INTERVIEW continued from page 3

from the Bay, and the sediment that flows from creek systems into the Bay, or that collects in our marinas, channels, storm drains, or grates. We need to think about re-using sediment, rather than taking it out and dumping it in different locations. We also need to look at where sediment may be available in the upper part of our watersheds, or behind our dams, and whether it could be released in some way without causing flooding or water quality problems. Emotionally, these sediments would have moved through the back of the marsh. Today, we may want to place dredged material in uplands, and areas to mimic the same function.

Another idea we may want to try is “trickle charging,” placing fine sediments in the shallow management. We’ll need a neutral and then allowing waves to re-suspend that material and carry it on to the marshes. Another idea for increasing local supplies of suspended sediment is to build living shorelines, with oyster reefs and eelgrass beds.

SHOULD WE BE CONCENTRATING RESTORATION EFFORTS IN SOME AREAS MORE THAN OTHERS? Personally, I think we should look at what we can do everywhere in the Bay, because everywhere is a stake, and everywhere is going to have the problem of sea level rise. There will be different solutions for different areas. Sure, we probably have to do the least amount of intervention in an area like the Petaluma River marshes, where there is a good natural sediment supply and an upland transgression zone, but restoration there is not going to help East Palo Alto or Fremont. Integrating wetland restoration with flood risk management in more urban and steep stretches of the Bay is going to be the big challenge but could have very big rewards.

WHEN WILL IT BE TOO LATE TO ADAPT TO SEA LEVEL RISE AROUND THE BAY? My fear is that if we aren’t proactive, and come up with solutions that have multiple and early benefits, as well as long term sea level rise benefits, then we’re going to end up with nothing happening until we’ve had several extreme storms and flooding. At that point we’ll decide we’ve got to do something right away, and it will be a knee-jerk reaction, like a big levee with steep sides, because economic losses are going to overwhelm ecological benefits. We want to avoid that, so the key thing now is to make plans that fit into our existing capital improvement plans. So we’re not building something specific for sea level rise, it’s in inaccessible areas. We also something to do another job, like flood control or wastewater treatment or freshening marshes, which can accommodate sea level rise.

HOW DO WE GET STARTED? The vulnerability analyses being done at the moment are really important. It gives us an understanding of how resilient our systems are, and informs adaptive management. We’ll need the first solution, we’ll have a Plan A that works for one range of elevations, or one range of sediment supply, and then we’ll have to have Plan B, and Plan C, and Plan D as sea level rise accelerates and sediment supplies decrease. We won’t have grade it, break it, and walk away anymore. ARO.

FEBRUARY 2013

OUTSIDE THE BOX - continued from page 3

spending not only to adverse effects like sea-level rise, but also to heat waves, water and energy shortages, and health and economic impacts. An action plan should be complete by March 2013.

The second project focuses more narrowly on sea level rise impacts on coastal areas. Adapting to Rising Tides (ART) is a partnership between BCDC and the National Oceanic and Atmospheric Administration. The ART project kicked off in 2010 with two major goals: to map sea-level rise and storms affect the Bay Area, and what strategies (ranging from collaboration with public and private interests to mitigate changes such as seawalls or relocation) will help us manage this risk? To begin to get a grip on these complex issues, the project opened with a pilot program assessing the vulnerability and adaptive opportunities of the East Bay shore where Emergyville in Pinole. This 23-mile stretch contains significant at-risk infrastructure, including the Oakland Airport, the Port of Oakland, extensive ground

BAY AREA FACILITIES AT RISK FROM 16-55 INCH PROJECTED SEA LEVEL RISE

- 19.186 miles of major roads and highways
- 70-105 miles of railroad track
- 22 wastewater treatment plants
- 720,000 residents of 82,000 acres
- 70-50% of airports
- 57-87% public access sites to shoreline

Source: BCDC

A new Source: BCDC

1. An interview with Will Travis, the facilitator of the East Bay Regional Climate Change Committee (EBRCCC), about the committee’s report on sea level rise, and its implications for the region.

