Annual Report 2013-14

Southwest Climate Science Center

ERICA FLEISHMAN

Contents

Providing natural and cultural resource managers with scientific information, tools, and techniques to anticipate, monitor, and adapt to climate change.

Introduction

In many ways, 2013–14 was a landmark year for climate science in the United States and globally. The National Climate Assessment and the Intergovernmental Panel on Climate Change's Fifth Assessment Report highlighted the consensus on climate change within the scientific community, while official policy shifts in the White House brought new attention to climate change and the science that seeks to understand it. At the Southwest Climate Science Center (SW CSC), we have continued to provide the region's resource managers with essential scientific knowledge and tools to anticipate and adapt to climate change. The Center remains unwavering in its mission to provide the best available science and partner with stakeholders in the U.S. Department of the Interior and other agencies and organizations to identify critical knowledge needs and share information.

Our commitment to make climate science useful and usable for the public is exemplified by our close contact with the Landscape Conservation Cooperatives (LCCs) and other stakeholders in the region, including the National Park Service, Fish and Wildlife Service, Bureau of Land Management, and the states of California, Nevada, Utah, and Arizona. These relationships are developed through the work of the SW CSC core office staff, the investigators from the six host institutions, and the researchers sponsored by the SW CSC. Connections between researchers and stakeholders are key to informing our research priorities and tracking our progress.

Now in our fourth year, the center continues to operate a competitive research award process, which this year funded six new projects. Through these and previously funded projects, our researchers and their graduate students, postdoctoral researchers, and research affiliates made valuable contributions to the field.


ERIKA FLEISHMAN

Milestones

ANNUAL SCIENCE AGENDA AND WORKPLAN

This year, under the leadership of federal Director Stephen Jackson, the SW CSC detailed specific research priorities and planned actions for fiscal year 2015 in the Annual Science Work Plan. The Annual Work Plan builds on the research themes laid out in the SW CSC Science Agenda, which reflects the expressed climate science needs and interests of our stakeholders. The Work Plan establishes priorities for each year of funding (HTTP://WWW.SW CSC.ARIZONA.EDU/SCIENCE-PLANS).

This year's plan highlights the importance of one research theme – Establishing Best Practices – in guiding the work of the Center. In the past year, the SW CSC sponsored integrative projects aimed at understanding, testing, and assessing approaches to scientist-stakeholder engagement that produce effective management and scientific outcomes with the ultimate objective of identifying a set of best practices for collaboration and knowledge exchange between researchers and stakeholders. We expect that focus to continue through this year's funding cycle.

The Work Plan outlines FY15 funding plans and identifies six major research priorities:

1. **Anticipating climate change and variability at intermediate timescales**
2. **Linking climatic, hydrological, and ecological changes at intermediate timescales (roughly 5 – 20 years)**
3. **Hydrological effects of climate change in the Southwest**
4. **Effects of climate change on coastlines, estuaries, and wetlands**
5. **Design and implementation of monitoring strategies**
6. **Hydroclimatic change and terrestrial ecosystems**

Proposals were developed in coordination with local or regional stakeholders and included a clear plan for engagement and communication with stakeholders throughout the project. Proposals were encouraged from projects that incorporated:

1. **local or regional stakeholders and a clear plan for engagement and communication with those stakeholders**
2. **partnerships with or relevant to tribes; and**
3. **a strong component of training and participation by early career scientists (graduate students and post-docs)**

Additionally, the Work Plan outlines new SW CSC hiring plans for the SW CSC. The first of those new positions to be filled is the Federal Deputy Director. Carolyn Enquist, who has spent two decades in the conservation science field, having worked for the USA National Phenology Network, The Wildlife Society, The Nature Conservancy, the National Park Service, the Forest Service, and the National Wildlife Federation, takes on this new role with the SW CSC. She largely has focused on the conservation and management implications of climate change, including the launch of the Southwest Climate Change Initiative (SWCCI), a regional collaboration focused on adaptation planning and on-the-ground action. She also has contributed to a number of national reports related to climate change impacts, vulnerability assessment, and adaptation. Carolyn joined the Southwest Climate Science Center as deputy director in August 2014.

University Program Manager Alison Meadow has departed the SW CSC but remains a funded investigator. Her position will be filled with a half-time grants and contracts coordinator and a full-time outreach and program manager.

MID-TERM REVIEW MEETING

In October 2013, SW CSC staff and investigators presented our progress during our mid-term review, which Doug Beard, National Climate Change and Wildlife Science Center (NCCWSC) Chief, Shawn Carter, NCCWSC Senior Scientist,, and all SW CSC PIs attended.

ALL-HANDS MEETING

In April 2014, the SW CSC hosted an All-Hands Meeting in Tucson. Center Director Stephen Jackson, members of the Stakeholder Advisory Committee, coordinators and science coordinators from all five LCCs in the SW CSC region, and the CSC University investigators attended.

CLIMATE-SMART CONSERVATION COURSE

In April and May 2014, the SW CSC co-hosted a Climate-Smart Conservation Course with the Desert LCC in Tucson. **Christine Albano** and **Matt Williamson** (both University of California, Davis) helped lead three workshops designed to familiarize employees of state and federal land management agencies with the SW CSC, share resources currently available to land managers who wish to better incorporate climate information into their decision-making processes, and begin a dialogue about how the SW CSC might better meet the climate information needs of its stakeholders.

SCENIC ONLINE DATA SOURCE FOR CLIMATE/WEATHER IN THE SOUTHWEST

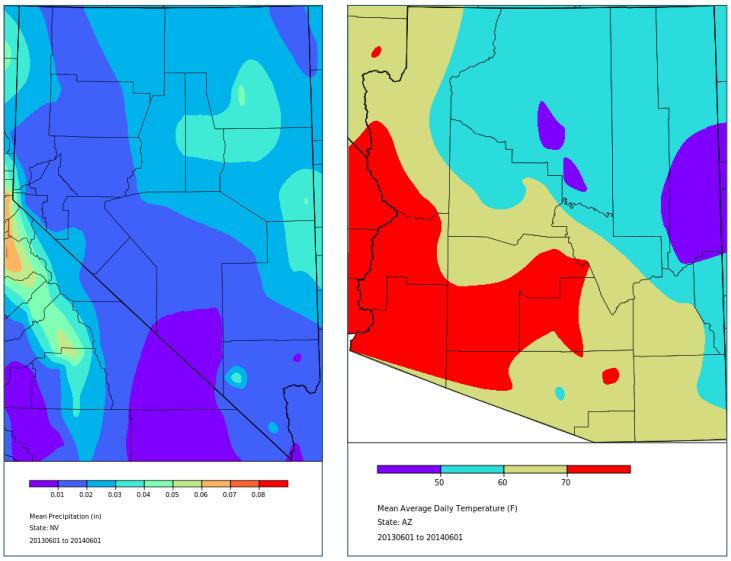
The Southwest Climate and Environmental Information Collaborative or SCENIC is an online application for interactive derivation of diverse climate metrics at spatial and temporal extents chosen by the user. Developed by the Western Regional Climate Center for the SW CSC and led by **Britta Daudert** at the Desert Research Institute, this tool can support research and decision making by the SW CSC, Landscape Conservation Cooperatives (LCC), and other stakeholders in the Southwest by providing access to climate data, analysis tools, and other climate and weather information.

Some examples of observed and simulated data available through SCENIC are:

- **Daily point data from weather stations across the United States from 1950-present**
- **Downscaled gridded data and model outputs for 1970-2000 and 2040-2070 at 50 km spatial and daily temporal resolution.**
- **Gridded climate data (e.g. PRISM) at daily (1980-present), monthly (1895-present), and yearly (1895-present) intervals at 4 km resolution.**

TO LEARN MORE ABOUT SCENIC, VISIT HTTP://WRCC.DRI.EDU/CSC/SCENIC/ OR ON THE SW CSC HOMEPAGE ON THE SCENIC LINK.

SAMPLE IMAGES FROM SCENIC SHOWING THE MEAN AVERAGE DAILY TEMPERATURE FOR ARIZONA, AND THE MEAN AVERAGE DAILY PERCIPITATION FOR NEVADA FROM JUNE 1, 2013 THROUGH JUNE 1, 2014.



Funded Research

RESULTS FROM 2012 PROJECTS

Climate change vulnerability of Native Americans in the Southwest

Principal Investigator: Karletta Chief, University of Arizona

Collaborators: Aleix Serrat-Capdevila (University of Arizona), William J. Smith Jr. (University of Nevada Los Vegas), David E. Busch (USGS), Edward Schuyler Chew (University of Arizona)

The Pyramid Lake Paiute Tribe in Nevada exemplifies tribal vulnerabilities as a result of climate change. Preliminary social and economic data and analysis reveal the tribe's vulnerability to climate change is related to cultural and economic dependence on Pyramid Lake, while external social and economic vulnerability factors influence adaptive capacity and amplify potential impacts. Reduced water supplies as a consequence of climate change would result in a compounded reduction of inflows to Pyramid Lake, thus potentially impacting the spawning and sustenance of a culturally significant livelihood, the endangered cui-ui fish (Chasmistes cujus). Meanwhile, limited economic opportunities and dwindling federal support constrain tribal adaptive capacity. Factors that contribute to tribal adaptive capacity include sustainability-based values, technical capacity for natural resource management, proactive initiatives for the control of invasive species, strong external scientific networks, and remarkable tribal awareness of climate change.

