aggressive groundwater recharge. He stressed the importance of enhancing and sustaining ecosystems, and recommended that resource management be designed into flood and water supply management (total resource management). He said that we need to "fix the Bay Delta system" – that it is the most at-risk water and ecosystem in the state for vulnerability to climate change.

Biodiversity/Planning for Acquisitions and Analyses of Species' Responses

CEC's PIER program funded the creation of the Biological Impacts of Climate Change in CA (BICCA), which funded about a dozen grad students and post-docs to do research on this topic. BICCA is working on a book based on the outcomes of this research (have drafts of chapters now, are looking for resource managers to review the chapters, book

will likely be completed by end of year). Future funding for this program is uncertain; PIER may not be able to fund it again this year. Research includes coastal redwood changes, purple needlegrass, impacts on marine species from ocean acidification and invasive plants. The BICCA leaders/mentors are Kim Hall from Michigan State and Mark Herzog and Chrissy Howell from PRBO.

Dr. Terry Root from Stanford gave a compelling talk on the potential biological impacts to CA. With a 9 degree F rise in temperature (high end of current projections), there will likely be extinctions of greater than 40% of CA species. From meta-analyses of species and shifts in phenology (timing), genetics and behavior, 20% of species exhibited the opposite of what would be expected. There is a lot of uncertainty and it is difficult to predict impacts. She recommended focusing on species instead of species assemblages, because there will be reshuffling of assemblages. She presented a hierarchy of actions for different levels of concern:

1. monitor for declines,
2. continue managing,
3. managed relocations (formerly called managed migrations),
4. out of our direct control (she pointed to ocean acidification).

Dr. Root said that we will need to start sorting species into these categories and identifying species that will take too much money and resources to make it feasible to do managed relocations. Obstacles: money (thousands of species at risk), political power, will power (to acknowledge some species will not be able to be saved), people power, space (recipient sites for managed migrations), infrastructure, invasive species management. She recommended that the National Academy of Science form a panel to address how to establish a process to consciously give up on some species, which is currently illegal under the Endangered Species Act, but which she thinks is necessary.

Lee Hannah from Conservation International presented on uncertainty, scale and cost for redesigning conservation in the face of climate change. He has developed algorithms to identify areas that would need to be added as reserves in order to allow for migration of species. He has applied this modeling to South African reserves. He noted that different models for individual species' responses to climate change have significantly different outcomes – there is large uncertainty. He recommended taking a portfolio approach to diversifying risk (multiple options for species and diverse landscapes) and modifying the approach as information improves. He summarized the Nature Conservancy's effort on classifying species response by low, medium and high risk and estimating investment costs (low, med and high) and then focusing on investing accordingly.

Jessica Blois from Stanford (part of BICCA program) presented on using the fossil record to learn how species have responded to climate change in the past. She listed the following categories of response to environmental changes: genetic change, range shift, change in event timing (phenology), behavioral change, morphological change, abundance change, immigration, turnover and extinction. She described how her research using fossil records in northern California has documented many of these responses to past climate change. She discussed the importance of a functional group in a

landscape (e.g. burrowing mammals that aerate the soil – her study showed that the species of burrowers changed over time, but the functional role was still filled).

Lori Hargrove from UC Riverside presented on elevational shifts in birds over the last 25 years in desert habitat in CA. Her study site had a 9 degree F temperature increase in the past 25 years, demonstrating that there are very different microclimate responses to global warming. Analysis of 28 bird species showed that they moved an average of 400 feet higher in elevation in the past 25 years and that the lower elevation species were more likely to show upward elevation shifts. She recommended that research focus on studying breeding/nesting success at species' distribution margins.

Blake Suttle from UC Santa Cruz presented on his research on changes to grasslands with climate change. He manipulated precipitation amounts on grassland plots, to simulate conditions under various scenarios for climate change, and monitored changes in biodiversity. His research showed that initial responses by plant species (especially nitrogen fixing plants) were followed by community responses (increase in annual exotics and decrease in biodiversity). He concluded that it is very difficult to predict the ramifications of climate change on a particular species or assemblage, because he just changed one variable (precipitation) and had plots with opposite outcomes. Timing and species interactions result in complex processes that are difficult to model. He quoted from U.S. Forest Service ecologist Nate Stevenson, who recommended:

1. Consider our targets (e.g. preservation of mix or tree cover),
2. Identify what we don't want/what conditions are undesirable,
3. Identify alternative scenarios, and
4. Expect surprises.