2. A section on the use of climate change adaptation strategies to protect the Bay Area’s coastal areas.

3. A discussion on the role of the Bay Area in addressing climate change, and the need for collaborative efforts.

4. An analysis of the potential impacts of climate change on the Bay Area’s ecosystems and industries.

5. A focus on the importance of planning and adaptation in response to climate change.

FEBRUARY 2013

CALIFORNIA LANDSCAPE CONSERVATION COOPERATIVE

CREATING SCIENCE-BASED TOOLS FOR ON-THE-GROUND CLIMATE CHANGE PLANNING AND ADAPTATION...

It’s been the hottest year on record, and California’s long past questioning the science on climate change and hell bent on developing electric cars, building bullet trains, trading carbon, and designing the habitats of the future, both human and wild. Perhaps it’s because we’ve always inhabited a continental crust primed for sudden shifts of ground. Perhaps it’s that we’ve never had enough water and we’ve always had too many cars. Or maybe it’s that we’re still a frontier state where people go to stretch their legs and imaginations. Whatever it is, we’re not running from the idea that temperatures may rise by 5-10 degrees Fahrenheit by 2100, and sea level by more than five feet. Extreme weather and changes in ocean ecosystems are already with us. By the time a child born today has a midlife crisis, it could be too hot to work outside on a summer day in Sacramento, and thousands of acres of San Francisco Bay wildlife habitats could be on the verge of drowning.

“Climate change is real, it’s now, and it can’t be ignored. It has to be integrated into land and resource management decision-making as soon as possible. If managers stay stuck in the day-to-day, they could really miss the boat as far as being prepared, and conducting actions now that are going to keep us from failure in the future,” says Rebecca Friis of the California Landscape Conservation Cooperative.

In 2010, the Department of the Interior set up California’s Landscape Conservation Cooperative, one of 22 similar collaboratives nationwide. Its purpose is to get good science on how climate change may impact California’s diverse landscapes into the hands of those managing parks, preserves, natural areas and rare habitats on the ground. It’s official boundaries stretch from northern Mexico up to Bodega Bay, as well as into the heart of the Central Valley, and along the spine of the Sierra.

California’s landscapes are already peppered with hundreds of natural landscapes, and an increasing frequency of fires and floods in the Golden State, and the Cal LCC is not trying to reinvent the wheel. It doesn’t fund projects that move dirt, grow organizations, build infrastructure, or revolve around single species or properties. Instead it looks for projects connecting climate concerns across big landscapes encompassing many jurisdictions and ecosystems, projects such as those described in the pages that follow.

Inside, you’ll read about two cutting edge computer modeling projects in the San Francisco Bay Area which seek to predict the future of the region’s tidal marshes – first in the path of rising sea levels. One takes a big landscape view of the region, and the other ground truths predictions of sea level rise impacts on 12 historic marshes (see p. 3 and p. 6). Used together, they tell our local shoreline managers a clearer sense of how to adapt to their rapidly changing environment. On page 8, you’ll read about research elsewhere in California which seeks to map the Sierra in response to changing conditions, grasp with shrinking rangelands across the region, and an increasing frequency.

Continued from page 2
and plan for resilience on the ground. Progress reports, data layers, and on-line planning tools are made available through the Cal LCC-funded research being collected on California’s Climate Commons (see below).

Of course, the Cal LCC has done much more in the past three years than what’s highlighted here. We’ve moved the San Francisco Bay region, it’s worked especially hard to collaborate on, and to support, existing initiatives like the Bay Area Ecosystems Climate Change Consortium and the San Francisco Bay Joint Venture, and helped fund their high priority projects including a climate change update of the 1999 regional restoration bible (aka the Baylands Ecosystem Management Goals). It has organized workshops on how to do vulnerability assessments. And in 2011, it put more than fifty scientists, local agency staffers, and shoreline landowners in the same room for a week for an exercise in structured decision-making around specific resource management planning questions.

These are only a few examples drawn from 25 projects supported by the Cal LCC with over $2.5 million since 2010. Add in partner contributions, and more than $6.5 million has been invested in preparing for California’s hotter, wetter, and more fiery future.

