



Photo credit: Alexander Gershunov



Southwest Climate  
Science Center

**Annual Report 2014–15**

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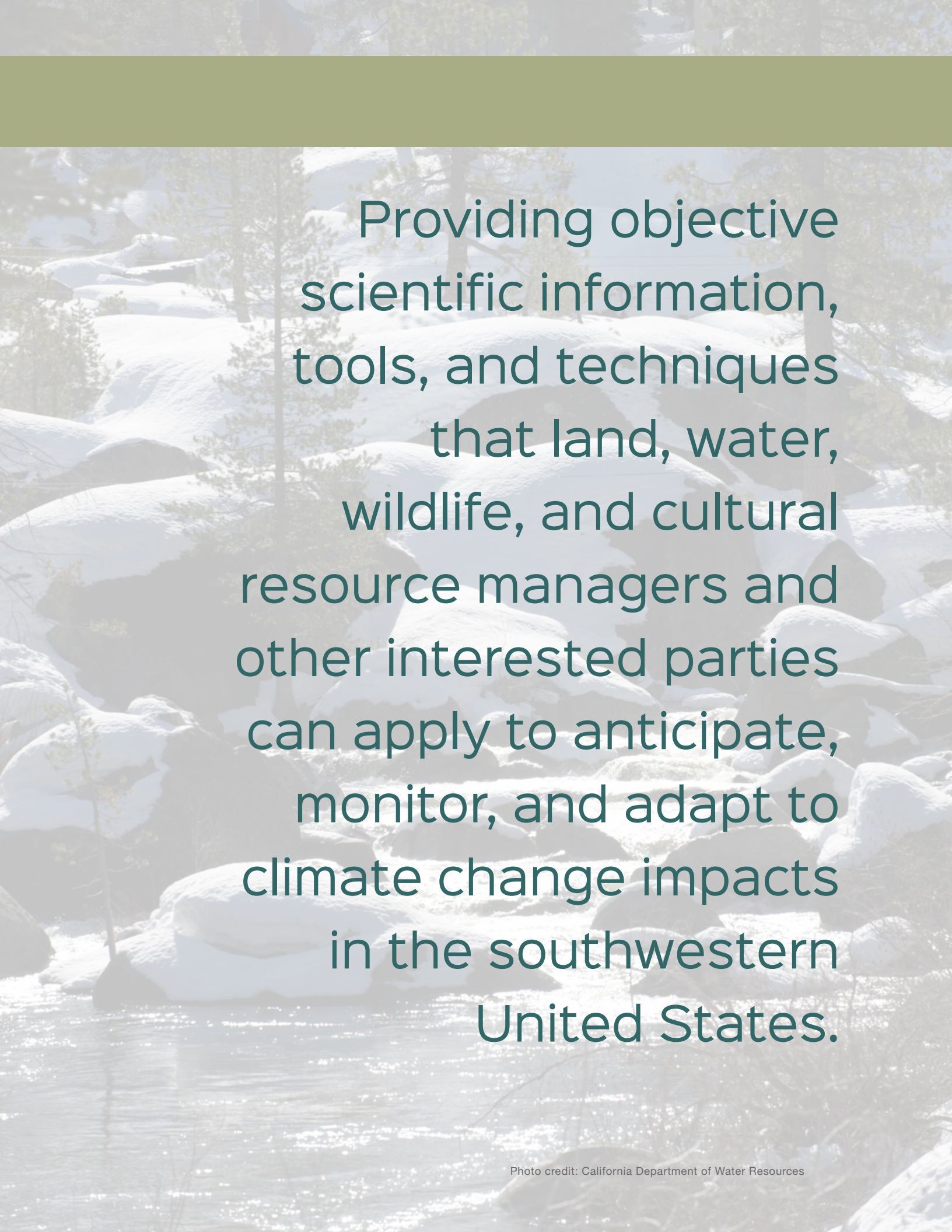
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Providing objective  
scientific information,  
tools, and techniques  
that land, water,  
wildlife, and cultural  
resource managers and  
other interested parties  
can apply to anticipate,  
monitor, and adapt to  
climate change impacts  
in the southwestern  
United States.

# INTRODUCTION

As the Department of the Interior (DOI) Southwest Climate Science Center (SW CSC) marks its fifth year, many projects have reached completion, producing decision-relevant results, and maturing and newly initiated projects are on course to address critical information needs in the years ahead.

Throughout 2014–2015, drought across the southwestern United States made headline news. At the start of 2015, more than 50 percent of the West, which is home to 51 million people, was experiencing moderate to exceptional drought conditions. In California, the drought resulted in the state's first-ever mandatory statewide water restrictions. SW CSC scientists spent significant time not only studying the unfolding situation in California, but also communicating their findings to resource managers, the business community, and the public.

This year also marked a continuing and increasing commitment to making climate science useful and useable to DOI resource managers, decision makers, and other users of climate information. SW CSC-funded research resulted in new insights into creating successful collaborations between scientists and managers on resource management problems. Additionally, the SW CSC continued to expand its collaborative efforts with the Landscape Conservation Cooperatives (LCCs) and other partners in the region, including the Bureau of Reclamation, U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), Bureau of Land Management (BLM), Bureau of Indian Affairs, U.S. Forest Service (USFS), and the states of California, Nevada, Utah, and Arizona. The SW CSC worked with many of these partners to plan the 2015 Southwest Climate Summit, a two-day conference in Sacramento, California, designed to enhance information sharing and use among scientists, resource managers, and other stakeholders.

SW CSC research in 2014–2015 resulted in new tools and frameworks for anticipating, monitoring, and adapting to climate change impacts in the Southwest and elsewhere. This annual report provides an overview of the work of SW CSC researchers, graduate students, postdoctoral scholars, research affiliates, and staff.