Ecological indicators related primarily to the lake's hydrology and the ecology of two culturally and economically significant fish species—cui-ui and the Lahontan cutthroat trout (Oncorhynchus clarki henshawi)—were monitored and assessed with the goal towards sustainability. A workshop with tribal members helped us identify additional problems and challenges facing the tribe and provided suggestions for management alternatives to address them.


KARLETTA CHIEF

PATHWAYS TO ADAPTATION FOR THE PYRAMID LAKE PAIUTE TRIBE

By Kimi Eisele

The Pyramid Lake Paiute Tribe has deep cultural, physical, and spiritual connections to Pyramid Lake, a terminal desert lake fed by the Truckee River in Nevada. The Paiute once called themselves the "Kooyooee Tukadu" or "Cui-ui Eaters," after the now-endangered cui-ui fish endemic to the lake, and rely on revenue from Lahontan cutthroat trout fisheries for their livelihoods.

But warmer temperatures, decreasing rain and snowfall, and diminished water quality threaten the tribe's traditions and economic ties to their environment, spurring Karletta Chief to determine the Paiute's potential to adapt to climate change and help the tribe develop water management strategies.

Colleagues from the University of Nevada, Las Vegas and the U.S. Geological Survey also are involved in the research, which is funded through a grant from the IE-based Southwest Climate Science Center to help decision makers, resource managers, and communities adapt to the effects of climate change in the U.S. Southwest.

Chief, an assistant professor in the University of Arizona's Department of Soil, Water and Environmental Science and a member of the Navajo Nation, has been working with the Paiute since 2009. In a survey she conducted with members of the tribe, 93 percent of respondents expressed a desire for climate change action at the national level.

In fall 2013, Chief and her research team held a two-day interactive workshop with the tribe and other stakeholders to identify the main environmental issues they face and brainstorm management alternatives to those issues.

Water quality and water quantity were among the most significant issues community members voiced, says Autumn Bryson, director of the tribe's Environmental Department.

"It's really important to the tribe to keep water levels up to keep cui-ui populations healthy but also to maintain water quality that's suitable for the cui-ui to live in," Bryson says.

With stakeholder input, Chief and other researchers will identify adaptive strategies to help the tribe prepare for changes and will continue to gather data and traditional ecological knowledge during a second workshop. "The strategies that they're going to be recommending for the tribe to be able to adapt to climate changes are really helpful," says Bryson.

Chief's research team will offer an online video that outlines the habitat and spawning needs of both the cui-ui and the trout to identify where the species might be most at risk to changing conditions. "[The work is] going to give us a head start in adapting to climate change," Bryson says.

Reprinted from the UA Institute of the Environment's Annual Report, Summer 2014

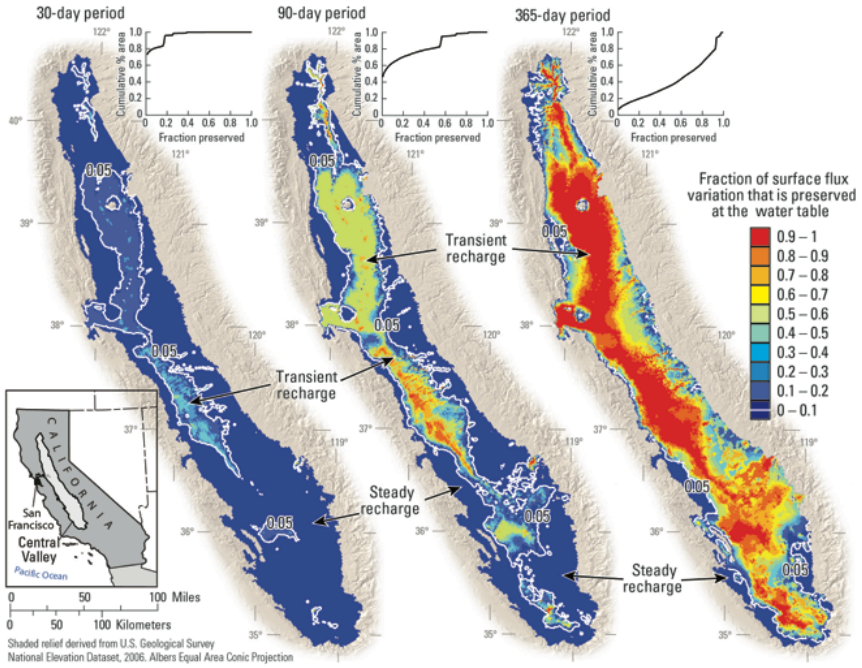
Multicriteria sensitivity analysis of the vulnerability of hydrologic systems to climate variability and change

Principal Investigator: Ty Ferré (University of Arizona)

Collaborators: Jesse Dickinson (USGS), Christopher Castro (University of Arizona), Peter Troch (University of Arizona), Matt Switanek (University of Arizona)

The potential consequences of climate variability and climate change have been identified as major issues for the sustainability and availability of the water resources of the United States. Long-term decreases in precipitation will result in reduced recharge, lowered regional groundwater levels, loss of groundwater storage for communities, stream base flow depletion, and loss of riparian vegetation. We examined how hydrologic systems filter climate signals and how this filtering depends on the frequency of the signal and the properties of the hydrologic system. We developed a screening tool for identifying subregions of groundwater systems at which recharge can be considered to be steady state. The advantage of having steady state conditions is that the recharge in the model can be a simple function of the average climatic conditions. If the recharge in a subregion is identified to be transient, then complex hydroclimatic processes may be required in order to obtain time-varying recharge rates to groundwater models. Our screening tool identifies the amount of infiltration variation at any depth. If the depth to the water table is known, the screening tool identifies the amplitude of the recharge variability, and if the recharge has damped to a steady state rate. This improved understanding of the vulnerability of hydrologic and riparian areas to future climate will inform water and riparian managers about which systems may be most sensitive to trends and periodic variations in climate.

RESEARCH CONDUCTED BY FERRÉ AND COLLEAGUES (AND FUNDED BY SW CSC) WAS FEATURED IN A JULY ARTICLE ON THE SOIL SCIENCE SOCIETY OF AMERICA WEBSITE. THE ARTICLE HIGHLIGHTED THE CREATION OF A NEW SCREENING TOOL THAT ALLOWS RESEARCHERS TO BETTER UNDERSTAND THE WAYS GROUNDWATER AQUIFERS ARE REPLENISHED. THE TOOL OFFERS A SIMPLER MATHEMATICAL MODEL TO HELP SCIENTISTS LOCATE AREAS WHERE AQUIFERS ARE REPLENISHED NATURALLY AND STEADILY, AND NOT SIMPLY DEPENDENT ON RAINFALL OR CLIMATE VARIATION. SUCH MODELS WILL HELP RESEARCHERS FORECAST HOW MUCH WATER REMAINS IN AQUIFERS, PARTICULARLY THOSE BEING TAPPED BY IRRIGATION, AGRICULTURE, AND URBAN USE.



HTTPS://WWW.SOILS.ORG/DISCOVER-SOILS/STORY/NEW-TOOL-EASES-TASK-SIMULATING-AQUIFER-REFILL

Downscaled climate and hydrologic response for California and the Great Basin

Principal Investigator: Lorraine Flint (USGS)

Collaborators: Alan Flint (USGS), James Thorne (UC Davis), Stuart Weiss (Creekside Science), Deanne DiPietro (Point Blue Conservation Science)

Climate change is causing rising temperatures and increased extremes in precipitation across the West, stressing vegetation, increasing forest fires, and challenging the survival of species. To adapt, natural resource managers need up-to-date, scientifically sound, and accessible information. Our research provides state-of-the-art climate and hydrology data for California and the Great Basin, as well as interpretations to guide the planning and decisions of natural resource managers. Analyses will help managers understand where effects of climate change are likely to be the most profound, how the environment is likely to change, and how certain the scientific community is about these changes. Results will be shared with managers and the public via a user-friendly website that includes interactive data and maps.

The project aims to build the capacity of the California Climate Commons and engage a larger management community to conduct and offer a water availability/water supply analysis. In this way, it aims to bring together the expertise, data, and analysis that lay the foundation for consistent state-of-the-art ensemble climate and hydrology datasets. These new datasets will be available to include in the next generation of analyses of water supply, groundwater, threats to agricultural crops, subsidence, urban planning, conservation and biodiversity, and human health and safety.