According to Debra Schlaflin, co-ordinator of California LCC, “Ever since the turn of the century, natural resource management has meant looking in the past, or restoring to some past, fairly stable, state. We’re trying to change that fundamental process so we can look to the future, which is more uncertain, and provide assistance with how to make decisions in that new reality.”

California Landscape Conservation Cooperative (www.calincc.org)

The methodology used by the USGS team offers a new scale of sea level rise projection that is highly site-specific; the future of the marsh on the ground, we take elevation readings and map vegetation, and we monitor water levels and collect sediment. And then we put all into our models and talk about what’s going to happen until 2100,” says Flinn, a USGS ecologist with computer modeling skills who teamed with Takekawa on the project.

In particular, the team used recent advances in technology — Real Time Kinematic GPS — to survey marsh elevations to the centimeter level of accuracy. “Many areas at the edge of San Francisco Bay have very shallow gradients, so there’s not a lot of difference between those areas and the level of the water,” says Takekawa.

It took three years of painstaking work involving 7,457 elevation points, 11 transects, 3,303 vegetation plots, and thousands of crossed-eyed hours at the computer, among other things, to develop the methodology. But by combining all the field data and sea level rise scenarios into sophisticated computer models, the team has been able to predict how 12 of the region’s most established salt marshes will respond from pickleweed to cordgrass-dominated marshes, and later into mudflat and subtidal habitats, and when, decade by decade (see chart p. 4).
The study's results can be found on the web and in the USGS 2012 open file Final Report for Sea-Level Rise Response Modeling for San Francisco Bay Estuary Tidal Marshes. According to the results, almost all of the marshes in the North Bay, including China Camp in Marin County, and sites along the Petaluma River, could flood completely by 2081-2090, after the bend in the hockey stick when sea level rise accelerates.

South Bay marshes could do better. “The water level difference has less to do with age and more to do with geography, where they are in the Bay,” explains Thorne. “Marshes in the North Bay didn’t keep up as long as marshes in the South Bay largely because sediment accretion rates are different.” Marshes naturally keep pace with sea level rise by trapping sediment and accumulating organic matter, at least until the water level starts rising faster than they can build up. This set of models is particularly detailed because of localized accretion data collected in the San Pablo Bay Wildlife Refuge by the USGS team, and backed up by other work in other marshes led by University of San Francisco wetland ecologist John Callaway.

According to the team’s future projections, the South Bay’s Laumeister Marsh may survive longest, while Marin County’s Corte Madera marsh may be the first to go under. Laumeister turns out to be in a good spot to collect sediment, whereas Corte Madera had further to go to keep up, because it has the lowest starting elevation of the 12.

“Knowing the elevations helps us predict when changes in water level will become a problem for species trying to survive in these fringe habitats,” says Takekawa. “They live on the edge of the Bay and the edge of existence, in the zone where water meets land and where habitats change quite a bit. So when a climate change occurs that, from an evolutionary perspective is relatively rapid, it’s likely wildlife populations will change too. They can’t adapt that fast.”

The good news is that all 12 marshes were able to keep pace for the next four or five decades. “It’s a real opportunity to look at this as a positive period, when you can boost your resources, and try to keep them very healthy. That way when the rapid sea level rise comes, your adaptation is from a base of strength, rather than from fragmented, weak populations across a landscape that have no chance of surviving,” says Takekawa.

This window of opportunity has shoreline managers already looking at the ups and downs of the North and South Bay results to see if they may present for stronger adaptive management. While the North Bay has lower sediment accumulation rates, for example, it has more open space behind marshes where wetlands could migrate inland and stay viable – so opening up avenues for tidal influence further inland may be important. And while South Bay marshes may build up more easily, and have a bigger sediment supply, most border big levees with houses and urban areas on the other side – leaving them little room to migrate inland. So managers are considering innovative types of setback leves and ways to help marshes grow in place.