Photo credit: California Department of Water Resources



# HIGHLIGHTS & MILESTONES 2

## SOUTHWEST CLIMATE SCIENCE CENTER'S NEW HOME

In the summer of 2015, the SW CSC moved into its new home in the Environment and Natural Resources 2 (ENR2) building on the campus of the University of Arizona in Tucson, Arizona. For the first time, federal and university SW CSC staff members are co-located, enhancing communication and collaboration. ENR2 features energy-efficient heating/cooling systems, rainwater harvesting, recycled construction materials, and other features aimed at LEED platinum certification. The new building houses the Institute of the Environment, the SW CSC's institutional home, as well as the School of Geography and Development, School of Natural Resources and the Environment, and other campus units. As the headquarters for flagship science, climate adaptation, and renewable energy programs, ENR2 creates an environment that facilitates collaboration among researchers, managers, and decision makers to develop innovative solutions and tools to anticipate, monitor, and adapt to climate change impacts in the southwestern U.S.







ANITA J.T. GOVERT



CHRISTINE L. SCHIRMER

## FULL TEAM

In 2014–2015, the SW CSC hired two new staff members: a half-time grants and contract coordinator, Anita J.T. Govert, and a full-time program and communications manager, Christine L. Schirmer. Govert, who joined the team in early August 2014, has extensive experience in grant management, having held similar positions at all three of Arizona’s universities, and she has received the Governor’s Excellence Award for grants management training design. In her new position, Govert focuses on all aspects of grants and contract administration generated by the SW CSC award.

Christine L. Schirmer, who joined the SW CSC in August 2015, coordinates communication between SW CSC researchers and stakeholders and assists with strategic planning and program development. Prior to joining the team, Schirmer worked at the Broad Institute of MIT and Harvard as well as the University of Arizona’s Department of Ecology and Evolutionary Biology, where she managed projects, facilitated communications, and developed systematic solutions to organizational needs.

## STRATEGIC PLANNING: TOWARD SW CSC 2.0

In April 2015, the SW CSC launched a strategic planning process to reflect on the first four years of operation, re-examine scientific and programmatic goals, and develop a roadmap for achieving its vision of enabling enhanced preparation for the ongoing impacts of climate change on the Southwest’s natural resources. Anthos Consulting led this process pro bono, interviewing more than 100 people representing the diverse partners and stakeholders of the SW CSC to produce a suite of future institutional scenarios. Anthos staff presented the five scenarios in a pair of two-day workshops (April 2015 in Tucson, Arizona; September 2015 in Sacramento, California). Approximately 35 participants attended each strategic scenario-planning workshop, including resource managers, tribal representatives, U.S. Geological Survey (USGS) scientists and managers, LCC staff, and SW CSC researchers and staff. Through a process known as Future Mapping, participants worked in teams to explore strategies that could operationalize each of the future scenarios, in addition to identifying common actions that could ultimately advance the mission of the SW CSC. In the coming year, outcomes of the workshop will be used to form the foundation of an updated strategic plan.



# AWARDS & HONORS 4

## SW CSC PRINCIPAL INVESTIGATOR ELECTED TO NATIONAL ACADEMY OF SCIENCES

SW CSC principal investigator Glen M. MacDonald was elected to the National Academy of Sciences in recognition of his distinguished and continuing contributions in original research. MacDonald is the John Muir Memorial Chair of Geography and a Distinguished Professor in the Geography and Ecology and Evolutionary Biology departments at the University of California, Los Angeles (UCLA). He is a former UC presidential chair and former director of the UCLA Institute of the Environment and Sustainability. MacDonald is active in the dissemination of information about climate change and environmental change to policymakers and the public.

## SW CSC PRINCIPAL INVESTIGATOR AWARDED HELMUT LANDSBERG AWARD

SW CSC principal investigator Kelly Redmond received the 2015 Helmut Landsberg Award from the American Meteorological Society in recognition of his distinguished career in applied urban climatology. Redmond, who is the regional climatologist for the Western Regional Climate Center at the Desert Research Institute (DRI), has worked on a wide range of topics, including climate variability, climate dynamics, drought frequency, data management, and much more. He has been an active participant in a number of important efforts, including the NOAA Regional Climate Center Program, the National Integrated Drought Information System (NIDIS), and the CalFed Bay-Delta Program.

## SW CSC PRINCIPAL INVESTIGATORS SELECTED AS AGU FELLOWS

SW CSC principal investigator Glen M. MacDonald and SW CSC University Director Jonathan T. Overpeck have been selected as 2015 American Geophysical Union (AGU) Fellows. Being elected a Union Fellow is a tribute to those AGU members who have made exceptional contributions to earth and space sciences as valued by their peers and vetted by section and focus group committees. This honor is bestowed on only 0.1 percent of the membership in any given year.

## SW CSC DIRECTOR NAMED A FELLOW OF THE ECOLOGICAL SOCIETY OF AMERICA (ESA)

SW CSC Director Stephen Jackson was selected as a fellow of the Ecological Society of America (ESA). The ESA states that it “designates as Fellows of the Society certain members who have made outstanding contributions to a wide range of fields served by ESA.” Jackson is one of 12 ESA Fellows elected for 2014.





Photo credit: California Department of Water Resources



## 2012 PROJECTS: RESULTS

### Climate Change Vulnerability of Native Americans in the Southwest

**Principal Investigator:** Karletta Chief, University of Arizona

**Collaborators:** Aleix Serrat-Capdevila, and Edward Schuyler Chew, University of Arizona; William J. Smith, Jr., University of Nevada, Las Vegas; David E. Busch, USGS

The challenges posed by climate change to the Pyramid Lake Paiute Tribe in Nevada exemplify the vulnerabilities faced by other Native Americans. The tribe's vulnerability to climate change is connected to cultural and economic dependencies on Pyramid Lake and two of its important fish species: cui-ui (*Chasmistes cujus*) and the Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*). Warmer water temperatures, reduced water supply, and diminished water quality impact these fish species, thereby threatening the tribe's traditions and economic livelihood.

