CALIFORNIA LANDSCAPE CONSERVATION COOPERATIVE

PLACING SCIENCE-BASED TOOLS IN THE HANDS OF LAND AND RESOURCE MANAGERS PLANNING FOR CLIMATE CHANGE

California is counting every drop of water as it falls from the sky this spring. Scientists, meanwhile, are looking back over millennia for signs of previous droughts, and modeling conditions in the ocean and atmosphere to see how they might change conditions on the ground over the next 100 years. The timeline for impacts of climate change and sea level rise on Pacific coast wildlife refuges, Sierra habitats, state parklands, and federal forests gives us a few decades of wiggle room, but the time is now, not later, to make adjustments so species and landscapes can adapt, says Debra Schlafmann, Coordinator of the California Landscape Conservation Cooperative: "It's hard to respond to extreme events on a moment's notice– no land or wildlife manager can act that fast. But in the context of California's environment-friendly public and spirit of innovation, we've been able to give a lot of land managers a leg up on how to address this global challenge locally," says Schlafmann.

In 2010, the Department of Interior set up California's LCC as one of 22 similar collaborative efforts nationwide. A main focus is to drive research on climate change impacts to California's diverse landscapes and translate that research into implementation of climate adaptation strategies in managed natural areas and human dominated ecosystems on the ground. The Cal LCC'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. But after four years work, some of the collaborative' s 27 projects have outgrown these bounds.

"The whole Pacific has the same issues with sea level rise. We're already talking to our counterparts in China about the possibility of comparing similarities and differences at coastal sites on the other side of the ocean," says John Takekawa, a biologist with the US Geological Survey's Western Ecological Research Center. Work by Takekawa and co-investigator Karen Thorne is part of a very multi-partner research project supported by the Cal LCC that meshes field data on San Francisco Bay marsh elevations, vegetation, and wildlife with localized climate models. The result is a USGS methodology that offers a consistent way to evaluate risk from sea level rise and plan a management response. After proving itself in San Francisco Bay, the project expanded to 18 coastal sites between Mexico and Canada with the help of multiple LCCs and USGS Climate Science Centers.

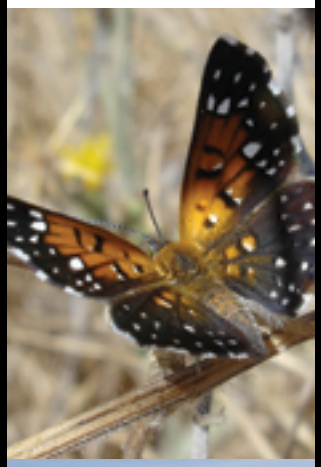
This year, Takekawa is taking the team's scientists and methodology on the road. "One really important thing that both the California and the North Pacific LCC have done is to support outreach with our datasets – what I call the 'roadshow.' So instead of refuge managers having to get travel permission and funding to come to a conference center in a big city to hear about our work, we're taking the science to them. This gives them a chance to really talk with us about individual sites, and local scale issues, and how our datasets can support their work," says Takekawa. The roadshow will visit four sites on the California coast in fall 2014.

In another boundary-breaking move, the Cal LCC leant support to its first entirely ocean-oriented project this winter. The project will ultimately produce climate-smart adaptation strategies for 966 square nautical miles of coast and ocean in the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries, where upwelling and other important processes for the marine food web occur.

The following pages offer snapshots of how seven other Cal LCC projects have been laying the foundations for lasting cooperative conservation partnerships. The Cal LCC has been striving to ensure that it's projects complete research and make it accessible to resource managers – through publications, maps, the Climate Commons web site, workshops, webinars, and more. The Cal LCC also completed a five-year strategic plan and science management framework in 2013.

"I'm really impressed with the energy of those working on the Cal LCC. As in many other areas, California leads the country," says Steve Jackson, director of the Southwest Climate Center.

CA LCC



SOUTHERN CALIFORNIA

REGIME CHANGE FOR SENSITIVE PLANTS

BY JOE EATON

Wart-stem ceanothus courtesy Helen Regan.