Matt Ferner, who coordinates research for the National Estuarine Research Reserves at Marin’s China Camp and So- laño County’s Bodega Bay to stick around, says there are innovative initiatives that could help address climate change but haven’t had the money or the computer modeling expertise to do much. “It was a breath of fresh air to have the USGS scientists come in and do the RTK surveys, think carefully about the habitats, monitor the water level, and develop this really nice report that has explicit predictions we can turn to,” he says.

Ferner compared the predictions for China Camp with detailed maps of the reserve, and with projections from two other sea level rise modeling efforts – one done by PRBO conservation science (see p. 6) and one done by U.C. Berkeley doctoral student Lisa Schile. “I was re- lieved that these models agreed on where the most sensitive and most dynamic areas are at China Camp,” he says. “Using these tools, I looked for the places where we have the most diverse plant communities, and where change was predicted to occur quickly because of steeper elevation gradients or because of dynamic features in the vegetation. The compari- son enabled me to lay out our transects across the marsh for long-term monitoring, so we can see if actual changes in the marsh match up with predicted changes.”

Ferner says the model predictions also helped him move a key project to the front burner, namely the restoration of two brackish marshes cut off from the bayfront marsh by North San Pedro Road. “If there’s any chance of China Camp surviving accelerated sea level rise, it’s going to be by transgressing up slope, whereas Corte Madera may go to keep up, because it has the lowest starting elevation of the 12.”

“Models are a great tool, but when it comes down to doing stuff on the ground, it may be just a matter of just let’s push this up a little higher with the dozer, or, as we cut away this levee, let’s smooth out the low point and put your high tide refugia underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” he says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

“Modeling is just one of the tools,” says Block. “We’re getting assistance in areas that we hadn’t added a few more scoopfuls of dirt,” she says.

“Models are a great tool, but when it comes down to doing stuff on the ground, it may be just a matter of just let’s push this up a little higher with the dozer, or, as we cut away this levee, let’s smooth out the low point and put your high tide refugia underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.

Giselle Block, a biologist who works for the U.S. Fish & Wildlife Service’s Inventory and Monitoring Program, says response from refuge managers like Bruder is typical of what she’s heard from other refuge managers along the Pacific coast. “It’s a slightly different direction in case of a storm surge. We want to build in a cer- tain amount of resiliency, because errors in those models could be just a matter of centimeters, and 2-3 centimeters could put your high tide refuge underwater all the time. Then you’d wonder why, when you had the dozer and excavators out, you hadn’t added a few more scoopfuls of dirt,” she says.
The future of the Estuary’s tidal marshes—and tidal marsh birds—will depend a lot on mud. If sea level rises and marshes do not keep pace by collecting sediment and building up (“accreting”), habitat will likely be inundated for the endangered California clapper rail and threatened California black rail, as well as for several California species of concern. three tidal marsh song sparrow subspecies and the San Francisco common yellowthroat. Can’t birds just fly away and nest and forage elsewhere? Not tidal marsh obligates, says PRBO’s Julian Wood. “These birds live their entire lives—and have evolved to adapt to—this marsh environment with high salinities. If this habitat is gone, these birds will be gone as well.”

“We found that tidal marsh sustainability over 100 years was very sensitive to the sediment scenario used but not to organic accumulation,” says Veloz. “Low sediment, we project a 50-100 percent decline in the Estuary’s song sparrow populations. This is an important warning to managers and getting their feedback, as well as making presentations at meetings and conferences. “Eventually what we’d like to see is as people use the tool, to put their info up on the web site. When new people come, they can see how others have used it,” says Veloz.

The next step is for PRBO to overlay its bird demographic model onto the sea level rise scenarios so that managers can see both changes to the marsh and potential changes to bird populations at the same time.

The latter two species frequently nest in the bright yellow gum plant that lines tidal marsh channels. Gumplant grows taller than other marsh plants, and the birds can conceal their nests in leaves and branches. But the nests will be more conspicuous and the birds will need to build nests higher in the vegetation, Veloz says. “The worst case scenario [high sea level rise, low input of marsh building sediment], shows declines for all of those species, even the marsh wren,” says Veloz. “Most of them trend down to 100 percent loss. Clapper rail, interestingly, does the best, but they’re starting from such a low number.”
CALIFORNIA’S WILDLIFE REACTS TO CHANGING CLIMATE

BY SUSAN SULEIMAN

Nearly a century ago, Joseph Grinnell, the first director of the Museum of Vertebrate Zoology at the University of California, and a man who spent 38 years on a definitive list of the state’s birds, was aware that his painstaking notes might be all that remained of many of the species he chronicled.