Trans-specific drivers of variation in forecasted distributional changes of Southwest birds and reptiles

Principal Investigator: Barbara Ralston (USGS Southwest Biological Science Center)
Former Principal Investigator: David Mattson (retired, USGS Southwest Biological Science Center)

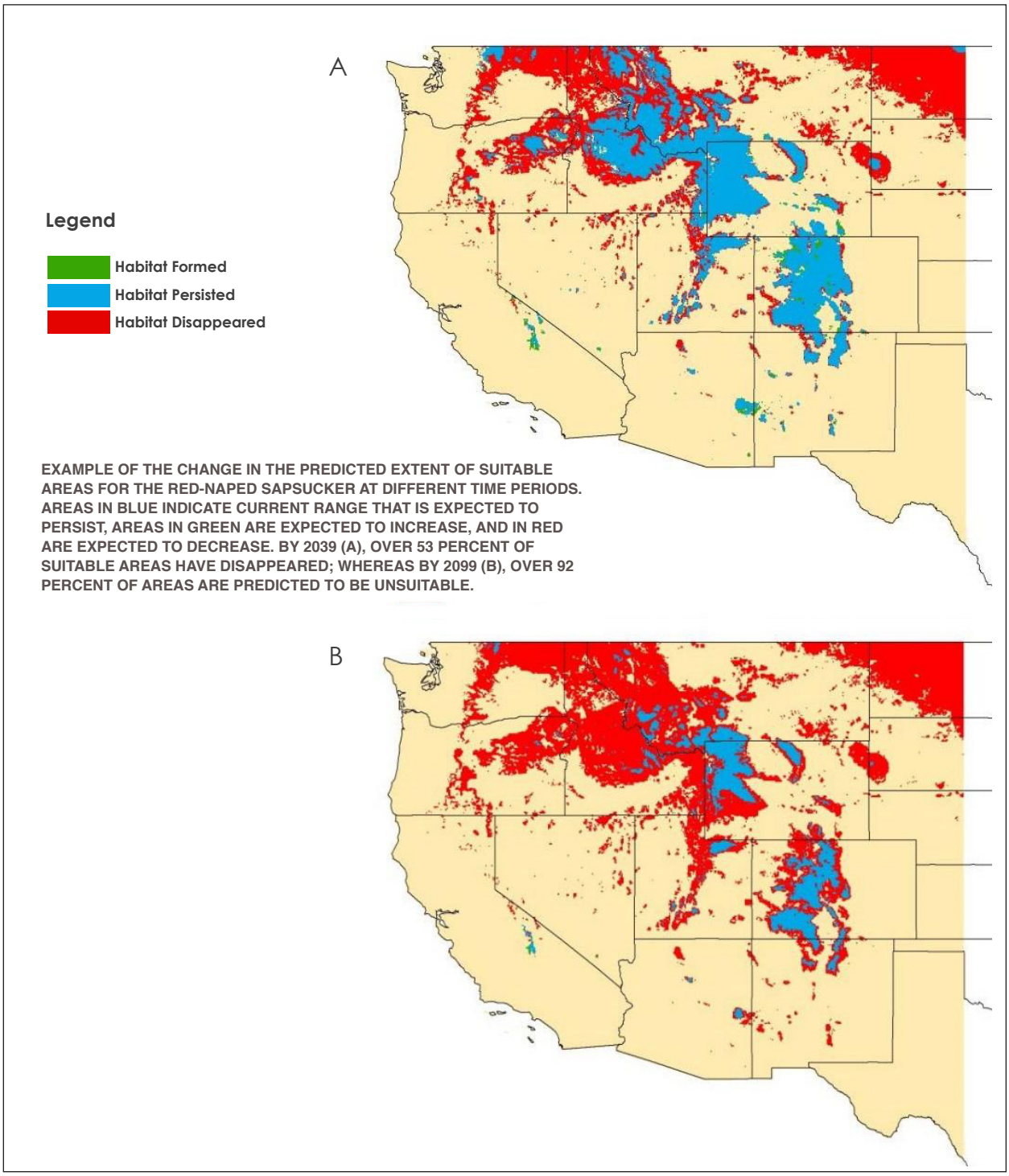
Collaborators: Jennifer Holmes, Matthew Johnson, Erika Nowak, Michael Peters (Northern Arizona University); James Hatten (USGS Western Fisheries Research Center); J. Tomasz Giermakowski, Paul Neville (University of New Mexico); Kirsten Ironside (Northern Arizona University)

Given the impact of climate change on biodiversity and its indicators, managers are faced with difficult decisions. Forecasts can provide managers with the prospective identities and locations of species that are likely to be at future risk. Species distribution models or SDMs (rather than ecological niche models) may provide useful projections of species distributional responses (and related vulnerabilities) to climate change, particularly if they identify factors that help explain variation among species in projected distributions. Our research investigates the trans-specific drivers of among-species variation in SDM-based projections, the relations between species-specific SDM-based projections and vulnerability assessments; and which bird and reptile species, currently common or on the cusp of rareness, will be at risk with projected climate change in the southwestern U.S. and why.

We modeled current and future distributions (breeding ranges) of bird and reptile species in the western U.S. with static (i.e., landscape features, soil characteristics), biotic (associated plant distributions), and climatic variables (i.e., temperature, precipitation). For each species, we developed a conceptual ecological model that links much of what is known from the scientific literature or our own research about the proximal factors that govern birth and death rates. We then associated those to distal factors, which we can model with candidate explanatory variables. Such conceptual models detail how candidate static, biotic, and environmental explanatory variables are expected to interact with or influence life and natural history processes to influence population parameters.

To date we have modeled the current and future distributions for six of the seven birds and some reptiles. Example results for two species, red-naped sapsucker and Gila monster, show projected future declines in distribution for both species—up to 92 percent of habitat areas lost by 2099 for the red-naped sapsucker and

more than 28 percent of areas predicted to be unsuitable by 2099 for the Gila monster (see figure below). Area for red-naped sapsucker decreased 80 percent between baseline (2010) and 2099 when vegetation distributions were not considered in the model and fell by 92 percent when vegetation distributions were added. No specific plants were identified in the conceptual model for Gila monster and thus vegetation was not included in that species' model.



EXAMPLE OF THE CHANGE IN THE PREDICTED EXTENT OF SUITABLE AREAS FOR THE RED-NAPED SAPSUCKER AT DIFFERENT TIME PERIODS. AREAS IN BLUE INDICATE CURRENT RANGE THAT IS EXPECTED TO PERSIST, AREAS IN GREEN ARE EXPECTED TO INCREASE, AND IN RED ARE EXPECTED TO DECREASE. BY 2039 (A), OVER 53 PERCENT OF SUITABLE AREAS HAVE DISAPPEARED; WHEREAS BY 2099 (B), OVER 92 PERCENT OF AREAS ARE PREDICTED TO BE UNSUITABLE.

POCO WILDFIRE, TONTO NATIONAL FOREST (USDAGOV)

Climate change vulnerabilities and adaptation strategies to wildfire in the Southwestern United States

Principal Investigator: Mark W. Schwartz (University of California, Davis)

Collaborators: Max Moritz (UC Berkeley), Tim J. Brown (Desert Research Institute), Jim Thorne (UC Davis), Andrew Holguin (UC Davis)

Climate change is driving stress in plant communities, and stressed communities have differing, often negative, responses to wildfire. Forest wildfire is a growing problem in the southwestern U.S., with millions of dollars spent each year in fire control. We are identifying where and when forest and woodland ecosystems of the southwestern U.S. will become vulnerable to change as a consequence of fire. Our objective is to develop a climate change vulnerability model for forests of the Southwest and couple these models to projections of altered fire regimes for the region. Changes to our objectives mostly have been in the form of process and model selection. Since our proposal was submitted, new CMIP 5 climate models have been released with a variety of additional climate downscales. These have caused us to shift our expectations with respect to the number of models we are running and the spatial scales at which we are running them, but not the general approach or objective.

Our work is principally in maps. Our results are largely consistent with what we found in the southern Sierra Nevada. Our major finding thus far has been that expanding our spatial scope has not significantly changed our previous outputs of future vulnerability at smaller spatial scales. Specifically, when using the southern Sierra Nevada as a description of a vegetation type (e.g., ponderosa pine forest), we may have found a smaller bioclimatic envelope, and hence higher climate change vulnerability potential, than when considering ponderosa pine over a larger spatial (and possibly climatic) extent. This has turned out not to be a major factor in assessing climate change vulnerability as we increased spatial scale from the Sierra Nevada to all of California.

RESEARCHERS MONITOR SEA-LEVEL RISE, SEDIMENTATION, AND VEGETATION IN SALT MARSHES AND TIDAL FLATS ALONG THE CALIFORNIA COAST.

Downscaling climate change models to local site conditions: effects of sea-level rise and extreme events to California coastal habitats

Principal Investigator: John Y. Takekawa (USGS)

Collaborator: Glen M. MacDonald (UCLA)

In California, the near-shore area where the ocean meets the land is a highly productive region that supports a wealth of wildlife, including several native bird species. The saltmarshes, mudflats, and shallow bays of this boundary region are connected ecosystems critical to wildlife, local people, and communities. Climate change effects such as sea-level rise are altering these ecosystems, and our project sought to examine the links among these ecosystems and expected future changes at several sites along the California coast. By reviewing the current weather patterns, elevations, tidal range, and sediment of these connected ecosystems to see how they affect plants and animals, and to project how climate change may alter that balance, our goal was to provide scientific information to support future planning and conservation of near-shore natural resources as climate changes.