Carbon Sequestration

Kim Taylor (working with Roger Fujii) from USGS gave an impressive presentation on the results of manipulations of Delta wetlands and the carbon sequestration potential of Delta wetlands. Starting in 1997, USGS has had funding from DWR for a demonstration project in which 7.5 acres were flooded inside a Delta island (behind levee) and planted with tules. They are not tidal wetlands; they are highly managed ponds with water pumped into the site. The researchers observed high levels of accretion and carbon sequestration in areas with dense stands of tules. This is very promising as a project to sequester carbon and reduce vulnerability of levee failure through accretion of sediment behind levees. She proposed a research plan for next steps of assessment.

Greg Rau from UC Santa Cruz presented on options for altering seawater chemistry to mitigate carbon dioxide emissions and address ocean acidification. He contends that there are various potentially safe, marine-based options for sequestering carbon dioxide in marine environments and that these options need to be evaluated, because the current terrestrial sequestration projects will not be adequate to sufficiently offset GHG emissions. He outlined physical approaches (deep ocean carbon dioxide injection), biological approaches (ocean fertilization) and chemical approaches (alkalinity addition and enhanced limestone weathering). He recommended focusing on speeding up carbonate weathering, by placing limestone and water in direct contact with carbon dioxide that was captured from point sources of emissions (e.g. power plants). He is

testing this wet limestone scrubbing at UCSC's Long Beach Marine Lab and said that if it was implemented at the Moss Landing power plant, with the current amount of water being pumped for cooling, using the limestone scrubbing could reduce 25% of the carbon dioxide emissions from the power plant.

Sandra Brown reported on a project that concluded that reducing fuel loads through selective thinning of forests results in a net increase in emissions of GHG; does not make sense as a carbon sequestration project.

John Henry Beyer from Lawrence Livermore Lab presented on the West Coast Regional Carbon Sequestration Partnership (WEST CARB), which is a government and industry partnership led by CED and funded by US Dept of Energy, CEC and industry. WEST CARB is focusing on geologic sequestration of carbon dioxide, by injecting carbon dioxide into bedrock at point source locations of carbon dioxide, such as oil refineries, power plants and cement plants. They have characterized regional carbon dioxide storage opportunities and have a map showing where there are deep saline water formations/bedrock (including in the Central Valley, eastern SF Bay, Central Coast). There is a question about ownership of pore space in bedrock; may want to ensure that state-funded acquisitions include language to clarify ownership of the pore space (Wyoming court just determined that surface owner is owner of pore space.) WEST CARB is testing pilot scale implementation at an Arizona power plant, where they are injecting carbon dioxide through a deep well, into porous carbonate formations. They will soon start a larger scale precommercial test project in southern Central Valley site. Projects in Germany and elsewhere have demonstrated good success with this technique. Need to monitor for risk to underground drinking water aquifers, risk from faults and fractures and escape of carbon dioxide.

Changes in Physical Conditions

Many scientists presented on the challenges of downscaling global models to CA. Various downscaling models for CA have done well in simulating temperature changes, but there is too much uncertainty and variance in outcomes for precipitation to have confidence in the precipitation predictions. It will likely take ten years before modelers can develop sophisticated models that address clouds and the resolution necessary to reasonably predict precipitation changes.

Analysis of observations of Santa Ana winds in Southern California concluded that these winds have decreased 30-50% in the period between 1959-2001.

David Schoelhammer from USGS presented the CASCADE modeling framework for analyzing scenarios for the Bay-Delta system. He discussed the sediment changes likely to occur with sea level rise and global warming.

Dr. Stefan Rahmstorf, a preeminent climate change scientist from the Potsdam Institute in Germany, presented the latest information on sea level rise predictions. He said that there was a dramatic decrease in sea ice north of Greenland last year, which has significant implications for the rate of temperature change, since the sea ice reflects the sun and

helps keep temperatures low. He said that the sea ice is melting faster than the current models predict.