“The India ink and paper of permanence will mean that our notes will be accessible 200 years from now,” he wrote to the museum’s founding president, Annie Montague Alexander. Grinnell added, by way of explanation: “We are in the newest part of the new world where the population will be immense in fifty years at most.”

As prescient as Grinnell was when he assembled his early ecological map of California, he didn’t foresee climate change. Climate change is already affecting wildlife from Lassen Peak to Mount Whitney, the same places Grinnell and his colleagues tracked California species. Rather than engaging in the basic science that Grinnell pioneered, scientists today are using cutting-edge technology to fashion plausible scenarios that can help land managers include climate change in their decision-making. It’s a bit like preparing for war. But instead of a map with pins indicating troop movements, they are putting together a new biological map, tracking the movements of birds and mammals as they adapt to rising temperatures and see-saving rainfall. Since 2009, key pieces of this strategic map have been falling into place with the help of collaborative initiatives and support from California’s Landscape Conservation Collaborative (Cal LCC).

As Hurricane Sandy revealed, the picture only grew more complicated. As prescient as Grinnell was when he assembled his early ecological map of California, he didn’t foresee climate change. Climate change is already affecting wildlife from Lassen Peak to Mount Whitney, the same places Grinnell and his team saw them. Grinnell’s exhaustive research. Grinnell felt they had to move quickly to update their reserve! That could be true, for a period of time. But it will be a species colonizing the warming end of their range, or for an endangered

American West has been affected more dramatically than most places. From 2002 to 2007, the average temperature increase in the western U.S. was 70 percent greater than the world average. Scientists studying California are observing an increase in rain versus snow, and earlier budding of plants. (More rain might sound good to perpetually water-starved California, but without storage, the most tangible effects are likely to be flooding and mudslides.) Fires also are becoming more frequent and severe.

In other words, climate change isn’t a distant possibility. It’s here.

“One way to think about it is this: when people were debating about whether climate change was happening, a lot of the plants and animals had figured it out,” says Steve Beissinger, a professor of Conservation Biology at UC Berkeley.

Ten years ago, Beissinger and a team of scientists undertook an historic task: re-surveying the landscape where Grinnell and his colleagues tracked Californian birds and mammals. Between 2002 and 2007, they used Grinnell’s colorfully annotated maps as they trooped around Yosemite, Lassen and Kings Canyon National Parks, and Southern California’s White Mountains.

In Yosemite, the researchers noted that about half of the small mammal species remained in place. Others, such as the pinyon mouse, had migrated uphill, seeking cooler temperatures. This was entirely surprising: minimum temperatures in the central Sierra had warmed by 5-6 degrees Fahrenheit since Grinnell’s surveys. But it wasn’t always easy to tell exactly how many species reacted differently. As they resurveyed other parts of the state, the picture only grew more complicated.

Sometimes two species in the same genus might have different patterns,” Beissinger says. “One might be moving uphill and another not at all. When we started looking at birds, we saw some species moving up, as we expected with climate warming, but others were moving down. And the same species was doing one thing in the Sierra and another in Lassen.”

“We began to get a sense of how climate change is different in different places and how it is different for different species,” says Beissinger.

The two main variables are temperature and precipitation, but California’s mountain ranges seemed to be experiencing many permutations of those two, according to Beissinger. While Yosemite was warming, Lassen was growing colder and rainier. The southern Sierra were warming, and experiencing the same amount of rain or getting drier. Plants and animals were all over the map, too, with some reacting to temperature, while others responded to precipitation.

With montane species, there’s a push and pull; warmer temperatures push species upslope to stay in the same climate, since temperature decreases with altitude. But increased rain pulls them downslope, because rainfall generally increases with elevation,” he says.