We have completed the fieldwork for the initial characterization of baseline conditions across all our sites. This includes the elevation and vegetation surveys, bathymetric surveys, and water level and salinity logger deployment as well as surface elevation table (SET) installment. We've noticed substantial differences from the location of the marshes within the tidal frame, which has implications for marsh sustainability with sea-level rise. We will gain substantial insight from the sediment cores regarding historic rates of sediment accumulation and present accretion from the SETs.

MONUMENT FIRE

PROJECTS FUNDED IN 2013

This fiscal year, the SW CSC funded six new projects. Annual reports for these projects are expected in late 2014 and summaries will be posted to our website soon after.

Influence of interannual North Pacific Jet variability on Sierra Nevada Fire regimes

Principal Investigators: Julio Betancourt (USGS), Valerie Trouet (University of Arizona)

The position of the North Pacific Jet (NPJ), a high altitude narrow path of strong winds over the North Pacific Ocean, is a key determinant of snowpack variability in California: when the NPJ is located more southerly than normal, winters are therefore wetter than average in California. Conversely, winters in the state are drier than average when the NPJ is more northerly. With ongoing and future climatic change, the NPJ is projected to slow down and exhibit a more north-south oriented trajectory, which could greatly influence California water resources and ecosystems. We are using tree-ring data to reconstruct NPJ variability over the last 400+ years. Our reconstruction will allow us to put current NPJ trends in a historical perspective and to study the occurrence of NPJ periodicity and extremes. We are also using historical fire data (1500–1900 CE) to look at NPJ influence on California fire regimes and analyze recent data on annual area burned to investigate whether the NPJ fire relationship persists into the 21st century. We anticipate our research will be relevant as input to seasonal outlooks that incorporate past, present, and future climate and fuels information to anticipate significant fire potential. The outlooks are designed to inform decision makers for proactive wildland fire management.

PROJECTING FUTURE CLIMATE WITH ANCIENT TREES

By Kimi Eisele

Valerie Trouet's research subjects may be 600 years old, but they can tell us a thing or two about the world we live in today.

Trouet's work, studying centuries-old tree rings to better understand past climate, could help us understand events like the current drought in California and the Southwest and the forces that spun waves of record snow and cold into the eastern U.S. this past winter.

"I really want to use my data and my research interests to see where tree-ring data can best solve the problems we're dealing with now and in the future," says Trouet, a paleoclimatologist and assistant professor at the UA's Laboratory of Tree-Ring Research.

Trouet recently received grants from the SW CSC and the National Science Foundation to analyze tree-ring and historical fire data to determine how the North Pacific jet stream—a high-altitude, narrow path of strong winds over the North Pacific Ocean that can play a key role in delivering hot and cold or wet and dry conditions to the western U.S.—influences the occurrence and size of California wildfires. She hopes her work helps save lives and property and helps protect natural resources by improving seasonal fire outlooks used in wildland fire management.

She also hopes her results provide an historical perspective on how human-caused climate change affects the jet stream—a hotly debated topic in climate science.

VALERIE TROUET POSING NEXT TO A FIRE-SCARRED PONDEROSA PINE TREE IN THE SIERRA NEVADA NATIONAL FOREST, CA.

COLORADO RIVER HORSESHOE BEND

Colorado River Basin streamflow projection under IPCC CMIP5 scenarios: from the global to basin scale using an integrated dynamic modeling approach

Principal Investigator: Christopher L. Castro (University of Arizona)

Collaborators: Peter Troch, Hsin-I Chang (University of Arizona); James Prairie (Bureau of Reclamation); Jon A. Skindlov (Salt River Project); Chuck Cullom (Central Arizona Project)

The Colorado River is the dominant water supply source for the southwestern U.S. Recent climate change studies for the region project a dire future, with chronic drought and substantially reduced Colorado River flows. The proposed project contains both regional climate and hydrologic modeling components designed to retrospectively diagnose and project streamflow in the Colorado River sub-basins, accounting for both natural variability and anthropogenic climate change. Of particular interest is whether there will be a synergistic relationship between the occurrence of extreme wet or dry conditions and the natural variability of El Niño-Southern Oscillation and Pacific Decadal Variability (ENSO-PDV). The main objective of this project is to characterize how the changing climate of the Southwest is affecting cool and warm season precipitation in the Colorado River Basin and the corresponding response of streamflow in individual sub-basins.

Natural variability in the changing climate: Interaction of interannual, decadal, and century timescales with daily weather and a focus on extreme events

Principal Investigators: Alexander Gershunov (Scripps Institution of Oceanography), Daniel Cayan (USGS and Scripps Institution of Oceanography)

Collaborators: Suraj Polade (UCSD/SIO), Noah Knowles, (USGS), Rupa Basu (California Environmental Protection Agency), Deanna Dullen (Devil's Postpile National Monument)

Natural climate variability can obscure or enhance long-term trends in experienced weather due to climate change. This can happen temporarily on timescales of a season to several years to a decade of two. Natural variability is poorly described and attributed to specific causes, contributing to uncertainty and misunderstandings about the nature of climate change. There exists, therefore, a need to clarify the magnitude and causality of natural climate variability. This connection needs to be explained for locally experienced

weather and particularly for daily extreme events, whose seasonal behavior impacts both resources and imagination. Conversely, it is also important to assess the impact of long-term climate change on natural variability affecting the Southwest. This project focuses on such assessments and clarifies impacts of natural climate variability on the frequencies and intensities of specific extreme temperature and precipitation events as well as their cascading influences on streamflow in the changing climate of the Southwest. Results aim to clarify the roles of natural influences on varying magnitude and rate of climate change over space and time, thus increasing stakeholders' awareness of certainty versus uncertainty about the future and facilitating better-informed decisions on various timescales.

Linking climatic, hydrological, and ecological changes at intermediate timescales in a Great Basin Watershed

Principal Investigator: Alexandra Lutz (Desert Research Institute)

Collaborators: Rosemary Carroll, Guoping Tang, James Thomas (DRI), Joseph F. Leising, Keely Brooks (Southern Nevada Water Authority), Michael Dettinger (USGS)

The project proposes to evaluate climate, hydrological, and ecological changes at intermediate timescales for the next 30 years in the Cleve Creek watershed in the eastern Great Basin. We hypothesize that observed lag times between climate and hydrologic changes affect vegetation on annual to decadal intervals and impact available water resources. The Regional Hydro-Ecological Simulation System (RHESSys) model will be employed to test our hypothesis leveraged with the Cleve Creek groundwater/surface water model and ancillary information from a related ongoing study conducted with the Southern Nevada Water Authority. By linking models, we evaluate: a) a comparison of two observed droughts, b) a comparison of two observed pluvial periods, c) a downscaled global climate model projection, d) a comparison of two projected droughts, and e) a comparison of two projected pluvial periods.

Expected results and products include a RHESSys model, vegetation parameters (vegetation productivity, phenological features), evaporation, transpiration, soil-moisture content, groundwater levels, and groundwater discharge to streams. All products will be given in 5- and 10-year intervals for the past and next 30 years and as text files, Excel files, map files (GoogleEarth or ESRI), and jpgs.

Evaluating the impact of climate science produced in the Southwest Climate Science Center on resource management agency decisions

Principal Investigators: Alison Meadow (University of Arizona), Tamara Wall (Desert Research Institute)

This project proposes to assess a sample of collaborative SW CSC-funded research projects in order to evaluate the approaches used by SW CSC investigators to collaborate with agency managers-stakeholders; assess the management outcomes of these collaborative processes; develop a tentative set of metrics to measure the effect of these collaborations on management outcomes and the research process; and distill a set of best practices that improve both management and collaborative research process-related outcomes.

Using both qualitative research methods such as interviews, surveys, and quantitative analysis, we are examining the various collaborative approaches used within the SW CSC and assessing their impacts on the resource management decisions of those who participated in the collaborative processes. Outcomes from this project include a series of webinars or workshops to share best practices for collaborative climate science production.

Preliminary assessment of the landscape of climate relevant resource management decisions in the southwest.

Principal Investigator: Mark W. Schwartz (University of California, Davis)

Collaborators: Christine Albano, Gwen Arnold, Erica Fleishman, Mark Lubell (University of California, Davis); Richard Ambrose (University of California, Los Angeles); Dan Cayan (USGS and Scripps Institution of Oceanography); Britta

Daudert(Desert Research Institute); Mike Dettinger (USGS and Scripps Institution of Oceanography); Alexander Gershunov (Scripps Institution of Oceanography); Glen MacDonald (University of California, Los Angeles); Alison Meadow, Jonathan Overpeck (University of Arizona), Kelly Redmond (Desert Research Institute); Brad Udall (University of Colorado)

With thousands of resource managers making tens of thousands of decisions across the Southwest that may require information from climate science, there is an urgent need to prioritize the climate science, technology transfer, and stakeholder engagement, decision support, and knowledge co-production. Our objective is to quantitatively characterize the landscape of climate-relevant resource decisions in the southwestern U.S. Using a topology of climate relevant resource management decisions, we will work with stakeholders to develop efficient decision-support tools, knowledge networks, and climate science targeted specifically to meet the needs of managers and decision makers.