Natural communities in San Diego County face a triple threat: climate change, urbanization, and a change in the frequency and severity of wildfires. With support from the Cal LCC, UC Riverside biologist Helen Regan is using computer modeling to simulate the effects of these forces on two sensitive plant species, the wart-stem ceanothus (*Ceanothus verrucosus)* and the Tecate cypress (*Hesperocyparis forbesii)*. Both plants have limited distributions. Although they need fire to reproduce, the fire regime in which they evolved has been altered by human activity. "Under frequent fires the ceanothus can be extirpated," Regan explains. "It needs a fire-free period for the seed bank to accrue. If fires are too close together, there's not enough time for plants to grow and produce sufficient seedlings."

In a case study submitted to the journal of *Conservation Biology,* Regan and her colleagues analyze the effects of the three threats on *C. verrucosus* and how three management options — reserve design, fire suppression, and translocation of the plants — can counter them. "The altered fire regime is by far the most serious threat to these plants," she says. "But fire is a complicated issue, social and political as well as ecological." Climate change will also reduce suitable habitat. "The current reserves weren't designed with climate change in mind, but they do provide a buffer against negative effects of climate change on habitat," Regan adds. "Since they're already in place, that provides a more certain management outcome than relocation."

That's what resource managers need to hear, says US Fish & Wildlife Service biologist Clark Winchell, a co-author of the case study. "One of the stumbling blocks in decision-making is uncertainty," he explains. "Helen is able to give us a model with formal constraints and assumptions and outcomes. She's able to say: 'This is what the future may hold; how do you want to make the management decisions?'"

Translocation of native species to potentially more sustainable habitats, says Winchell, is a contentious issue even among conservationists: "But with what she's laid out, we can begin to have a structured dialogue."

PARTNERS: Arizona State University, Conservation Biology Institute, University of California Riverside, US Fish and Wildlife Service, and Cal LCC.

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CAL LCC BY THE NUMBERS

8 ECOREGIONS supported in climate change planning — Sierra Nevada, Central Valley, Bay Delta, North Coast, Central Coast, South Coast, Baja California and adjacent marine area.

27 PROJECTS since 2010 (see websites). Cal LCC projects + partner support from over 40 federal, state and local agencies, universities and non-governmental organizations since 2010 = $8.8 million.

1000 HITS per month on the Climate Commons website, which now has 227 registered users from universities, conservation related NGOs, and federal and state agencies.

326 DOCUMENTS, 10 presentations and 5 learning exercises from workshops posted on Climate Commons website, as a resource for broader audience.

170 SCIENTISTS and resource managers met in 1 workshop to discuss how to achieve shared conservation goals in the Southern Sierra Nevada, given so much uncertainty and such rapidly changing conditions.

Two vulnerable Sierra birds: white tailed ptarmigan & great grey owl (see p. 8). Photos: Mandy Holmgren (left) and Kristen Strohm (right).

750 SUBSCRIBERS to the weekly CA LCC Newsletter, spreading the word about partner events, updating readers on progress, highlighting new data, funding opportunities, and sharing the latest news on climate change and other stressors.

300 DATA DOWNLOADS from the Climate Commons since 2010, especially of the California Basin Characterization Model developed by the USGS, an important dataset for evaluating potential climate and hydrological futures for California's watersheds.

17 WEBINARS, 8 workshops, and 31 event presentations on how to model species distribution, set conservation priorities, and integrate climate change into conservation management held in 2013, attended by hundreds of natural resource managers and scientists from dozens of agencies and organizations.

MORE INFO?

Cal LCC

www.californialcc.org

Climate Commons

www.climate.calcommons.org

CENTRAL VALLEY

WANING WATER FOR WATERBIRDS

BY ROBIN MEADOWS

With less water to go around as California's climate changes, will there still be enough for the 10-12 million waterbirds that winter in the Central Valley each year? With Cal LCC support, Joe Fleskes of the US Geological Survey (USGS) led a team that is helping conservationists make long-term plans for waterbirds that — essentially for the first time — account for climate change.

The Central Valley is one of the biggest draws for waterbirds in North America, attracting 25 waterfowl species, 33 shorebird species, and more than 20 other waterbird species. But only 5% of the state's original wetlands remain. "Water in the Central Valley is pretty much a plumbed system today," says Fleskes, a biologist at the USGS Western Ecological Research Center. "It's mostly reservoirs and delivery systems." This water also has competing and often conflicting demands from urbanization to agriculture to other species — such as salmon — making holistic management the only way to know if there will be enough for waterbirds as the climate changes.