Climate change gets even more complicated when you consider the conundrums faced by land managers. “That’s where the new map being constructed by scientists becomes not just an interesting set of observations but also something of practical use.

“With a changing climate, you’re likely to have new species coming in,” Beissinger says. “You might think, ‘Wow, this could increase the biodiversity in my reserve!’ That could be true, for a period of time. But it will be a species colonizing the warming end of their geographic range. For species at the cool edge of their range, or for an endangered

species, you could have a whole lot of problems. In addition, exotic species and new diseases from locations with warmer climates are showing up.”

One thing became clear after Beissinger finished his study: land managers needed to plan, and do it quickly. Like the rest of the country, many of California’s parks, forests, and wildlife refuges had been established back in Grinnell’s day, when scientists didn’t understand landscape-level conservation. Scenic vistas, so-called “rocks and ice” were protected, but lowland habitat needed for migrating species was often left open to development. As climate change forced species from their customary niches, scientists felt they had to move quickly to update Californian biological maps. It wouldn’t be possible to save everything, but prioritizing areas essential to wildlife could help buffer the impacts of climate change.

In California, researchers had the advantage of the state’s tradition of valuing its landscape, which included a wealth of scientific research, and of land managers accustomed to collaborative decision-making. For example, post-doctoral researcher Toni Lyn Morelli would never have known that the Belding’s ground squirrel was disappearing from the Sierra without access to Grinnell’s exhaustive research. Grinnell had studied this common squirrel, also called the sage rat, pot gut or pcket pin, in 1918. With funding from the National Science Foundation and later the Cal LCC, Morelli, under the direction of principal researchers Craig Moritz and Steve Beissinger, decided to study the squirrel because small mammals can be bellwethers of climate change, reacting to both temperature and precipitation.

“We went back to every site I could find,” Morelli says. “I brought along female undergraduates on backpacking trips through Yosemite. Some of them had never been hiking before, and it was a great experience for them. And then our data surprised everyone.”

When the results came, Morelli’s research showed that while heads of state were arguing in Kyoto, Copenhagen, and Durban, Belding’s ground squirrels had disappeared from 42 percent of the sites where Grinnell and his team saw them.

Morelli and another post-doctoral researcher, Sean Maher, drilled down to causes and solutions. The Belding’s ground squirrels live in meadows, where cooler air pools, providing a buffer from climate change. But these areas are continued on page 11

Belding’s ground squirrel, (Otospermophilus beldingi), species distribution model results projecting (a) current distribution from historical presences and absences, (b) future distribution from less severe climate change scenario and (c) future distribution from more severe future scenario.

Source: Morelli et al. 2012 Proceedings of the Royal Society B.
While Morelli and others update and collect information about specific species in specific places, others are working together to inform the larger map of the region. The Cal LCDD provided the support for Jason Kreitler, a research geographer with the U.S. Geological Survey (USGS), to develop an overall map that will help land managers incorporate climate change scenarios into management decisions. "People are doing this kind of climate science in different parts of the country, but in the Bay Area perspective has been used to working collaboratively, and tackling issues without waiting for the federal government. So the response of managers has been 'Great! Tell me what I can do.' With the Cal LCDD involved, there's an incentive for interaction with different agencies, state land managers, the forest service, everyone," Kreitler says.

"Everyone" includes people who farm or run cattle ranches. Another Cal LCDD-funded project is sketching out possible futures for California's shrinking rangelands. Sixteen million of the state's more than one billion acres are grazed, and much of this land provides habitat for wildlife as well as domestic animals. Kristin Byrd of the USGS, working with a multidisciplinary team looking at climate and development patterns in the Central Valley and its surroundings, Byrd says that the most likely scenario is that higher temperatures will, in the long term, reduce water availability for pasture and wildlife. The researchers are identifying where water and wildlife "hotspots" and assessing their vulnerability, information that can be used not only by wildlife agencies but also for land-use planning.

In a panoramic view, how does this emerging map of 21st century California look? "Landscapes are really lumpy out there, in terms of what will happen to them, climate-wise," says Steve Bessinger, "some species will adapt. Others will move, which increases the importance of connectivity. And others may disappear if we don't find ways to sustain them. What did that great social critic and songwriter Tom Lehrer say? 'Be prepared. It's the Boy Scout marching song.'"