RECOMMENDED FOR FUNDING IN 2014

Five projects were recommended for funding in the 2014 proposal process.

Linking interannual variations of extreme storms with ecological and hydrologic disturbance in the Sierra Nevada

Principal Investigator: Michael Dettinger, Scripps Institute of Oceanography and U.S.

Collaborators: Christine Albano, (UC Davis John Muir Institute of the Environment), Gerald Bawden, (USGS Western Geographic Science Center), Sandra Bond (USGS California Science Center), Dale Cox (USGS Pacific Regional Hazards Coordinator), Maureen McCarthy (Tahoe Science Consortium and University of Nevada, Reno), Christopher Soulard (USGS Western Geographic Science Center)

Development, delivery, and application of data on climate extremes for the southwestern United States

Principal Investigator: Erica Fleishman (University of California, Davis)

Collaborators: Dan Cayan, Michael Dettinger (USGS and Scripps Institution of Oceanography); Alexander Gershunov (Scripps Institution of Oceanography); Jonathan Overpeck (University of Arizona); Kelly Redmond (Desert Research Institute); Mark Schwartz (University of California, Davis)

A coastal site network for advancing understanding and prediction of climate change effects on nearshore ecosystems: integrating interdisciplinary process studies

Principal Investigators: John. Y. Takekawa (USGS), Glen MacDonald (UCLA)

Collaborators: Rich Ambrose (UCLA Env. Science and Eng. Program); Patrick Barnard (USGS Pacific Science Center); Lauren Brown (UCLA); Kevin Buffington (Oregon State Univ.); Susan De La Cru, (USGS WERC); Bruce Dugger (OSU); Chase Freeman (USGS WERC); Neil Ganju (USGS Woods Hole); Glenn Guntenspergen (USGS Patuxent Wildlife Research Center); Alex Hall (UCLA); James Holmquist, Jordan Rosencranz (UCLA); Karen Thorne (USGS WERC)

How does climatic stress at intermediate timescales influence fire severity?

Principal Investigator: Phillip van Mantgem (USGS)

Collaborators: Donald Falk (University of Arizona); Adrian Das (USGS); Jeffrey Kane (Humboldt State University); MaryBeth Keifer, Jonathan Nesmith (National Park Service);Nathan Stephenson (USGS)

Disentangling the influence of antecedent temperature and soil moisture on Colorado River Water Resources

Principal Investigator: Connie Woodhouse (University of Arizona)

Collaborators: Adam Csank (Nipissing University/University of Nevada, Reno), Greg Pederson (USGS-Bozeman)

Other Partners: Stephanie McAfee (Univ. of Nevada, Reno), Greg McCabe (USGS-Denver), Steve Gray (USGS)

SW CSC Principals' and Affiliates' Activities

PEER-REVIEWED PUBLICATIONS

Publications made possible by SW CSC research funds are listed in green.

Albano, C.M., C. Angelo, R. Strauch, and L. Thurman, 2013: Potential Effects of Climate Warming on Visitor Use in Three Alaskan National Parks. *Park Science*, 30(1): 36-43.

Berg, N., **A. Hall**, F. Sun, S.C. Capps, D. Walton, B. Langenbrunner, and D. Neelin, 2014. 21st-century precipitation changes over the Los Angeles region. *Journal of Climate* (submitted).

Byrd, K., L.E. Flint, P. Alvarez, A.L. Flint, and C.F. Casey. (In preparation). Integrated scenarios and outreach for assessing threats to ecosystem services on California rangelands.

Charman, D., D.W. Beilman, M. Blaauw, R.K. Booth, S. Brewer, F.M. Chambers, J.A. Christen, A. Gallego-Sala, S.P. Harrison, P.D.M. Hughes, **S.T. Jackson**, A. Korhola, D. Mauquoy, F.J.G. Mitchell, I.C. Prentice, M. van der Linden, F. de Vleeschouwer, Z.C. Yu, J. Alm, I.E. Bauer, Y.M. C. Corish, M. Garneau, V. Hohl, E. Karofeld, G. Le Roux, R. Moschen, J.E. Nichols, T.M. Nieminen, G.M. MacDonald, N.R. Phadtare, N. Rausch, O. Sillasoo, G.T. Swindles, E.-S. Tuittila, I. Ukonmaanaho, M. Väliranta, S. van Bellen, B. van Geel, D.H. Vitt, and Y. Zhao. 2013. Climate-driven changes in peatland carbon accumulation during the last millennium. *Biogeosciences* 10:929–944.

Curtis, J.A., L.E. Flint, A.L. Flint, and J.D. Lundquist. 2014. Application of a regional-scale hydrologic model to determine impacts on snow-dependent ecology under current and future climates in the Sierra Nevada, CA. *PLoS One* (submitted).

Das, A., N. Stephenson, T. Das, P. van Mantgem, A.L. Flint. 2013. Forecasting climate-related tree mortality in energy-versus water- limited forests. *PLoS ONE* 8(7):e69917.

Dettinger, M. 2013: Atmospheric rivers as drought busters on the US west coast. *Journal of Hydrometeorology* 14:1721-1732.

Drexler, J.Z., D. Knifong, J.L. Tuil, L.E. Flint, and A.L. Flint. 2013. Fens as whole-ecosystem gauges of groundwater recharge under climate change. *J. Hydrology* 481:22–34.

Fleishman, E., J.R. Thomson, L. Kalies, B.G. Dickson, D.S. Dobkin, and M. Leu. 2014. Projecting current and future location, quality, and connectivity of habitat for breeding birds in the Great Basin. Ecosphere 5(7):82. doi: 10.1890/ES13-00387.1.

Flint, L.E., A.L. Flint, and J.H. Thorne. 2014: California Basin Characterization Model: A Dataset of Historical and Future Hydrologic Response to Climate Change: U.S. Geological Survey Dataset Report. In press.

Flint, L.E., A.L. Flint, and J.H. Thorne. 2014. Evaluating Climate Change Using the Basin Characterization Model. *USGS Fact Sheet*. In press.

Flint, L.E., A.L. Flint, and J.H. Thorne, and R. Boynton. 2013. Fine-scale hydrological modeling for climate change applications; using watershed calibrations to assess model performance for landscape projections. *Ecological Processes* 2:25.

Franklin, J., Davis, F.W., Ikegami, M., Syphard, A.D., Flint, L.E., Flint, A.L., and Hannah, L. 2013: Modeling plant species distributions under future climates: How fine scale do climate projections need to be? *Global Change Biology* 19:473-483.

Gautam, M., K. Chief, and W. J. Smith, Jr. 2013. Climate change in arid lands and Native American socioeconomic vulnerability: The case of the Pyramid Lake Paiute Tribe. *Climatic Change* 120(3):585–599.

Guirguis, K., **A. Gershunov**, A. Tardy, and R. Basu. 2014. The impact of recent heat waves on human health in California. *Journal of Applied Meteorology and Climatology* 53:3–19.

Hudgens, B., J. Young, E. Boydston, P. Terletzky-Gese, **L. Flint**, A. Flint, and J. Curtis. Incorporating climate change into evaluating wolverine (Gulo gulo) reintroduction into the Sierra Nevada. *Biological Conservation* (submitted).

Jackson, S.T., R.K. Booth, K. Reeves, J.J. Andersen, T.A. Minckley & R.A. Jones, 2014. Inferring local to regional changes in forest composition from Holocene macrofossils and pollen of a small lake in central Upper Michigan, USA. *Quaternary Science Reviews* 98:60–73.

Lesser, M.R. and **S.T. Jackson**. 2013: Contributions of long-distance dispersal to population growth in colonizing *Pinus ponderosa* populations. *Ecology Letters* 16:380–389.

Lesser, M.R., T.L. Parchman, and **S.T. Jackson**. 2013. Development of genetic diversity, differentiation and structure over 500 years in four ponderosa pine populations. *Molecular Ecology* 22:2640–2652.

Liu, Y., Andersen, J.J., J.W. Williams, and **S.T. Jackson**. 2013. Vegetation history in central Kentucky and Tennessee during the last glacial and deglacial period. *Quaternary Research* 79:189–198.

Overpeck, J.T. 2013. The challenge of hot drought. *Nature* 503:350–351.

Overpeck, J.T. 2014. The challenge of biodiversity adaptation under climate change. *Applied Studies in Climate Adaptation*, J.P. Palutikof, S.L. Boulter, J. Barnett, and D. Rissik (eds.). Wiley, Oxford. In press.