The project, which was completed in 2014, monitored and assessed ecological indicators related primarily to the lake's hydrology and the ecology of the two fish species. Additionally, the research team held a workshop with tribal members to help identify other climate change-related problems and challenges facing the community and provided suggestions for management alternatives. During a public meeting in August 2014, the research team presented 19 adaptation recommendations. To address tribal members' concerns about how the lake's elevation might be affected by climate change, researchers developed a hydrologic water-balance model that simulates and predicts lake elevation over time that can be used by tribal managers in adaptation planning and educational outreach.

**Project website:** <http://nativeadaptation.arizona.edu>

### Downscaled Climate and Hydrologic Response for California and the Great Basin

**Principal Investigator:** Lorraine Flint, USGS

**Collaborators:** Alan Flint, USGS; James Thorne, University of California, Davis; Stuart Weiss, Creekside Science; Deanne DiPietro, California LCC

As the predicted impacts of climate change are becoming more apparent, natural resource managers are faced with the task of developing climate adaptation plans. These managers need state-of-the-art, scientifically sound, and accessible climate and hydrological information upon which to base plans and decisions that are consistent across the region. This project, which focused on California and the Great Basin, provided managers with the datasets, maps, and interpretive information they need.

Working closely with web developers, the researchers provided user-friendly tools and guidance from site to regional scales with direct feedback from natural resource managers for utility, understandability, relevance, and accessibility. The climate data developed for this project represent three major efforts that involved procuring Global Climate Models (GCMs), downscaling the GCMs to a fine scale for model application, and running the fine-scale versions through a landscape hydrological model: Basin Characterization Model for California and the Great Basin. Historical climate and hydrology projections and a variety of future GCM and emission scenarios are provided. All climate data have been downscaled to 270 meters for both California and the Great Basin. Fine-scale climate and hydrologic derivatives have been shown to be particularly applicable to biological studies, describing species distributions, resilience, and potential vulnerability.

**Datasets:** <https://nccwsc.usgs.gov/display-project/4f8c6580e4b0546c0c397b4e/5012a20de4b05140039e02c6>



## Downscaling Climate Change Models to Local Site Conditions: Effects of Sea-Level Rise and Extreme Events on California Coastal Habitats

Principal Investigators: John Y. Takekawa, USGS, and Glen M. MacDonald, UCLA

Co-investigators: Rich Ambrose, UCLA

Climate change impacts such as sea-level rise are altering the productivity and diversity of ecosystems along the California coast, but little is known about the exact ways in which these ecosystems are being affected or how they will change in the future. The overall goal of this project was to assess the vulnerability of California's salt marshes to sea level rise to provide scientific information to support future planning and conservation of coastal natural resources as the climate changes.

The research team calculated tidal sediment fluxes within Seal Beach National Wildlife Refuge, a fragmented salt marsh with no external sediment source, and Mugu Lagoon, a much less impacted marsh with a robust terrestrial sediment source. The project, which was completed in September 2015, measured suspended sediment concentrations and vertical accretion on the marsh plain. The project collected 70 sediment cores from eight marsh locations, which were photographed, described, tested for magnetic activity, and analyzed for organic and mineral content. Rates of sediment accretion were calculated using radioisotopic dating techniques. The project resulted in a better understanding of historical rates of sediment accumulation and present accretion. These findings are documented in recent and forthcoming articles.

Map files: <https://nccwsc.usgs.gov/display-project/4f8c6580e4b0546c0c397b4e/504756d5e4b067bd38f7f457>

# Seal Beach

## NATIONAL WILDLIFE REFUGE

## HEADQUARTERS



*U.S. Fish and Wildlife Service  
Department of the Interior*





## Multi-Criteria Sensitivity Analysis of The Vulnerability of Hydrologic Systems to Climate Variability and Change in the Southwestern U.S.

Principal Investigator: Ty Ferré, University of Arizona

Collaborators: Jesse E. Dickinson, USGS; Christopher L. Castro and Peter A. Troch, University of Arizona

The potential consequences of climate variability and climate change have been identified as major issues for the sustainability and availability of water resources in the U.S. Long-term decreases in precipitation will result in lower regional groundwater levels, loss of groundwater storage for communities, streamflow depletion, and loss of riparian vegetation. This project, which was completed in 2014, examined how hydrologic systems in the Southwest respond to climate changes and how this response depends both on the frequency of the changes and the properties of the system.

The research team developed a comprehensive system and screening tool that scientists or water resource managers can use for creating maps of watersheds that indicate the degree to which climate variability affects recharge to aquifers. Climate-controlled recharge can affect the amount of stored water in aquifers, which is important information for water managers. As water resources become more limited, an understanding of how climate variability affects recharge may produce more accurate forecasts of water resources. This tool is available to resource managers to predict if climate variations, such as the El Niño-Southern Oscillation (ENSO) phenomenon, affect the variability of aquifer storage.

**Datasets:** <https://nccwsc.usgs.gov/display-project/4f8c6580e4b0546c0c397b4e/5012a706e4b05140039e02cf>

## 2013 PROJECTS: PROGRESS AND RESULTS

### 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 and Hsin-I Chang, University of Arizona

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. This project contains both regional climate and hydrologic modeling components designed





Photo Credit: Ralph Earlandson

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 is a synergistic relationship between the occurrence of extreme wet or dry conditions and the natural variability of the ENSO 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.

The research team advanced its efforts to dynamically downscale global climate models for regional climate modeling, comparing model results with historic records. Model test simulations of individual years demonstrated reasonable results in terms of the spatial distribution of precipitation and temperature and climatological evolution of precipitation and temperature over an annual cycle. A methodological approach for dynamically downscaling of new 20th Century Atmospheric Reanalysis was also completed, which will provide a 100-year retrospective regional climate simulation.