The project used two climate models, one predicting drier and warmer conditions, the other wetter and warmer. Along with species distribution and urban growth models. Results: "Suitable habitat is projected to decline in most cases, but frequent fire is a much more serious threat than loss of habitat with climate change," Regan plans to include the threatened California grackle (Quiscalus quiscula), a coastal sage-scrub bird, and the big-eared wood rat (Neotoma macrotis) in the next phase of her study.

Her US Fish and Wildlife Service collaborators "want a scientifically defensible method for investigating the potential of different types of management action under the threats of climate change, urban growth, and altered fire regimes," she says. "They're interested in how the science can inform managers.

Cohen was one of 12 speakers who acquainted the 130 attendees at the Oakland workshop with the climate changes projected for the Bay Area, and what we might do about them. First, the USGS Tom Suchak gave an overview of west coast trends in precipitation, temperature, wave surges, storm frequencies and sea level rise. USGS projects a 3-6 degree centigrade rise in temperature for Northern California, and 46-165 cm (16-65 inch) rise in sea level by 2100. "Wave surges are going to increase in magnitude and frequency. The research many 100-year storms are we going to start seeing every year?" he asked. Part of being prepared is to do a vulnerability assessment, and the next step was, The Nature Conservation's Kirk Klausmeyer, explained how to do one. If you can figure out where on your property vulnerability is low and where it's high, you can take informed actions to minimize threats and enhance resilience, he said.

In the next section of the workshop, land managers described what steps they had taken to make their restoration or acquisition or development projects. "Climate Smart – a new term adopted from the National Wildlife Federation by workshop organizers. As one speaker commented, 'We called it 'resilience' a couple weeks ago.'"

First, the National Park Service's Carolyn Holmes described restoration work at the mouth of Redwood Creek at Muir Beach, on Marin County's ocean coast. The park report is realigning the creek channel to follow its more natural course and to fully connect the creek with its floodplain, rebuilding a pedestrian bridge over the new floodplain, and expanding a tidal lagoon. In summer 2013, the visitor parking lot that has dammed the system for decades will also be relocated. "Visitor access is still important, but needed to be accommodated without compromising ecosystem function," she said. "The hallmark of the project is that it allows natural floodplain processes and creek migration, and it's no surprise that the benefits of opening up the flood plain will increase with sea level rise. We removed obstacles so the landscape can adapt as it may."

Next, The Nature Conservation's Sarah Gennet described their assessment strategy they conducted for 654 miles of habitat. The research uses spatial analysis to determine which habitat would adapt to climate change. Though the assessment suggested this landscape might be relatively climate resilient, connectivity of wildlife habitats emerged as a real concern. "The mountain could become an island, it's very threatened by development spreading south from Silicon Valley. If you cut off that corridor, the Conservancy took a broader, more regional look at habitat connectivity and ended up identifying one unassuming, degree or two of habitat in the Pajaro Creek watershed "as a small but mighty piece of the connectivity puzzle, she said. "It really helped us to convince our funders that this 167 acres of farmland was a linchpin property, and that acquiring and preserving it should be the highest conservation priority in the Bay Area," she said. She described plans for restoring some riparian habitat on the linchpin property, and returning other areas to farming or grazing uses. "Increasing the pace and scale of protection and restoration in the face of climate change is important, but stewardship is incredibly expensive and forever. We have to engage private landowners, including the farming community, in adaptation," she said.