Polade, S.D., D.W. Pierce, **D.R. Cayan**, **A. Gershunov**, and **M.D. Dettinger**. 2014. The key role of dry days in changing regional climate and precipitation regimes. *Nature Scientific Reports* 4:4364–4372.

Ralph, F.M., **M.D., Dettinger**, A. White, D. Reynolds, **D. Cayan**,T. Schneider, R. Cifelli, K. Redmond, M. Anderson, F. Gehrke, J. Jones, K. Mahoney, L. Johnson, S. Gutman, V. Chandrasekar, J. Lundquist, N. Molotch, L. Brekke, R. Pulwarty, J. Horel, L. Schick, A. Edman, P. Mote, J. Abatzaglou, R. Pierce, and G. Wick. 2014: A vision of future observations for western U.S. extreme precipitation and flooding. *Journal of Contemporary Water Resources Research and Education* 153:16–32.

Rudd, M.A. and E. Fleishman. 2014. Policymakers' and scientists' ranks of 40 high priorities for science to inform resource-management policy in the United States. *BioScience* 64:219–228. (Editor's choice for the issue)

Schwartz, R.E., **A. Gershunov**, S.F. Iacobellis and **D.R. Cayan**. 2014. North American West Coast summer low cloudiness: Broad scale variability associated with sea surface temperature. *Geophysical Research Letters* 41:3307–3314.

Stahle, D.W., R.D. Griffin, M.D. Therrell, J.R. Edmondson, M.K. Cleaveland, L.N. Stahle, D.J. Burnette, J.T. Abatzoglou, **K.T. Redmond**, D.M. Meko, **M.D. Dettinger**, and **D.R. Cayan**. 2013. The ancient blue oak woodlands of California—Longevity and hydroclimatic history. *Earth Interactions* 17:1–23.

Sun F., D. Walton, and **A. Hall**. 2014: A hybrid dynamical–statistical downscaling technique, Part II: End-of-century warming projections predict a new climate state in the Los Angeles region. *Journal of Climate* (submitted).

Thompson, A. and **S.T. Jackson**. 2013: The human influence: moral responsibility for novel ecosystems. *Designer Biology: The Ethics of Intensively Engineering Biological and Ecological Systems*. R. Sandler and J. Basl (eds.). Lexington Books, 125–150.

Torregrosa, A., M. Taylor, L. Flint, and A. Flint. 2013. Present, future, and novel bioclimates of the California coastal ranges. *PLoS ONE* 8(3)e58450.

Walton, D., F. Sun, **A. Hall**, and S.C. Capps. 2014: A hybrid dynamical–statistical downscaling technique, Part I: Development and validation of the technique. *Journal of Climate* (submitted).

Ward, P.J., S. Eisner, M. Florke, **M. Dettinger**, and M. Kummu. 2014. Annual flood sensitivities to El Nino/ Southern Oscillation at the global scale. *Hydrology and Earth System Science* 18:47–66.

Weiss, S., Hamilton, H., Flint, L., and Flint, A. Climate scenarios for San Francisco Bay Area, 2014: *PLoS One* (submitted).

White, A.B., M.L. Anderson, **M.D. Dettinger**, F.M. Ralph, A. Hinajosa, **D.R. Cayan**, R.K. Hartman, D.W. Reynolds, L.E. Johnson, T.L. Schneider, R. Cifelli, Z. Toth, S.I. Gutman, C.W. King, F. Gerhke, P.E. Johnston, C. Walls, D.J. Gottas, and T. Coleman. 2013. A 21st Century California observing network for monitoring extreme weather events. *Journal of Atmospheric and Oceanic Technology* 30:1585–1603.

NON-PEER-REVIEWED PUBLICATIONS

Dettinger, M. 2014. Climate change—Impacts in the third dimension. *Nature Geoscience News and Views* 7:166–167.

MacDonald, G.M. 2013: Yosemite Fire Puts San Francisco on the Front Lines. *San Francisco Chronicle*, August 30.

Jackson, S.T. 2013. Ecological novelty isn't new. *Novel Ecosystems: When and How Do We Intervene in the New Ecological World Order?* R.J. Hobbs, E.S. Higgs, and C. Hall (eds.). Wiley-Blackwell, 63–65.

REPORTS

Weiss, S.B., A.L. Flint, L.E. Flint, H. Hamilton, M. Fernandez, M., and L. Micheli. 2013. Climate scenarios for San Francisco Bay Area. Technical report to the Moore Foundation. 29p.

CONFERENCE PRESENTATIONS

Presentations resulting from SW CSC-funded projects are listed in green.

Albano, C.M. EEffects of decision rules on characterization of land facet diversity in the southwestern U.S. Invited presentation. *Conserving the Stage Workshop, Society for Conservation Biology Conference*, Baltimore, MD. July 2013.

Albano, C.M., **M.D. Dettinger**, C. Soulard. Linking interannual variations of extreme storms with ecological and hydrologic disturbance in the Sierra Nevada. *Southern Sierras Fire and Hydroclimate conference*, Yosemite National Park, Yosemite, CA. April 2014.

Albano, C.M., B.G. Dickson, L.J. Zachmann. Identifying new conservation priority areas and opportunities on unprotected roadless lands in the western U.S.: a Great Basin case study. *Great Basin Consortium conference*, Reno, NV. December 2013.

Brown, L.N., **MacDonald, G.M.** A Paleoenvironmental Study of California Coastal Wetlands. *Association of American Geographer's Annual Meeting*, Los Angeles, CA. April 2013.

Brown, L.N., **MacDonald, G.M.**, Ambrose, R.A. Reconstructing the long-term record of coastal marsh dynamics in California, *California Society for Ecological Restoration (SERCAL) annual meeting*. May 2013.

Brown, L.N., J.R. Holmquist, and **G.M. MacDonald**. A mid-Holocene record of sediment dynamics and high resolution accretion rates in coastal salt marches from Southern California. *Geological Society of America Annual Conference*. October 2013.

Brown, L.N., J.R. Holmquist, and **G.M. MacDonald**. A mid-Holocene record of sediment dynamics and high resolution accretion rates in a coastal salt marsh from Northern California, *American Geophysical Union Annual Meeting*. December 2013.

Chew, E.S., K. Chief, A. Serrat-Capdevila, W. Smith Jr., and D.E. Busch. Resilience to climate change: Collaborating on adaptive management strategies for the Pyramid Lake Paiute Tribe. *Nevada Water Resources Association 2013 River Symposium*, Reno, NV. November 2013.

Chief, K., K. Cozzetto, K. Dittmer, M. Brubaker, R. Gough, K. Souza, F. Ettawageshik, S. Wotkyns, S. Opitz-Stapleton, S. Duren, and P. Chavan. Climate change impacts on the water resources of American Indians and Alaska Natives in the U.S. *Biennial Conference of Science and Management on the Colorado Plateau*, Northern Arizona University, Flagstaff, AZ. September 2013.

Dettinger, M.D., F.M. Ralph, A. White, M. Anderson, J. Florsheim, D. Cayan, and A. Hinojosa. Severe storms and California's fragile Delta—Historical impacts and new monitoring approaches. *AGU Fall Meeting*, San Francisco, CA. December 2013.

Dickinson, J.E. and T.P.A. Ferré. Screening tool for delineating subregions of steady recharge within groundwater models. *Arizona Hydrological Society Conference*, Tucson, AZ. September 2013.

Dickinson, J.E. and R.T Hanson. Software for assessing the relations between variable climatic and hydrologic time series. *Arizona Hydrological Society Conference*, Tucson, AZ. September 2013.

Dickson, B.G., Zachmann, L., **Albano, C.M.**, Duncan, L. Identifying new conservation priority areas and opportunities on unprotected roadless lands in the western U.S. *Society for Conservation Biology Conference*, Baltimore, MD. July 2013.

Fleishman, E. Deriving practical information about management of Great Basin ecosystems from pretty things with wings. Humboldt–Toiyabe National Forest Supervisor's Office, Sparks, NV. September 2013.

Fleishman, E., B. Dickson, J. Anderson, and J. Cole. Assessment of connectivity of habitat for multiple species of large mammals on Navajo Nation lands. Symposium on climate change impacts on Native Americans on the Colorado Plateau. *Biennial Conference of Research on the Colorado Plateau*, Flagstaff, AZ. September 2013.

Flint, L. Basin hydrology in the face of climate change. *Water Education Foundation Annual Meeting*, Sacramento, CA. March 2013.

Hudgens, B. Incorporating climate change into habitat suitability assessments for species reintroductions. *Conservation Biology Meeting*. April 2013.

Hamilton, H. and M. Fernandez. Observed trends in climate space in Bay Area conservation lands. *San Francisco Bay Area National Parks Science and Natural Resources Symposium*, San Francisco, CA. April 2013.

Gershunov, A. Diagnosing probability models for observed daily precipitation extremes. CLIVAR workshop on extremes: *Analyses, Dynamics, and Modeling of Large-Scale Meteorological Patterns Associated with Extreme Temperature and Precipitation Events*, Berkeley, CA. July 2013.