Dr. Rahmstorf presented different predictions on SLR by 2100:

- 18-59 cm plus an unknown amt to account for the faster melting of ice sheets (10-20 cm?) IPCC 2007 (Rahmstorf says that it is overly cautious since with the current SLR rate of 3.3 mm/year, would have 33 cm rise by 2100 and that the rate is expected to increase exponentially.)
- 50-140 (55 inches) Rahmstorf 2007
- 55-110 Delta Commission – Dutch Govt 2008
- 80-200 cm Pfeffer et al. 2008 Science magazine (inc. consideration of outlet glaciers)

He concluded that SLR will likely be below/close to 1 m by 2100. But these calculations do not include the effects of dam impoundments, which will likely result in a few tens of cm of accumulated SLR by 2100; Ramstorf will publish new estimates soon.

By 2200: 150-350 cm (Delta Commission-Dutch govt 2008)

By 2300: 250-510 cm (German Advisory Council for global change, 2006)

Dr. Rahmstorf doesn't expect a major breakthrough in improvement of models to address ice sheet responses by the next IPCC report, because there is still a lot that is unknown about ice sheet dynamics.

IPCC 2007 report and Rahmstorf's research concludes that there is a 10% chance of major change in ocean circulation system by 2100. However, he said that these analyses have not included the freshwater inputs from Greenland meltwater, so the 10% chance is an underestimate.

Dan Cayan from Scripps gave a presentation concluding that global climate change has quite certainly been affecting California's climate and is quite certain to continue. He noted that recent carbon dioxide emission levels have exceeded model assumptions and predictions, which will have implications for the rate of climate change. He presented on projections for changes to CA's climate, including a graph of predictions for temperature in Sacramento over the next hundred years, which showed a range of 2-6 degrees C increase, and a graph of hourly sea level projections for SF Bay over the next hundred years.

Impacts and Adaptation Studies – Coastal Resources

Peter Bromirski from Scripps presented on sea level and runup projections along CA coast and thanked OPC for funding. He noted that the sea level in CA has been depressed due to a broad scale circulation pattern and that if the circulation patterns change, there could be an increase in sea level in CA (regional difference in sea level vs. global sea level rise). He presented a good graphic on changes in beach profile with a sea wall (*possibly include in adaptation plan for coastal/ocean sector). He said that grain size is important for calculations of storm surge erosion. He noted that in the 1990s, there were

more high wave events that were not in the winter and that this is significant for the success of beach nourishment projects (waste of money when an individual storm removes significant amounts of nourished sands). He presented several graphs on observed and projected sea levels through 2100, extreme winter wave projectsions, SF region run up projection – estimate of erosion potential. He concluded that SLR will have greater impact on lower slope beaches.

Noah Knowles from USGS presented on inundation vulnerability from SLR in SF Bay. He has completed a new composite elevation dataset for the bay area, mostly using photogrammetry (2 m resolution), with some LiDAR data (1 m resolution) and small amount of IFSAR data (5 m resolution). He used the 140 cm projected SLR from Dr. Rahmstorf to generate hourly sea levels at the Golden Gate and then used the TRIM 2D hydrodynamic model to determine inundation throughout SF Bay. As early as 2050, the 1 year peak event nearly equals the present day's 100 year peak event. Dr. Knowles developed a graph of area of land cover types under different SLR scenarios and concluded that developed areas are the land cover type that will have the most inundated area (followed by wetlands and grasslands). He is putting the information into Google Erath to make it accessible to public. He noted that the maps he has developed do not address the degree to which sediment will accrete and whether wetlands will avoid becoming subtidal (he used the term "estuarine roll-over" to describe wetlands shifting inland).

Noah Knowles calculated the amount of matter that would need to accrete in wetlands to keep pace with SLR for 140 cm scenario = ½ billion cubic meters, or 5 million cubic meters/year. He noted that the current sediment input from the Delta was only 1 million cubic meters/year and is declining, so there is a significant gap between the amount of sediment needed for wetlands and the current sediment inputs.

Dr. Knowles next steps will be to include levee height data and examine extreme events to assess overtopping potential and to incorporate bathymetric data and address shifts in tidal zones and shallow water habitat.

Jeffrey Dorman from UC Berkeley gave an excellent presentation summarizing impacts to CA's marine species from climate change. He cited a study of 66 marine organisms with larval dispersal and how all of these species had an increase in their metabolic rate with increased temperature. This increased metabolic rate resulted in more rapid development of the larvae, which settled out of the water column sooner, resulting in shorter dispersal distances. This research has significant implications for connectivity between MPA reserves. He also gave a summary of impacts on krill, ocean acidification, changes in winds and upwelling and trophic mismatch between predator and prey species (changes in timing and abundance).