To help find out, Fleskes' team adapted a model used for managing water worldwide to account for waterbird habitats. In the Central Valley, this means wetlands and flooded rice fields. The Valley's 200,000 acres of wetlands are currently augmented by an additional 260,000 acres of flooded rice. Besides doubling waterbird habitat, flooded rice fields boost their food tremendously during winter. The team used their new model to look at climate-driven changes in water supplies, competing demands such as urbanization, and management changes such as idling rice fields to bump up streamflow for salmon or to transfer more water to other parts of the state.

The Central Valley is divided into nine planning basins by the Central Valley Joint Venture, a consortium of 21 agencies, nonprofits and other groups with the common goal of restoring and protecting waterbird habitat. The basins stretch from Butte at the north to Tulare at the south, and Fleskes' team began at the top. "Butte basin was a good one to start with," he says. "It has lots of National Wildlife Refuges and lots of rice." Assuming moderate climate change and urbanization, the model showed that idling rice fields in the Butte basin would leave waterbirds there in a lurch. "Ducks would run out of food in January," Fleskes says. "We can restore habitat but it won't do much good if there's not enough water to support food" (see chart).

Pintails and white-fronted geese in a Central Valley rice field. Photo by Bob Mclandress.

Now the team is expanding their work south into the San Joaquin Valley basins, which could be more impacted by climate change because temperatures there are projected to be higher. "We wouldn't be doing any of this without the LCC," Fleskes says. "Agencies often have to look at the day-to-day, not how to manage for changes."

Joint Venture Science Coordinator Greg Yarris agrees. "We used to take a cursory look at climate change because our planning window was five to 10 years," he says. "Now we realize we need to plan for the longer term or our restoration efforts will be for naught." The Joint Venture is now using the new model to integrate climate change projections into their conservation implementation plan. "It's hard to plan for a crisis if you don't know the impacts of that crisis," Yarris says.

Fleskes' team is also working with another multi-disciplinary group that proposes to develop a comprehensive water-decision tool for California called Farms, Faucets, Fuels, Fish and Fowl, or the "Five Fs". Says Fleskes, "Without the LCC, we would not have been able to join this effort to provide a holistic water supply management approach for California."

PARTNERS: California Department of Fish and Wildlife, Central Valley Joint Venture, Ducks Unlimited, Delta Waterfowl, Point Blue Conservation Science, Stockholm Environment Institute, UC Davis, US Fish and Wildlife Service, and Cal LCC.

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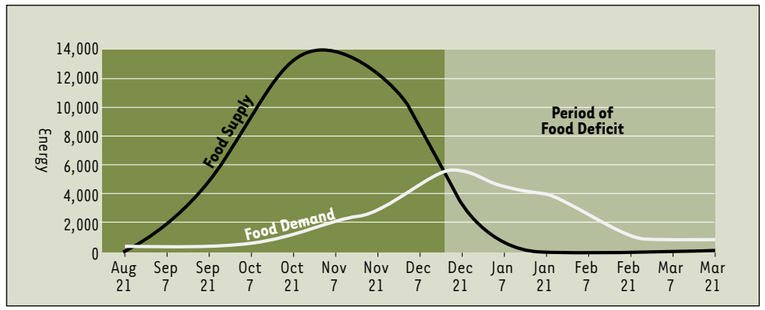

Moderately severe climate change (GDFL-A2) + urbanization + idling of rice fields in Butte Basin for water transfers = waterfowl food deficit. Source: Preliminary Data, J.Fleskes, USGS

CALIFORNIA

TESTING THE LIMITS OF NATIVE FISH

BY JACOBA CHARLES

California boasts a rich suite of native fish—most of which are found in this state alone. Yet this trove of diversity is seriously threatened by climate change. Over 80 percent of the state's 129 native fishes were found to be "highly vulnerable" to population decline or extinction over the next century, according to research done at U.C. Davis and funded in part by the Cal LCC.

"This indicates that we'll see a major shift in the aquatic ecosystems in California," says Dr. Peter Moyle, who headed up the study that was published in the journal *PLoS One* last year.