Gershunov, A. Climate variability and change: observations and projections for California and the South Coast. NOAA's *Climate Adaptation for Coastal Communities*, San Diego, CA. October 2013.

Hatten, J. et al. T*he importance of plants in bioclimatic models. 12th Biennial Conference of Research on the Colorado Plateau*, Flagstaff, AZ. September 2013.

Jackson, S.T. Time as an ecological dimension: the historical thread in ecological thinking in the 19th and 20th Centuries. Symposium on Ecology's Recent History, *Ecological Society of America Annual Meeting*, Minneapolis, MN. 2013.

Jackson, S.T. Seeking Leopold's Quadrant: How do we foster research that addresses needs of resource-management decision-makers? Symposium on Implications of Climate Change for Ecosystem Processes in the Southwest U.S., *Ecological Society of America Annual Meeting*, Minneapolis, MN. 2013.

Jackson, S.T. Traffic safety at the corner of Ethics and Epistemology. ESA Ignite Session on The Value of Philosophy for Ecology, *Ecological Society of America Annual Meeting*, Minneapolis, MN.

Jackson, S.T. Panel: Linking climate science to resource management. *Arizona Planning Association*, Scottsdale, AZ.

Jackson, S.T. History of ecological history in ecological restoration. Symposium on The History of Ecological Eestoration, *5th World Conference on Ecological Restoration*, Madison. (Presentation canceled owing to federal government shutdown).

Jackson, S.T. What's new about ecological novelty? Symposium on Novel Ecosystems. *5th World Conference on Ecological Restoration,* Madison. (Presentation canceled owing to federal government shutdown).

Jackson, S.T. Challenges in climate-change adaptation in the Southwest. Keynote presentation, Seventh Annual *Phenology Research and Observations of Southwest Ecosystems (PROSE) Symposium*. USA-National Phenology Network and the American Society for Photogrammetry and Remote Sensing, Tucson, AZ. (Presentation canceled owing to federal government shutdown).

Jackson, S.T. Invited speaker and participant, *Conservation and natural resources management in an uncertain future: using the southeastern U.S. as a model for managing change*. National Science Foundation, U.S. Forest Service, Department of Defense, and the Joseph W. Jones Ecological Research Center, Bainbridge, GA.

Jackson, S.T. Biodiversity consequences of climate change: lessons from the past, questions for the future. *Looking forward from the past: climate change impacts through the lens of history /Arizona Geological Society annual lecture*, School of Natural Resources and Environment, University of Arizona Tucson, AZ.

Jackson, S.T., **A. Meadow**, J. Leenhouts, **D. Cayan**, **E. Fleishman**, **A. Gershunov**, **G.M. MacDonald**, **J.T. Overpeck**, **K. Redmond**, **M.W. Schwartz**, and **B. Udall**. The Southwest Climate Science Center: developing best practices at the science/management interface. *Climate Prediction Applications Science Workshop*, Logan, UT. 2013.

Mandell, S., O. Anderson, E.S. Chew, K. Chief, A. Serrat-Capdevila, W. Smith Jr., and D.E. Busch. Resilience to climate change: Collaborating on adaptive management strategies for the Pyramid Lake Paiute Tribe. *National Congress of American Indians Tribal Leader/Scholar Forum: "Agriculture, Timber, & Water: Sustaining our Natural Resources,*" Reno, NV. June 2013.

Maoqiao M.; N.L. Brown, J.R. Holmquist, and **G.M. MacDonald**. Particle Size Analysis of Coastal Marsh Sediments in Southern California. Final Poster and Oral Reports for *Cross Disciplinary Scholars in Science Summer Program*, UCLA and Nankai University. September 2013.

Schwartz, M. and K. Nydick. Initial findings. *Ecological Society of America*.

Schwartz, M. and J. Thorne. *AGU meetings*, San Francisco, CA.

Takekawa, J. *Coasts and Estuaries Research Federation conference*. San Diego, CA. November 2013.

Williamson, M. A., C.H. Hoglander, **C.M. Albano**, B.G. Dickson, and T.D. Sisk. Building the infrastructure for climate adaptation: the Kane and Two Mile Ranches, Arizona. *12th Biennial Conference of Science and Management on the Colorado Plateau*, Flagstaff, AZ. September 2013.

Williamson, M.A., B.G. Dickson, **C.M. Albano**, T.D. Sisk, and E.N. Aumack. Targeting collaborative conservation actions using novel spatial datasets: A case study from Grand Canyon's North Rim. *Society for Conservation Biology Conference*, Baltimore, MD. July 2013.

WORKSHOPS

Christine Albano attended workshops on the use of geophysical units for coarse-filter conservation planning in a changing climate at the *International Congress for Conservation Biology Meeting* (Baltimore, July 2013), a training on the climate-smart process with the *National Conservation Training Center* (Sacramento, March 2014), and a workshop on the drought challenges facing the Great Basin region at the *Great Basin Climate Forum, Desert Research Institute* (April 2014).

Mike Dettinger presented workshops on Northern California precipitation variations and atmospheric rivers at the *California Department of Water Resources Winter 2014 Outlook Meeting* (La Jolla, CA, November 2013) and the *California Drought Summit* (Sacramento, CA, May 2014). He also co-organized and presented a research challenge on "Quasidecadal oscillation and extreme storms in California" for a *California Department of Water Resources Workshop* (La Jolla, May 2014).

Karletta Chief coordinated a Climate Change Planning Workshop with members of the Pyramid Lake Pauite Tribe in order to gain better insight on climate change challenges from the perspective of tribal members. The workshop also served to identify some management alternatives and solutions that address the challenges. Nixon, NV (September 2013).

Glen MacDonald participated in the UC Drought Science, Policy & Management Summit at the California State Capitol (April 2014). This summit brought together invited faculty from across UC campuses and others to brief policymakers and the public and explore the best ways to mitigate effects of the current drought and prepare for future water shortages.

COMMUNICATIONS AND OUTREACH

Christine Albano is a member of the California LCC Science-Manager team.

Albano co-organized six stakeholder meetings and one tabletop emergency response exercise for the ARkStorm@Tahoe project, which is focused on helping the greater Lake Tahoe/Reno/Carson communities identify vulnerabilities and increase preparedness for extreme winter storm events. More than 350 participants from a wide array of sectors attended the meetings.

- **Incline Village, NV (water supply, September 2013)**
- **South Lake Tahoe, CA (business, emergency response, natural resources, October 2013)**
- **Carson City, NV (interagency coordination between state/federal governments, November 2013)**
- **Reno, NV (2 meetings: water managers, tribal entities, December 2013)**
- **South Lake Tahoe, CA (natural resources, January 2014)**
- **Reno, NV (emergency response tabletop exercise, all audiences mentioned above, March 2013)**

Albano also co-organized three consultative group meetings in April and May of 2014 involving some 35 natural resource managers to assist in identifying opportunities for climate science use in natural resource planning and decision making. Participants included planners, line officers, and resource specialists from NPS, DOD, FWS, BLM, USFS, and BIA. The meetings were held in Sacramento, Reno, and Tucson.

Albano presented a briefing, "Identifying new conservation priority areas and opportunities on unprotected roadless lands in the western U.S.," to 10 Nevada BLM state office employees in April 2014.

Dan Cayan gave a USGS public lecture on ways climatologists are using earth system physics and computer modeling to develop plausible scenarios of California's changing climate (Menlo Park, CA, March 2014).

SW CSC grantee **Karletta Chief** has presented her research on the Lake Pyramid Pauite Tribe seven times to tribal and non-tribal audiences. She also connected with several tribal environment program managers through quarterly conference calls. Additionally, the Pyramid Lake Paiute Tribe led a tour of their reservation focusing on climate change impacts to a group attending the Northern Arizona University Inter Tribal Environmental Professionals Climate Change Workshop in October 2013.

Britta Daudert attended a Consultative Group Meeting hosted by Schwartz, Albano, and Williamson at the BLM/FWS State Office in Reno (April 2014).

Mike Dettinger gave four talks about climate change, two to stakeholders from water agencies and two to public audiences in California and Nevada:

- **Climate change, ARkStorms & the Sierra Nevada. *Sierra Water Working Group Summit*, Kings Beach, CA, June 2013. [Stakeholders: Sierra water agencies and interests]**
- **The new science of atmospheric rivers and Yosemite. *Parsons Lodge Public Seminar*, Tuolumne Meadows, Yosemite National Park, August 2013. [Public visitors to Yosemite NP]**
- **Climate change and the Sierra Nevada. *Sierra Nevada Alliance Conference*, South Lake Tahoe, September 2013. [Stakeholders: Sierra land, wildlife, and water agencies and interests]**
- **Preparing for Climate Change—What Nevadans should know. *League of Women Voters*, Public seminar, Reno, November 2013. [Public audience]**

SW CSC grantee **Ty Ferré** presented screening methods to state hydrologists, consultants, and non-profit organizations, and shared tools with the Sonoran Institute and the Arizona Land and Water Trust in May 2013. His discussions with the Arizona Land and Water trust have culminated in a new method for quantifying the strength of ecohydrological linkages, which amplify or absorb climate variability in riparian systems.