**Project website:** <http://swclimatehydro.wordpress.com>

## Evaluating the Impact of Climate Science Produced in the Southwest Climate Science Center on Resource Management Agency Decisions

Principal Investigator: Alison M. Meadow, University of Arizona

Collaborator: Tamara Wall, DRI

Few evaluations of actual collaborative science or coproduction processes have been undertaken that can point to specific outcomes for either resource management or science decisions. This project was developed to evaluate the approaches used by SW CSC-funded investigators to collaborate with agency managers and stakeholders with the goal of identifying a set of best practices that improve both management and collaborative research process-related outcomes.

The research team completed an extensive literature review of previous work on the process and outcomes of coproduction of actionable science, which included performance metrics for all pertinent federal agencies. The researchers then conducted interviews with several groups that could provide insight into the process of science coproduction. An extensive review of current performance metrics was undertaken for relevant DOI agencies, programs with similar missions, and several development agencies that have instituted strong evaluation components. The research team developed a draft evaluative framework using a process called Outcome Mapping, which was developed by the International Development Research Centre, and then used the framework to assess how well draft indicators suited the projects selected as case studies.



## Influence of Interannual North Pacific Jet Variability on Sierra Nevada Fire Regimes

**Principal Investigator:** Valerie Trouet, University of Arizona

**Collaborator:** Julio Betancourt, USGS

The position of the North Pacific Jet (NPJ), a high-altitude, narrow path of strong winds over the northern Pacific Ocean, is a key determinant of snowpack variability in California. The research team proposed to use tree-ring data to reconstruct NPJ variability over the last 400-plus years, allowing them to put current NPJ trends in a historical context and study the occurrence of NPJ periodicity and extremes. Historical fire data (1500–1900 CE) are being used to examine NPJ influence on California fire regimes. This 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.

The research team has completed three key steps: (1) compilation of 20th century NPJ data and selection of the optimal target for reconstruction; (2) compilation of tree-ring data and development of a tree-ring based NPJ reconstruction; and (3) compilation of Sierra Nevada fire history data and comparison to NPJ reconstruction. The project's objectives were modified when it became clear that tree-ring based NPJ reconstruction using the existing tree-ring records would not be feasible before about 1870 CE. In modifying its objectives, the research team focused on the translation of its data products and management applications for use by fire and fuels managers.

## Linking Climatic, Hydrological, and Ecological Changes at Intermediate Timescales in a Great Basin Watershed

**Principal Investigator:** Alexandra Lutz, DRI

**Collaborators:** Rosemary Carroll, Guoping Tang, and James Thomas, DRI; Joseph F. Leising, Leising Geoscience; Keely Brooks, Southern Nevada Water Authority; Michael Dettinger, USGS

This project links climate, hydrological, and ecological changes at intermediate timescales for the next 30 years in the Cleve Creek watershed in the eastern Great Basin. Researchers hypothesized that observed lag times between climate and hydrologic changes affect vegetation on annual to decadal intervals and impact available water resources. Project researchers used the Rasterized-Regional Hydro-Ecological Simulation System (R-RHESSys) model along with the Cleve Creek groundwater/surface water model and ancillary information from another study to test this hypothesis. By using a “model linking structure,” the project was able to compare two observed droughts, compare two observed pluvial periods, observe a downscaled global climate model projection, compare two projected droughts, and compare two projected pluvial periods.





# The Big Picture: Making Science Useful to Managers

Social scientists Alison Meadow and Tamara Wall have the “big picture” in mind for the goal of their research: they want to help climate scientists make their research useful to land managers. Although their goal seems straightforward enough, it turns out that the devil is in the details.

With funding from the SW CSC, Meadow and Wall are exploring the best practices for successful collaboration between scientists and managers on resource management problems. Often called coproduction of knowledge, this process is an effective way to produce climate science that is useful to resource managers. There are general principles for making coproduction successful, including establishing long-term relationships, ensuring two-way communication, and focusing on the production of useful science. But beyond these general principles things get murky.

How do you build a long-term relationship between a scientist and a manager? Where do you start? What kind of communication is most effective? These are the types of questions Meadow and Wall are asking and what they are finding offers insights to both scientists and resource managers.

“Engagement requires some thoughtfulness and needs to be considered at the beginning of any project, just as a scientist would think about research methods,” said Meadow, a social scientist at the University of Arizona. “Not every project will benefit from intensive collaboration between scientists and managers, but we should be aware of the context and the questions being asked and identify the engagement methods that are most appropriate. Context matters.”

Meadow and Wall recently co-authored a paper with scientists from the Climate Assessment for the Southwest, or CLIMAS, that describes the types of interaction and communication that lead to effective coproduction and five approaches designed to guide the research process. Coproduction can be improved by first understanding the questions raised by the resource manager, the context in which the questions arise, and the resources available to address the questions. This information will help in selecting the appropriate coproduction approach.

“There are many different rooms in the coproduction house,” noted Wall, a researcher at the Desert Research Institute. “Those scientists successfully engaged in coproduction are those willing to do the time-consuming work of building relationships and sharing information.”

For their part, Meadow and Wall are hopeful that scientists and resource managers are becoming more effective in working together to answer climate-related questions. These types of collaboration hold tremendous potential for improving the ways science is integrated into management decision-making activities. Meadow and Wall have noticed a shift in the way that management agencies are using science in decision making as the result of coproduction, and participating scientists are enthusiastic.





Photo credit: USDA Forest Service

Because of the increased severity of drought in Nevada during the project period and stakeholder interest, project efforts focused on evaluating current and future drought.

Concluded in September 2015, project results and products include information and figures for vegetation productivity, evapotranspiration, soil moisture, groundwater level, streamflow, and snowpack. Project products, including figures and verbal explanations of historic and future climate and streamflow conditions, have been distributed at White Pine County Water Advisory Committee meetings. All project information will be made available through the Great Basin LCC website.