The research also found that very few non-native species are likely to suffer from predicted changes in climate. This means that natives such as the sleek Sacramento splittail, Red Hills roach, and Pacific lamprey will become less common while invasive species like largemouth bass will continue to expand. "We'll be moving from a very unique and complex group of species to the kind of species that are found in altered habitats around the world," Moyle said.

Native fish are already under pressure from competition with alien species as well as from habitat loss due to dams, agriculture, and other challenges. A changing climate is expected to exacerbate those challenges. The Intergovernmental Panel on Climate Change predicts up to a 6-degree centigrade increase in average air temperature, which will in turn lead to the loss of 57 to 99 percent of the cool water habitat on which most native species depend, said Rebecca Quiñones, a co-author of the *PLoS One* study.

Greater climatic variability will make droughts longer and hotter, while storms in wet years get more numerous and more severe. Streams may dry up that didn't in the past, and those that don't dry will have shallower and warmer water. Yet major winter storms may scour the streambeds, removing the habitat complexity upon which fish such as salmon depend.

Sea level rise is also a threat to some estuarine-dependent species. Because most of the Bay Area's existing estuaries are hemmed in by development, there is no room for them to migrate inland. If this happens the muddy floodplains and reedy marshes will be drowned, leaving only deep water and dry uplands with little of the vibrant in-between habitat.

Additionally, there is a grab-bag of lesser and indirect impacts that are also poised to affect native fish. Everything that happens within a watershed—whether it is a wildfire burning through, different crops being planted, or a redwood forest gradually being replaced by chaparral—all of these changes can filter back into interconnected aquatic and riparian ecosystems. This means that whatever changes affect a fish's microclimate are what that fish will have to live with—or not.

(HUCs are hydrologic units relevant to mapping specific watersheds). Trout photo courtesy UC Davis.

Moyle and his team synthesized details including life history traits, population trends, current status, and threats for all fishes in the state. The result has been incorporated in a new database (aptly called PISCES) that systematically combines 20 different metrics to come up with a score regarding vulnerability to climate change.

But PISCES can be used for much more than that—and already is. Because it shows where each species is in the state, and is linked to each fish's status on both a statewide and a regional basis, it's a powerful tool for scientists, land managers, and conservationists.

Already, PISCES is being used by the US Forest Service to develop range maps of specific fish species of concern. The California Department of Fish and Wildlife also plans to incorporate it as their primary repository for fish information from now on; The Nature Conservancy is using it for conservation planning; and the UC Davis Center for Watershed Science is also using it for conservation purposes, by identifying areas with high biodiversity at different landscape scales such as state, bioregion, and large watershed.

For the layperson, one of the most exciting uses might be a mobile app that is about to be launched by UC Cooperative Extension. Once this is up and running, anyone with a Smartphone can touch a button and get a page for the watershed they are in, and pages for the native and non-native species found there.

"People don't realize what might be right in their back yard," says Dr. Lisa Thompson, who is designing the app. With PISCES, we are getting down to a resolution where people will see their local creek name and feel some connection with that."

PARTNERS: CalTrout, California Energy Commission, National Fish & Wildlife Foundation, UC Davis Center for Watershed Sciences, US Forest Service Region 5, and Cal LCC.

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COAST

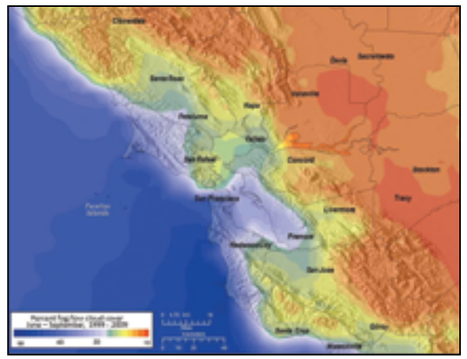
FOG'S FINGERPRINT ON COASTAL ECOLOGY

BY JACOBA CHARLES

Fog is an iconic part of the landscape in Coastal California, from San Francisco Bay—where islands of hills rise above a sea of mist—to the majestic redwoods of Humboldt. Blankets of fogs keep salmon cool in their streams, and both grasslands and chaparral make the most of this amorphous source of water during long rainless seasons.