SW CSC grantee **Lorraine Flint** and colleagues participated in workshops addressing the impacts of climate change on California's vineyards and on hydrological systems in the Sierra Nevada and served on an expert panel for California's Forest and Range Assessment Steering Committee. Flint's team also shared project goals in a webinar on Pyramid Lake and presented applications for resource management at a California Water Science Center Focus on the Scientist seminar.

Alexander Gershunov presented a webinar, "Abilities of modernizing climate models to simulate teleconnections of Pacific climate variations," to national resource managers, politicians, and other decision makers at the CENRS Subcommittee on Water Availability and Quality (July 2013).

Alex Hall was invited to give talks on "Developing a Physical Understanding of Regional Climate Change" at Princeton's Geophysical Fluid Dynamics Laboratory (March 2014) and UC Irvine (May 2014).

Jonathan Overpeck visited the University of Utah to discuss the CSC and offer an invited Science seminar, "Assessing Future Drought & Megadrought" (January 2014).

Mark Schwartz presented his project's process and approach to understanding climate vulnerabilities to the California Resource Conservation Districts forest committee and continues to collaborate with the Sequoia and Kings Canyon national parks to implement these models within the context of their resource stewardship strategies and climate change adaptation plan. Schwartz also presented project findings with respect to future forest vulnerability to an interagency task force on the Rim Fire, held in Sacramento.

John Takekawa, a SW CSC grantee, presented project posters at the Coasts and Estuaries Research Federation Conference in San Diego, CA. Prior to beginning fieldwork, his team met with each site manager to discuss proposals and gather information about existing datasets. They released preliminary results of the

baseline condition fieldwork to each site manager (March 2013) and are currently releasing reports to Humboldt Wildlife Refuge and San Diego Wildlife Refuge.

Matt Williamson is leading efforts to work with the Sacramento Field Office of the U.S. Fish and Wildlife Service and the Dixie, Fishlake, and Manti-LaSalle national forests to identify opportunities for the SW CSC to directly engage with land managers as they embark upon their respective Wildlife Habitat Management Plan and Forest Plan revision processes. Large-scale, long-term planning processes such as these have been identified by workshop participants and the SW CSC Strategic Advisory Committee as significant opportunities for the Center to provide direct value to its stakeholders and to demonstrate best practices for incorporating climate information into land management decision making.

SW CSC WEBINAR SERIES

The SW CSC offered a series of webinars this year with the aim of sharing research findings with partners, other researchers, and the public, and expanding the dialogue about climate science. A total of nine webinars between November 2013 and April 2014 allowed participants to interact with presenters about topics related to climate change and its impacts. The first-time webinar series drew more than 360 participants. An additional series of webinars focused on results from SW CSC-funded projects is expected to begin in fall 2014..

The nine webinars featured the following topics and presenters:

- **IPCC Working Group 1 Report and Implications for the Southwest, Jonathan Overpeck**
- **Modeling Southwestern Forest Vulnerability, Mark Schwartz**
- **Sea Level Rise and Impacts to Coastal Habitats, Glen MacDonald**
- **Projecting and Detecting Species-Level Responses to Variations in Weather and Changes in Climate, Erica Fleishman**
- **Storms, floods and climate change in the Southwest, Mike Dettinger**
- **Drought conditions and outlook for the Southwest, Kelly Redmond**
- **Colorado River Myths and Realities: The Coming Conflict, Brad Udall**
- **California heat waves in the present and future and implications for human health, Alexander Gershunov and Kristen Guirguis**
- **Climate Change and Fire Regimes in the Southwest, Julio Betancourt**

SOUTHWEST CLIMATE ASSESSMENT

The Assessment of Climate Change in the Southwest is a regional section of the National Climate Assessment. It provides a summary and synthesis of the past, present, and projected future of the region's climate. SW CSC principals and affiliated researchers were instrumental in writing the assessment, which compiled state-of-the-art science about climate change in the region and presented it in a format accessible to resource managers (**WWW.SWCARR.ARIZONA.EDU**).

Overpeck, J., **G. Garfin**, A. Jardine, D. Busch, **D. Cayan**, **M. Dettinger**, **E. Fleishman**, **A. Gershunov**, **G. MacDonald**, K. Redmond, W. Travis, and **B. Udall**, 2013. Ch. 1: Summary for decision makers. *Assessment of climate change in the Southwest United States: a report prepared for the U.S. National Climate Assessment*, G. Garfin, A. Jardine, R. Merideth, M. Black, and J. Overpeck (eds.). Southwest Climate Alliance, 1–20.

Cayan, D., M. Tyree, K. Kunkel, **C. Castro**, **A. Gershunov**, J. Barsugli, A. Ray, **J. Overpeck**, M. Anderson, J. Russell, B. Rajagopalan, I. Rangwala, P. Duffy, 2013. Ch. 6: Projected Averages. *Assessment of climate change in the Southwest United States: a report prepared for the U.S. National Climate Assessment*, G. Garfin, A. Jardine, R. Merideth, M. Black, and J. Overpeck (eds.). Southwest Climate Alliance, 101–120.

Gershunov, A., B, Rajagopalan, **J. Overpeck**, K., **D. Cayan**, M. Hughes, **M. Dettinger**, **C. Castro**, R. Schwartz, M. Anderson, A. Ray, J. Barsugli, T. Cavazos, and M. Alexander, 2013. Ch. 7: Future Climate: Projected Extremes. *Assessment of climate change in the Southwest United States: a report prepared for the U.S. National Climate Assessment*, G. Garfin, A. Jardine, R. Merideth, M. Black, and J. Overpeck (eds.). Southwest Climate Alliance, 126–143.

Fleishman, E., J. Belnap, N. Cobb, C. Enquist, K. Ford, **G. MacDonald**, M. Pellant, T. Schoennagel, L. Schmit, **M. Schwartz**, S. van Drunick, A. Westerling, A. Keyser, and R. Lucas, 2013. Ch. 8: Natural ecosystems. *Assessment of climate change in the Southwest United States: a report prepared for the U.S. National Climate Assessment,* G. Garfin, A. Jardine, R. Merideth, M. Black, and J. Overpeck (eds.). Southwest Climate Alliance, 148–167.

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THE FULL TEXT OF ASSESSMENT OF CLIMATE CHANGE IN THE SOUTHWEST UNITED STATES CAN BE FOUND AT: **SWCARR.ARIZONA.EDU**

NATIONAL CLIMATE ASSESSMENT

This year, a team of more than 300 experts guided by a 60-member federal advisory committee produced the National Climate Assessment. The report summarizes the impacts of climate change in the United States, now and in the future (**HTTP://NCA2014.GLOBALCHANGE.GOV/REPORT**). SW CSC principal researcher **Mike Dettinger** was a lead author on one chapter.

Georgakakos, A., P. Fleming, **M. Dettinger**, C. Peters-Lidard, T.C. Richmond, K. Reckhow, K. White, and D. Yates. 2014. Ch. 3: Water Resources. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T.C. Richmond, and G. W. Yohe (eds.). U.S. Global Change Research Program, 69-112.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (5TH ASSESSMENT)

SW CSC principal researcher **Jonathan Overpeck** contributed to the Fifth Assessment of the U.N. Intergovernmental Panel on Climate Change. This assessment reveals a clear understanding among scientists about climate change and its significant impacts around the globe.

Field, C. et al. 2014. Summary for Policymakers. *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field, C. et al. (eds.). Cambridge University Press.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, **J. Overpeck**, M. A. Taboada, and 16 others. 2014. Chapter 4. Terrestrial and Inland Water Systems.In: *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field, C. et al. (eds.). Cambridge University Press.

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ERIKA FLEISHMAN

Professional Development

The SW CSC supports a number of graduate and post-graduate students in studies and research that assist the Center's principals and helps prepare future scientists.

The SW CSC supported postdoc **Suraj Polade** and his research on how climate change is projected to change the frequency, intensity, and annual amount of precipitation in the Southwest in comparison to other global regions, through an investigation of a broad set of Global Climate Models (GCMs). Polade's contribution to *Nature Scientific Reports* this year is particularly noteworthy (see p. 16).

Ty Ferré's research supported work by graduate students **Jesse Dickinson** and **Matt Switanek**.

Glen MacDonald's research supported work by graduate students **Lauren Brown**, a Ph.D. student in geography; **Kathryn Hargan**, a NSERC visiting doctoral student in biology from Queens University, Canada; **James Holmquist**, a postdoc in geography at UCLA; and **Jordan Rosencranz**, an environmental science and engineering (ESE) doctoral student at UCLA.

Graduate student publications resulting from SW CSC research funds include:

Brown, L.N. 2014: A Late Holocene Reconstruction of Coastal Salt Marsh Net Accretion Rates and Environmental Change from Three Sites in Southern California. Master of Arts Thesis, Department of Geography, UCLA.

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