### **Natural Variability in the Changing Climate: Interaction of Interannual, Decadal, and Century Timescales with Daily Weather and a Focus on Extreme Events**

Principal Investigator: Alexander Gershunov, Scripps Institution of Oceanography (SIO), and Daniel R. Cayan, SIO and USGS

Collaborators: Suraj Polade and Kristen Guiruis, SIO

Natural climate variability can obscure or enhance long-term trends in experienced weather resulting from climate change. This can happen temporarily on timescales of a season or for a decade or two. Natural variability is poorly described and attributed to specific causes, contributing to uncertainty and misunderstandings about the nature of climate change. The research team has conducted assessments that clarify the effects 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.

The researchers have developed an approach to summarize seasonal behavior of daily temperatures over the Southwest that has proven to be successful and powerful in the assessment of natural variability and trends in the seasonal statistics of daily weather across the Southwest. In particular, this research has highlighted the preferential importance of cold and warm extremes in determining the average seasonal temperatures. Project research also has detected a clear precipitation regime change signature. Recognizing the relevance of atmospheric rivers (ARs) to the projected changes in the precipitation regime over the Southwest, the project has developed an automated detection scheme for ARs and created a catalog of ARs affecting the western U.S. dating from 1948 to the present.

### **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, and Matthew Williams, University of California, Davis



Photo credit: Patrick Berry

The project 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, the research team has worked with stakeholders to develop efficient decision-support tools, knowledge networks, and climate science targeted specifically to meet the needs of managers and decision makers.

The project team has conducted four consultative group meetings (Reno, Nevada; Sacramento, California; Tucson, Arizona; and Salt Lake City, Utah) to query resource planners and managers on how they integrate climate information into adaptation planning. Participants were asked their opinions on the capacity of climate information and climate change training to inform their decision-making processes. A content analysis of decision documents was conducted for the USFS, BLM, NPS, and USFWS to develop a quantitative assessment of the kinds of decisions facing Southwest managers and determine which documents mention climate in the decision process. These results have not yet been analyzed. The research team is beta testing an electronic survey to be issued to USFS, BLM, NPS, and USFWS staff who have engaged in decision documents. The purpose of the survey is to determine how these individuals view using climate information and how they envision integrating climate change into adaptation decisions.

## 2014 PROJECTS: PROGRESS

### Disentangling the Influence of Cool Season Temperature and Precipitation on Colorado River Water Resources Using Paleo Data

Principal Investigator: Connie Woodhouse, University of Arizona

Collaborators: Adam Csank, DRI; Gregory Pederson and Stephen T. Gray, USGS

**Water Manager Partners:** Jim Prairie, Bureau of Reclamation; Eric Kuhn and Dave Kanzer, Colorado River District; Lurna Kaatz and Steve Schmitzer, Denver Water; Paul Miller, NOAA Colorado Basin River Forecast Center; Charlie Ester and Jon Skindlov, Salt River Project

Snow-fed rivers of the western United States are becoming especially vulnerable to warm spring temperatures, which, along with dry winters, are increasingly contributing to low flows. While winter precipitation is very important to the water supplies that result from melting snow, temperatures in spring can also have an important impact on river flow and water supplies. Using existing Colorado River streamflow and winter precipitation reconstructions for the past 1,000 years, this study is evaluating past droughts to investigate the different combinations of temperatures and winter precipitation that have contributed to past droughts. The research team is collaborating with water managers to help them determine how warming temperatures may influence river flow in the future.



This project has reached several milestones in its first year, completing the instrumental analysis for the Upper Colorado River Basin and major sub-basins for periods of drought, progressing on the reconstruction and analysis of prior soil moisture and winter/spring temperatures, and developing a project website. The research team has made presentations at meetings with water manager partners, including a workshop with representatives from all of their management partner agencies that described the project's results to date.

**Project website:** <http://www.nrm-sc.usgs.gov/ColoradoRiverWater>

## A Coastal Site Network for Advancing Understanding and Prediction of Climate Change Effects on Nearshore Ecosystems: Integrating Interdisciplinary Process Studies

Principal Investigator: Karen M. Thorne, USGS

Former Principal Investigator: John Y. Takekawa, USGS

Collaborator: Glen M. MacDonald, UCLA

In California, the nearshore region where the ocean meets the land is a highly productive area that supports a wealth of natural resources and local communities. The salt marshes, mudflats, and shallow bays of this boundary region are connected habitats critical to sustaining wildlife and other resources. Climate change effects such as sea level rise and increased storms are altering these habitats, but it is not known how they are being affected or will change in the future. This project is examining the links among these habitats and expected future changes at several sites along the California coast to support future planning and conservation of nearshore natural resources as the climate changes.

In its first year, this project demonstrated progress in three key areas: (1) establishing a collaboration involving USGS and resource managers to measure water level, salinity, temperature, and Surface Elevation Table (SET) at a network of research sites; (2) examining site-specific community response to inundation; and (3) delivering and transferring project results to resource managers. Instruments were deployed at all research sites. The research team designed a “marsh organ” experiment that allowed them to examine flooding effects on three common northern California species. Three in-person science delivery workshops, lasting one to two days, were held in California at Humboldt Bay (October 2014), San Pablo Bay (September 2014), and San Diego (December 2014) estuaries. More than 100 participants attended from federal, state, and local management agencies.

From these projects, the project team is now conducting a study to determine if sediment augmentation is an effective way to increase marsh elevation and improve cordgrass-dominant salt marsh habitat. Project modeling work has resulted in the decision of the USFWS to test this climate change adaptation strategy.