Despite being vital to ecosystems up and down the coast, there has been little comprehensive research on the science of fog, says Alicia Torregrosa of the USGS. Until recently, that is. For the last three years, Torregrosa has been leading a team of researchers who are working to change that. The Pacific Coastal Fog Project is an unprecedented effort to provide information on fog formation, frequency and character.

"Fog is our natural air conditioner, and it also provides water to certain kinds of vegetation and streams," says Lisa Micheli of the Pepperwood Preserve's Dwight Center for Conservation Science in Sonoma County. "The future of fog is going to be critical to understanding what may happen with climate change."



San Francisco Bay Area fog frequency contour map. The contour gradient of blue to red represents high to low percentage of summertime fog and low cloud cover. The percentages were calculated from cloud cover data from night and day hourly weather satellite images over the June, July, August, and September months of 1999 - 2009. Source: Pacific Coastal Fog Project.

The Fog Project, launched in 2011 with Cal LCC funding and a match from the Gordon and Betty Moore Foundation's Terrestrial Biodiversity Climate Change Collaborative, has been instrumental in bringing together a disparate group of researchers who study fog, whether it's from the perspective of atmospheric and ocean dynamics or hydrology and biology. For the past three years, the project has held monthly—or sometimes weekly—meetings. They have also hosted two workshops giving scientists face time with stakeholders, and convene an annual session at the American Geophysical Union meeting.

The focus of their work has been on developing, connecting, and fleshing out the available data—and on making sure it is in a format that is usable by the land managers and scientists who need it. Much of this effort has consisted of converting 10 years of historical ongoing satellite data — or 40,000 individual files — into an accessible format.

Several satellite programs collect fog data, but each one uses slightly different time frames, resolutions, and regions. Torregrosa and the fog team "laundered" the data through different types of software. The final results are maps of fog frequency; data at monthly, yearly and decadal intervals; and summary statistics making the massive amounts of data available at a glance.

The fog team has also been trying to make actual on-the-ground measurements of fog as it moves inland. Scientists identified this fog-monitoring network as a priority, because it allows them to analyze the relationship between real fog measurements and satellite data. In the last two years, the fog project has contributed studies that augment data from a transect that runs from the Bodega Marine Lab to the Pepperwood research station.

Next year, Torregrosa and the team plan to investigate how much water actually is produced by fog by deploying passive mesh collectors at 20 or more sites along the California coast. Fog condenses on the fine-gauge mesh, making it easier to measure.

Fog provides moisture for coastal forests. Photo: Max Eissler.

"Fog is a very complex phenomena in the sense of how it forms, how it evolves, and how it dissipates or disappears," Torregrosa says.

In part because of this complexity, fog is also rarely included in climate models. This research aims to address this gap, enabling resource managers and scientists to more closely predict regional changes.

One resource manager who would have a use for such predictions is Michael Reichmuth, a National Park Service fisheries biologist involved in developing an ecosystem dynamics model for coho salmon: "It would be helpful to get an understanding not only of the number of days of fog, but also of the different types of fog too—the high fog and the lower fog act differently. Any data that we have to add as an input, as a driver, into our model is useful in terms of restoration," says Reichmuth.

In the meantime, the Pacific Coastal Fog Project has solidified into something less ephemeral than it's misty subject matter. "Network and community building turns out to be a relatively big and exciting part of what we are doing," said Torregrosa. "We now have a phenomenal nucleus of researchers that has coalesced into something that will continue beyond this project."

PARTNERS: CSU Monterey Bay, Environment Canada, National Park Service, National Weather Service NOAA, Naval Research Laboratory, Oregon State University, Pepperwood Preserve, UC Davis, UC Berkeley, UC Santa Cruz, Scripps /UC San Diego, and Cal LCC.

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SIERRA NEVADA

CONNECTIONS COUNT AS TEMPERATURES RISE

BY ROBIN MEADOWS

When it comes to surviving climate change, it's all about connections. Animals and sometimes even plants are more likely to escape a habitat gone bad if routes to good ones exist. Of course, this assumes that good habitats — called "climate refugia"— also still exist. With Cal LCC funding, Toni Lyn Morelli of UC Berkeley is part of a team searching for climate refugia, and connections between them, in the Sierra Nevada.