Linwood Pendleton from UCLA presented on estimating the potential economic impacts of climate change on Southern California beaches. He modeled changes to 51 beaches using the assumption of 1 meter of sea level rise by 2100 and determined that the mean beach width change would be minus ten meters. His results showed that medium width beaches would have the most significant loss in visitation, with people going to nearby very wide beaches instead. He assumed that with travel costs increasing, beaches that are

further away from freeways would have lower visitation. He predicted that there would be serious changes in visitation and expenditures on a local level, which could have significant impacts on local economies. He calculated that the lost expenditures from sea level rise impacts to the beaches would be $12 million/year and the cost of nourishment would be $4 million/year and the lost consumer surplus would be $63 million/year. However, those figures were just for "bathtub inundation". Under a single extreme erosion event, his modeling showed uneven effects on beaches, with some losing up to 140 meters, most losing about 20 meters and some beaches accumulating sand. He recommended more research to predict the uneven impacts across the region. He calculated the cost of nourishment after a single severe erosion event as being $317 million. He estimated that Redondo Beach would lose $20 million/year after a single severe erosion event. He concluded that storms and wave generated erosion would have a much more important impact to beaches and beach economies than the inundation from sea level rise.

Susanne Moser presented on social science research priorities for vulnerability and adaptation. She noted the need to identify factors that facilitate and speed up adaptive learning, to explore the feasibility of adaptation strategies, variance in human and institutional behaviors and response to warnings of risk.

Meg Caldwell from Stanford presented on law and adaptation. She recommended thinking of the following categories for adaptation:

1. mitigation (is also an adaptation policy - reduce all stressors);
2. emergency preparedness
3. realignment (rolling easements, long term planning)
4. hard engineering (coastal armoring, redesign)
5. soft engineering (habitat restoration, beach nourishment)
6. land use regulations (setbacks, zoning reform)

She mentioned the outcomes from a Del Mar lawsuit in which the City was successful in a nuisance suit against a landowner who was impacting sand supply to a beach from shoreline armoring. She presented the following legal considerations related to adaptation:

1. Constitutional & Common Law (public trust, nuisance, prescription (public rights to access), 5th amendment takings
2. Market Incentives (private insurance, government as reinsurer and insurer of last resort (NFIP), transfer of development rights, payment for ecosystem services (compensating landowners for maintaining ecosystem functions on private land), government's role to promote adaptation by market creation)
3. State and Federal Government Framework (property law (nonpossessory interests for protection of beaches, habitats, migration pathways, etc.), easement law (can facilitate establishment of reserve system and migration pathways))

She presented a research agenda to cultivate responsive and accountable institutional structures and arrangements, to provide resources and decision support, to train and educate decision makers and to conduct legal and policy gap analyses.

Michael Hanemann from UC Berkeley presented on the economics of adaptation. He said that most adaptation is local. He focused on the issue of water rights and that the state currently does not monitor or quantify surface water diversions and that there is only

an informal system of appropriative rights for stream flow. He recommended changing the system of water rights to one of equitable distribution, instead of the current system of prior appropriation. He described Australia's response to prolonged drought, in which they switched to a system of providing an amount of streamflow for environmental needs, then assigned percentages of inflow to various groups. (It was a switch from historical rights for a certain volume of streamflow, to an assigned percentage of inflow.) He said that it created a pattern of risk sharing to help address overall changes in streamflow.

Louise Bedsworth from the Public Policy Institute of CA presented on adaptation challenges and noted that reports will be released soon on adaptation for coastal CA (authored by Ellen Hanak and Georgina Moreno) and on ecosystem conservation in CA (authored by Elisa Barbour and Lara Kueppers). She questioned how prepared our institutions were and the need to evaluate practices, laws and regulations that influence the ability to adapt. She described barriers to adaptation, including lack of scientific certainty, lack of funding (restrictions on funding) and resources, lack of authority and lack of political will or incentives.

Cristina Rumbaitis del Rio presented on the Rockefeller Foundation Climate Change Initiative, which is providing $70 million to address climate change resilience for poor and vulnerable people (focusing on Asia & Africa, but also includes U.S. policy & city resilience).