## Assessing Climate Change Vulnerability and Adaptation in the Great Basin: A Policy Perspective on Resource Managers and the Use of Science in Decision Making

(Funded Jointly by the Northwest CSC and Southwest CSC)

Principal Investigator: Eric Lindquist, Boise State University

Co-Investigator: Shawn Benner, Boise State University

Collaborator: Mark Brunson, Utah State University; Matt Germino, USGS, Great Basin LCC; Todd Hopkins, USFWS, Great Basin LCC; Richard Klein, Stockholm Environment Institute; Denise Lach, Oregon State University; Stephanie Witt, Boise State University; Tamara Wall, DRI

Resource managers in the Great Basin are dealing with significant questions regarding how best to make decisions for the natural and human systems in response to climate change. Vulnerability assessments and other tools are used for climate change adaptation, but their effectiveness is not widely understood or examined. This project is assessing these tools for their utility and for their ability to translate science into accessible and available information for users, including the general public.

In its first year, the project team conducted a literature review of vulnerability assessments in general and those specific to resource management; wrote summaries from these literature reviews to help frame subsequent tasks; developed an inventory of the Great Basin resource management stakeholder network and mapped them against the Great Basin LLC boundaries for future reference; and initiated informal and formal stakeholder interviews and survey designs.

## Development, Delivery, and Application of Data on Climate Extremes for the Southwestern United States

Principal Investigator: Erica Fleishman, University of California, Davis

Collaborators: Alexander Gershunov, SIO; Daniel R. Cayan, SIO and USGS; Kelly Redmond, Britta Daudert, and Nina Oakley, DRI; Kristen Guirguis, David Pierce, Suraj Polande, and Seethala Chellappan, SIO; Michael Dettinger, SIO and USGS; Jonathan Overpeck, University of Arizona; Mark Schwartz, University of California, Davis

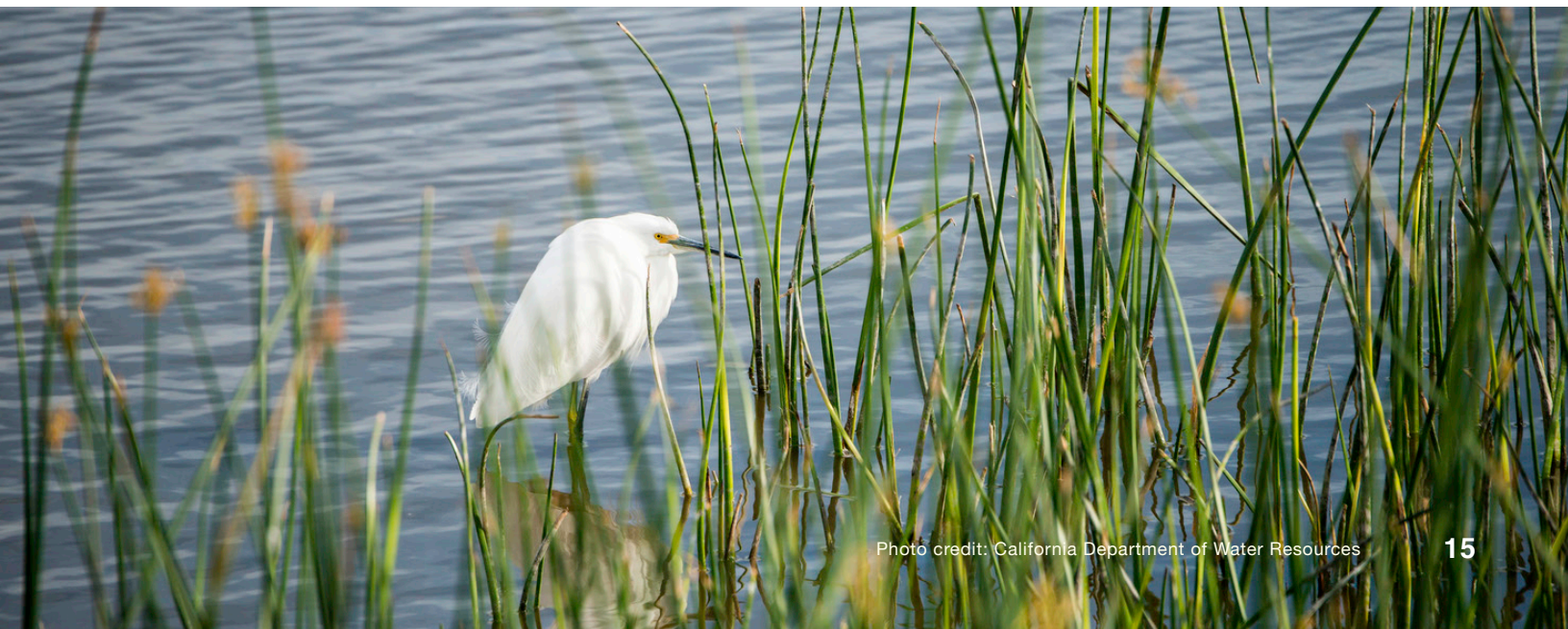
Extreme climate can have substantial effects on endangered species such as the Mojave desert tortoise and on non-native invasive species such as cheatgrass. Changes in extreme temperature and precipitation also are likely to affect the health of people who use or visit public lands. By 2100, droughts of 10 or more years are likely to become more frequent. There are likely to be fewer wet days per year, and there is likely to be more precipitation on those few wet days. This research project is examining how such precipitation extremes may affect numerous ecological processes, from streamflow to fire.

The research team identified a set of 10 global climate models on the basis of their ability to replicate climate variables at global, regional, and California-wide extents. Downscaled data for these models were used as inputs to a variable infiltration capacity (VIC) model to simulate the surface water and energy balances. Researchers have begun evaluating relations between maximum and minimum temperature and seasonal mean temperatures, and relations of temperature extremes and means to El Niño, La Niña, and the Pacific Decadal Oscillation. To improve the delivery of data through a web-based platform that allows users to obtain data from weather stations across the region or from climate models, the project team has undertaken programming and hardware upgrades. During the past year, two working groups were established to apply data on climate extremes to ongoing research.