"We want to see if we can find places where species are doing well despite climate change," Morelli says, explaining that climate refugia have been theorized but not actually validated in the landscape. Her team focused on meadows high in the Sierra because these open, water-rich habitats are hopping with rodents like ground squirrels, which in turn support a wealth of birds and carnivores.

The first step was mapping which of the 17,000 meadows across the Sierra are likely to be climate refugia. "We identified meadows that had changed the least," Morelli says. This meant those where the average temperature changed less than 1C between the early and late 1900s. But just making this cutoff doesn't necessarily guarantee that these meadows really are havens for wildlife faced with climate change.

"Are climate refugia real?" asked Morelli. "We are testing that by overlaying the map with biological data." Belding's ground squirrel is an ideal test case. These colony-dwelling rodents have vanished from nearly half of the Sierra meadows where they lived a century ago. "The species has disappeared particularly from the places that have gotten hottest, indicating that it's sensitive to climate change," she says. If the meadows identified as climate refugia are in fact refuges for Belding's ground squirrels, they will be more likely to still live in this subset of meadows and, just as importantly, their genetic diversity will be higher there.

The researchers are also using the squirrels' genetic data to map connections between meadows. "If they're very connected, the squirrels in them should be similar genetically because they're moving back and forth all the time," Morelli says. Connectivity is essential because if climate change forces species to relocate, they need a way to reach their new homes. "The maps will highlight the refugia that are most connected," she says. "This will help managers make decisions on where to put limited resources."

Map showing hypothesized connectivity among meadows around Yosemite National Park (bold outline), with blue indicating paths of greatest connectivity. Source: S. Maher, UC Berkeley.

U. beldingi in Diamond Valley, Central California. Photo: Toni Lyn Morelli

Cal LCC support is also helping the team deliver this new science directly to conservation nonprofits, and state and federal wildlife agencies who can use it on the ground. The team held a webinar and a workshop in 2013, and more outreach is planned. "We got people in a room and got them excited about the maps and using them for management," Morelli says. "We could not have produced these maps or shared them with managers without the LCC."

Workshop attendee David Wright is enthusiastic about using Morelli's connectivity maps for a statewide California Department of Fish and Wildlife project on linkages for animals. "This is cool methodology," says Wright, a biologist for the department. "She's using genetics to inform linkages — you won't have to guess." Next, he'd like to see Morelli's approach extended to other species and habitats. Will pikas, relatives of rabbits that live in talus high on mountainsides, traverse deep valleys that lack these rocky areas? Likewise, will California's threatened native red foxes cross roads and highways? Someday, maps that show connections between climate refuges could also help managers plan any assisted migration necessitated by climate change. "The possibilities are wonderfully rich," he says.

PARTNERS: California Department of Fish and Game, National Park Service, US Fish and Wildlife Service, US Forest Service, US Geological Survey, and Cal LCC.

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WORKSHOPPING ADAPTATION

BY JOE EATON

Coping with climate change in the Sierra Nevada is an enormously complex proposition. The mountains John Muir called the Range of Light contain a broad array of habitats, from foothill chaparral and blue oak woodland through the conifer belts to alpine krummholz, plus a web of creeks and rivers, ponds and lakes. It's a patchwork of state and federal jurisdictions and private lands, used for timber, grazing, watersheds, and recreation. Some native plant and animal species in these landscapes may thrive in a warmer, drier climate; others may be driven to extinction.

How can resource managers set priorities and make policy for an altered Sierra? In a Cal LCC-funded project, the US Forest Service and Washington-based EcoAdapt engaged diverse experts in answering this question – first evaluating the vulnerability of species and ecosystems to climate change, and then developing adaptation strategies that could be implemented throughout the Sierra Nevada. "It was a great opportunity to work within the LCC framework, involving many stakeholders and interest groups for science-based resource management," says Forest Service wildlife ecologist Chrissy Howell.

A small group workshop. Courtesy EcoAdapt.

Building on a climate change stakeholder group already formed by the Forest Service, the project held two workshops, adding participants from the Sierra National Parks, the US Fish and Wildlife Service, the California Departments of Fish and Wildlife, Forestry, Fire Protection, Water Resources, and NGOs.

"We like to work in larger coalitions," says EcoAdapt director Lara Hansen. "It's a way of avoiding solutions that are at cross purposes."