Next, the Sonoma Land Trust's Julian Meisler identified three climate change challenges for his 2300-acre shoreline restoration site at Sears Point: designing a marsh that wouldn't go under the sea level rise; providing refuge for endangered wildlife from extreme events (such as a combination king tide and storm); and anticipating what level of protection was necessary for the adjacent railroad and highway infrastructure. "Highway 37 is completely in harm's way, it sits at or below sea level, and we need to be careful not to don't worsen the condition," he said. To address some of these challenges, the project includes a big levee completely surrounded by seawalls, designed to put setbacks and rock outcrops in place so it can be used later to raise the levee as needed. In closing, Meisler said that "the role of adaptive restoration actions work under multiple climate change scenarios, and that an even bigger challenge may the strings and tiles attached to many restoration grants."
The next speaker, John Parodi who manages PRBO’s STRAW program, called climate change in restoration "a game changer." Parodi described a recent experiment in which he modified the planting palette for an estuary in Santa Cruz County. "Parodi described a recent climate smart restoration side-by-side, parkland, you won't be able to move the game changer," he said. She points out that most water planning is based on past hydrologic records that can no longer be counted on to indicate the future. "It's a big change in thinking for many agencies, not just our agency. Having these examples is very useful!"

Another participant, a San Mateo County planner, felt the case studies could come in handy as a reference when they review permits applications for park open space projects. "It's difficult for the public and politicians to understand things like vulnerability and adaptation, so hearing about specific projects like moving the Muir Beach parking lot to enhance natural drainage, and how the planners got the public on board, was intriguing," said San Mateo’s Matt Sedward.

In the end, Cohen reiterated some of the core principles of the Bay Estuary Collaborative (BECBC) in promoting. "We have to have a future focus, and imagine beyond the science that's there today. Going forward, we're going to adapt in more uncertain environments because our environment is changing at an accelerated speed. So don't wait for your boss to tell you, or your government to tell you, what to do. The time to test and experiment is now!"

View looking east toward Mt. Hamilton, with development encroaching across the San Clara Valley floor. Just south of the farms and ranches of the Upper Pajaro Valley, where conservation and restoration could not only protect farming but enable animals to move between big blocks of one habitat in the mountains, and adapt to change climate. Photo: William K Matthias and presented on-line on the California Climate Commons, explained the final speaker, Deanne DePuyt.

After the workshop, several participants commented on its usefulness. Erin Chappell, from the state's Department of Water Resources, whose job is to bring one of the largest water agencies in world, as well as numerous local water agencies, up to speed on climate science, said: "Most people can understand the climate change concept, but when it comes time to design your water supply or flood control or restoration project, it's not so clear what it should look like. These climate smart principles interest me because they provide a link from theory to practice, and the case studies make the concepts more real," she says. She points out that most water planning is based on past hydrologic records that can no longer be counted on to indicate the future. "It's a big change in thinking for many agencies, not just our agency. Having these examples is very useful!"

On his phone, Matern pulled up a recent photo of the spot where he was standing. It showed the water nearly at the top of the levees during a moderate storm — the sort that happens every five years or so. If all that rain hadn’t soaked into the soil and more quickly run off, he said, the water would have been six feet above the levee. With their backyards running right up to the north bank levee and their foundations below sea level, those homes are high and dry and they’re not going to flood. So are homes upstream in Palo Alto, where 1,700 homes flooded in 1998 when this slender creek could not carry rainwater out to the Bay fast enough to prevent it from overflowing banks.

On his phone, Matern pulled up a recent photo of the spot where he was standing. It showed the water nearly at the top of the levees during a moderate storm — the sort that happens every five years or so. If all that rain hadn’t soaked into the soil and more quickly run off, he said, the water would have been six feet above the levee. With their backyards running right up to the north bank levee and their foundations below sea level, those homes are high and dry and they’re not going to flood. So are homes upstream in Palo Alto, where 1,700 homes flooded in 1998 when this slender creek could not carry rainwater out to the Bay fast enough to prevent it from overflowing banks.

On his phone, Matern pulled up a recent photo of the spot where he was standing. It showed the water nearly at the top of the levees during a moderate storm — the sort that happens every five years or so. If all that rain hadn’t soaked into the soil and more quickly run off, he said, the water would have been six feet above the levee. With their backyards running right up to the north bank levee and their foundations below sea level, those homes are high and dry and they’re not going to flood. So are homes upstream in Palo Alto, where 1,700 homes flooded in 1998 when this slender creek could not carry rainwater out to the Bay fast enough to prevent it from overflowing banks.