## How Does Climatic Stress at Intermediate Timescales Influence Fire Severity?

Principal Investigators: Phillip van Mantgem, USGS, and Donald A. Falk, University of Arizona

Drought and fire are two well-known hazards expected to increase in the Southwest in an era of climate change. Might the effects of drought and fire combine to cause even greater risks for southwestern forests in





the future? This project is solving part of this puzzle by discovering how drought might weaken trees, leading to increased tree death following fires. It is important to understand how drought and fire might work together to cause tree death; more frequent tree deaths will mean compromised wildlife habitat, increased erosion, and greater carbon emissions following fires across the Southwest.

The research team has collected data and tree cores at 265 plots at 11 NPS units, including Yosemite National Park, Sequoia National Park, Bandelier National Monument, Bryce Canyon National Park, El Malpais National Monument, Grand Canyon National Park, Zion National Park, Crater Lake National Park, Lassen Volcanic National Park, Lava Beds National Monument, and Whiskeytown National Recreation Area. Analysis of collected cores is progressing at the University of Arizona's Laboratory of Tree-Ring Research.

**Project website:** <http://www.werc.usgs.gov/project.aspx?projectid=278>

## Linking Interannual Variations of Extreme Storms with Ecological and Hydrologic Disturbance in the Sierra Nevada

**Principal Investigator:** Christine Albano, University of California, Davis, and Mike Dettinger, USGS and SIO

**Collaborators:** Christopher Soulard, USGS; Maureen McCarthy, University of Nevada; Dale Cox, USGS; Justin Huntington, DRI; Miguell Villarreal, USGS

Most extreme Pacific coast storms are strongly linked to atmospheric rivers (AR), which are long corridors of water vapor transport. These storms have costly and long-lasting societal and ecological impacts. This project is developing a historical AR chronology that identifies extreme storm events that have affected the Southwest during the past 30 years. Specifically, it is examining how extreme storms, and especially ARs, have affected Sierra Nevada and western Great Basin ecosystems, including effects on snowpack, streamflow and water supply, vegetation productivity, and fire characteristics.

The AR chronology is close to completion, with the research team leveraging work by colleagues at the Center for Western Weather and Extremes to revise their approach. Through a collaboration with DRI, data processing has been made more efficient, and the project has access to data at higher (30-m Landsat) spatial resolution and larger spatial extents than originally anticipated. This collaboration also has allowed more resources to go toward an analysis of meadow vegetation responses to interannual variability in climate, specifically ARs, in the Sierra Nevada—information that USFS managers identified as useful. Statistical modeling is progressing to address three primary hypotheses. Key publications are anticipated describing patterns of meadow-AR-climate relationships and the results of broader scale vegetation-climate-fire analyses.





## Training a New Kind of Climate Scientist

Like our understanding of climate change, climate science and its practice are evolving. Today, climate science is not only about scientific research, but also increasingly requires translating research findings into information, tools, and techniques that can be used by on-the-ground managers. Christine M. Albano is one of a new breed of climate scientists doing just this.

Albano joined the SW CSC in January 2012 as a research associate with the John Muir Institute of the Environment at University of California, Davis, which is a key SW CSC partner. Albano was selected because, in addition to her competency as a biologist, she was sincerely interested in the social aspects of translating conservation science into policy.

“I want to make a difference, and I believe this involves first understanding the management challenges and questions and drawing on these to develop practical science questions,” Albano said. “Like many other early career scientists in this field, I am more interested in the nexus of climate science and application than traditional academic research.”

Albano’s SW CSC research has examined empirical issues, including the degradation of rangelands, post-fire grazing, and conservation priority areas, as well as conceptual and methodological issues. Her position also has afforded Albano the opportunity to work closely with stakeholders, particularly natural resource managers. She was instrumental in the development of the SW CSC’s stakeholder consultative groups, which are helping to focus the center’s efforts in decision support and information transfer.

Albano is involved in helping managers develop climate-adaption strategies; recent work includes developing a new approach that uses geophysical diversity, including topography and soils, to identify lands in the Southwest that offer the best opportunity to protect biodiversity in the face of climate change.



## 2015 PROJECTS: FUNDED

### Relations Among Cheatgrass-Driven Fire, Climate, and Sensitive-Status Birds Across the Great Basin

(Funded jointly by the Southwest CSC and Northwest CSC)

Principal Investigator: Erica Fleishman, University of California, Davis

Collaborators: Jennifer Balch, University of Colorado, Boulder; Bethany Bradley, University of Massachusetts, Amherst; Ned Horning, American Museum of Natural History; Matthias Leu, College of William and Mary; Ralph Mac Nally, University of Canberra; Todd Hopkins, Great Basin LCC; Mike Pellant, BLM

As the distribution and abundance of nonnative cheatgrass (*Bromus tectorum*) in the Great Basin has increased, the extent and frequency of fire in the region has increased by as much as 200 percent. These changes in fire regimes are associated with loss of the sagebrush (*Artemisia tridentata*) and native grasses and forbs in which many native animals, including greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage grouse), breed and feed. Changes in fire regimes, fuels treatments, and post-fire restoration have been suggested with the intent of increasing the probability of sage-grouse persistence. However, the potential responses of other sensitive-status birds to these interventions have not been assessed rigorously. This project will model current and future (to 2050) spatial interactions among cheatgrass cover and biomass, precipitation, and fire across the Great Basin and model current and future cover of sagebrush and herbaceous vegetation. The research team will also examine projected changes in fire regimes and fire and fuel treatments that may affect habitat quality for and probability of occupancy of sensitive-status breeding birds. Statistical analyses will be used to detect any abrupt, nonlinear temporal changes in projected vegetation cover, habitat quality, and occupancy.