Howell agrees: "We took an all-lands approach, not just focusing on the Forest Service. It made it more challenging but gave us a stronger product. The animals and trees don't know who owns the land."

At the first workshop, participants reviewed and narrowed a list of birds, animals, forests, rivers and other natural resources identified by Forest Service stakeholder groups as being potentially vulnerable to climate change. Then they ranked 27 species, ecosystems, and ecosystem services, using vulnerability criteria and background information from EcoAdapt, Geos Institute, and TACCIMO. At the second workshop, participants focused on a subset, five ecosystems (alpine/subalpine, yellow pine/mixed conifer, red fir, wet meadow/fen, oak woodland) and three species (Sierra Nevada and southern mountain yellow-legged frogs and marten). For each, they came up with a set of potential adaptation strategies.

These strategies included reducing non-climate stressors. "It's a way people can see action now," says EcoAdapt's Jessi Kershner. For the frogs, this could mean removing non-native game fish that prey on them and compete for food. For wet meadows, this might mean restoring floodplain function and reducing livestock grazing impacts. Reintroducing natural fire regimes through thinning and (where allowed) prescribed burning was a common theme for several forest ecosystems. So was a search for disease- and pest-resistant conifer strains.

Blue oaks. Photo courtesy Sierra College.

"Many of the adaptation strategies are activities we're already doing," says Howell. On the most recent Forest Service climate change scorecard, 94 percent of the managers responding for California's 18 National Forests reported that they were conducting management actions related to climate change; 56 percent were developing information on the vulnerability of key resources. The Forest Service integrated information from the workshops into the Forest Plan Revision process for Sierra forests.

What's next? With additional Cal LCC support, EcoAdapt is preparing concise summaries for frontline managers of the results of the vulnerability assessments and the recommendations for adaptation strategies. They will also visit Sierra Nevada subregions to disseminate project findings to national forests and parks and discuss how these entities can use the results. Future strategy-generating workshops may also be in the cards.

PARTNERS: Conservation Biology Institute, EcoAdapt, Geos Institute, TACCIMO, US Forest Service, and Cal LCC.

CONTACTS: Chrissy Howell, cahowell@fs.fed.us; and Jessi Kershner jessi.kershner@ecoadapt.org

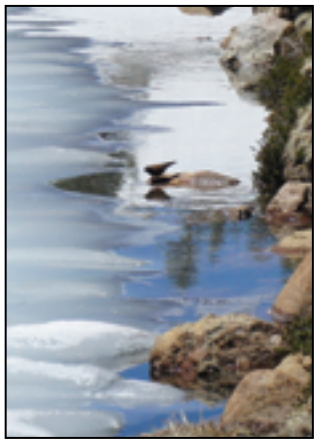
SIERRA NEVADA

ALARM BELLS FOR BIRDS

BY JOE EATON

More mobile than creatures on legs or with roots, birds may have more choices about where to go as the climate changes, according to research funded in part by the Cal LCC. But they still remain vulnerable to habitat and temperature changes, especially species whose life histories are inextricably linked with streams, lakes, and other aquatic ecosystems.

A study conducted by The Institute for Bird Populations projected future climatic changes across the ranges of 167 bird species that nest in the Sierra Nevada, plus one summer migrant. The Institute ranked each species for vulnerability to climate change based on a medium-high greenhouse gas emissions scenario and two climate models projecting warmer and drier conditions. According to executive director Rodney Siegel, only one bird, the introduced white-tailed ptarmigan, had the top ranking of Extremely Vulnerable. No native species ranked higher than moderately vulnerable. That may reflect the fact that birds are more mobile than some other organisms, with better dispersal options.



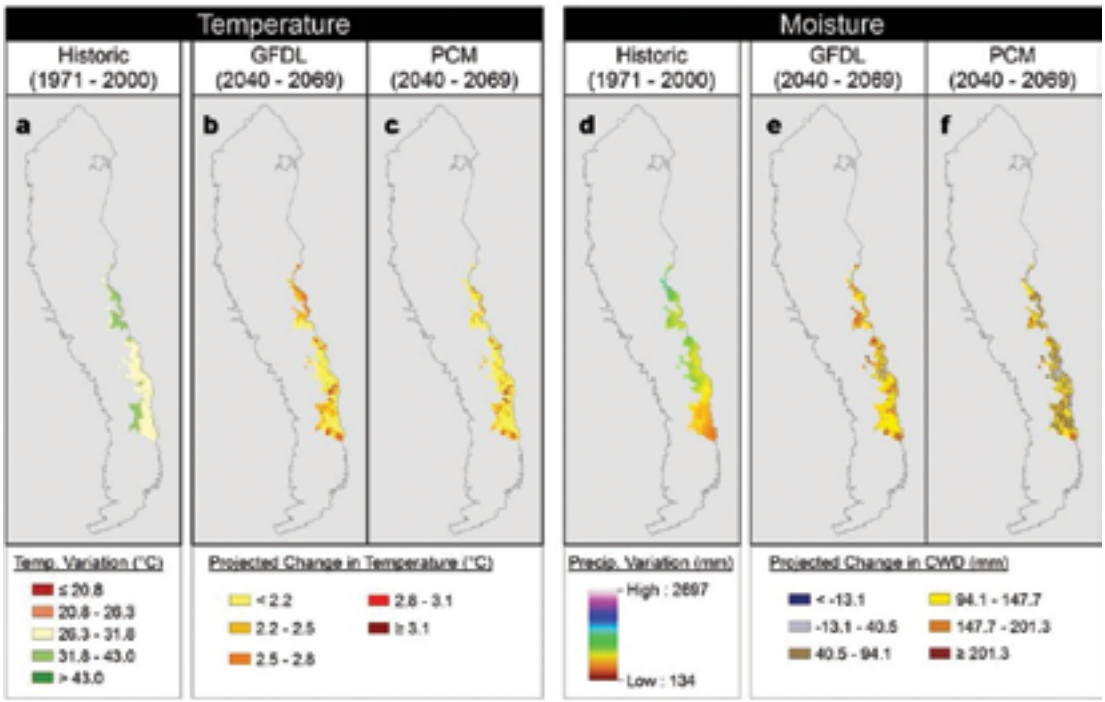
Gray-crowned rosy-finch, one of 16 bird species ranked as Moderately Vulnerable to climate change in the Sierra Nevada. Photo: Ryan Carlton.

In addition, the ranking revealed some interesting habitat-based patterns, with high-elevation birds like the gray-crowned rosy-finch and Clark's nutcracker among the more vulnerable. Birds dependent on streams and ponds, including John Muir's favorite, the American dipper, may also be at risk—a group that was not on most people's radar for conservation concern in the Sierra. On the other hand, meadow-nesting birds may be less vulnerable than expected. A long-term Institute banding study in Yosemite National Park shows most meadow species produce more offspring in years of low snowpack, possibly thanks to earlier starts and a longer window for second or replacement broods.

"Individual land managers in the Sierra can't do much to affect the actual changing climate," says Siegel. "But for the birds, they can try to increase ecosystem resilience and reduce non-climate stressors."

Siegel described the unsuspected vulnerability of birds dependent on aquatic ecosystems as "an alarm call." Adaptive strategies for that group might include streambank restoration or changes in the timing of water releases from reservoirs. Helping high-elevation species may be more challenging, with components of resilience harder to identify. Again, addressing non-climate stressors may be the key. "Rosy-finches are more abundant around lakes with no introduced fish," he explained. "The birds and fish compete for the same insect prey, consuming them at different stages of their life history." As such, prior proposals to remove introduced trout to help Sierran frogs could also benefit an imperiled bird.

Results of the research have been submitted to the journal *Avian Conservation and Ecology* for publication. Siegel and colleagues are currently developing adaptation strategies for the birds predicted to be most vulnerable.



Exposure of gray-crowned rosy-finch to recent temperature variation (a) and recent precipitation variation (d) within its mapped breeding range in the Sierra Nevada, based on climate data from the 30-year period 1971-2000, and projected change in temperature (b and c) and climatic water deficit (CWD) (e and f) between the 30-year periods 1971-2000 and 2040-2069 based on the GFDL and PCM climate models and the A2 (medium-high) emissions scenario. Source: IBP

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BIRD VIDEO: www.youtube.com/watch?v=BNVb2_HV10o&feature=youtu.be

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