### Can Management Increase Forest Resistance to Drought?

Principal Investigator: James Thorne, University of California, Davis

Collaborators: Phillip van Mantgem, Adrian Das, USGS; Carlos Ramirez, Hugh Safford, USFS; Susan Ustin and Mark Schwartz, University of California, Davis; Anthony Ambrose, University of California, Berkeley

The San Joaquin region of Southern California is currently undergoing the most severe drought in its recorded history. In the central and southern Sierra Nevada, federal land managers are scrambling to respond to this event, but they lack information needed to make informed decisions. It is assumed that removing small trees using a combination of mechanical thinning and/or prescribed fire will result in reduced competition for water and light and allow the remaining trees to be more resistant in the face of stressors, such as drought. Yet this proposition remains largely untested. This project will integrate extensive field data with remote sensing and GIS to inform a key management decision for forest climate change adaptation: Are current thinning prescriptions sufficient to promote forest health under severe drought conditions or will prescriptions need to be more aggressive to meet this goal under increasingly frequent drought?

### Feedback Index for Assessing the Impact of Restoration on Ecohydrological Processes in Response to Variable Climate

Principal Investigators: Ty Ferré, University of Arizona, and Jesse Dickinson, USGS

Collaborators: Bill Radke and Sally Flatland, USFWS; Liz Petterson, Arizona Land and Water Trust; James B. Callegary, USGS; Christopher Castro and Hsin-I Chang, University of Arizona

Resource managers must balance the impacts of competing management decisions on multiple, interacting natural systems. Hydrologic and ecological processes, such as groundwater fluctuations and riparian evapotranspiration, can be tightly coupled. Ideally, managers would have tools and models that include all processes to better understand how each management action would propagate through the environment. The goal of this project is to develop a metric of hydrologic feedback strength for weighing the impact of

conservation and restoration actions. Modeling and feedbacks will be used to quantify how hydrologic processes or restoration can amplify or absorb the effects of climate variability on riparian systems. The project's framework also allows scientists to assess which processes are critical for hydrologic models to predict response to climate change. Using these index values, managers can predict which processes will amplify or absorb the potential effects of variable climate, climatic change, and proposed restoration actions.

## Fighting Drought with Fire: Can Managers Increase Forest Resistance to Drought Using Prescribed Fire?

Principal Investigators: Phillip van Mantgem, USGS; and Donald A. Falk, University of Arizona

Collaborators: Matthew L. Brooks, Adrian J. Das, Nathan L. Stephenson, USGS; MaryBeth Keifer, NPS

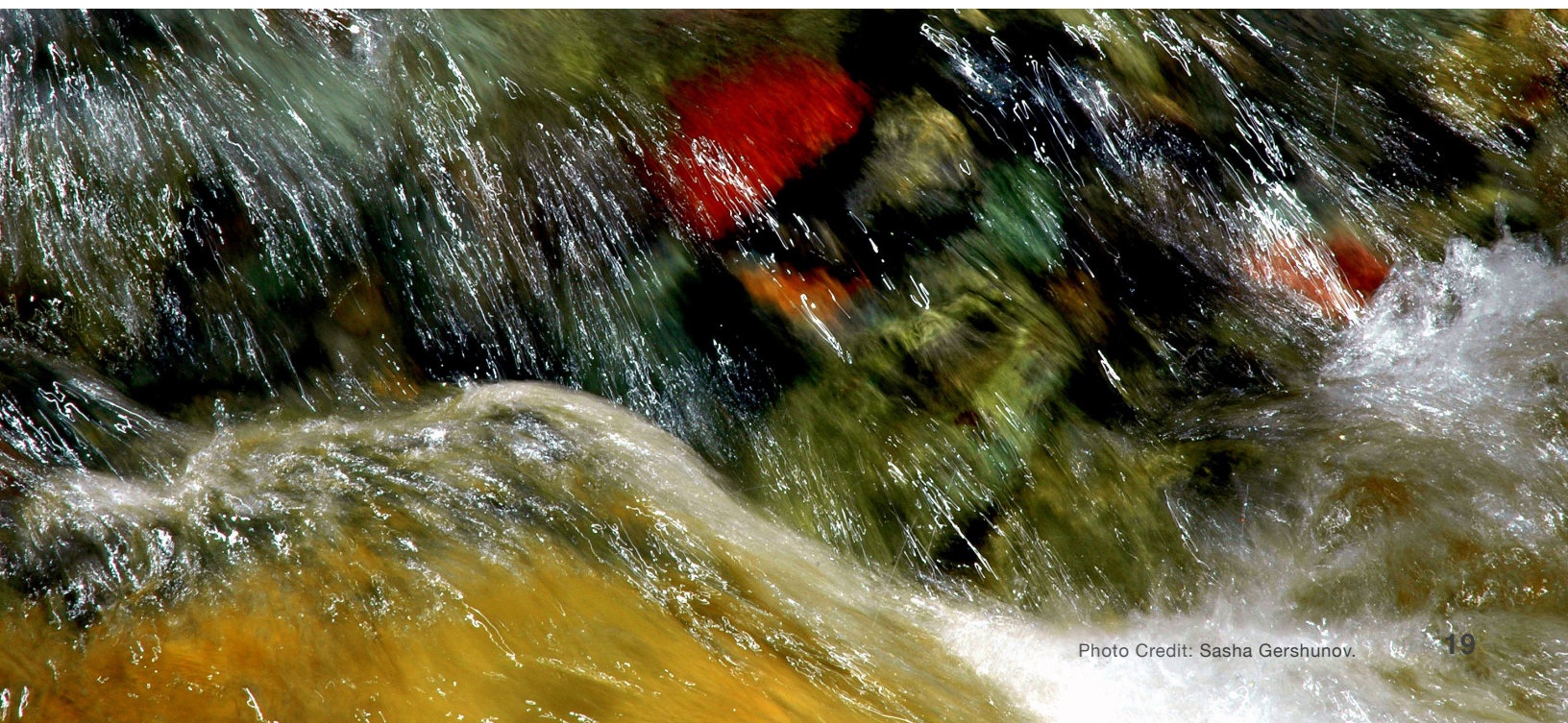
Prescribed fire is a primary tool used to restore southwestern forests following more than a century of fire exclusion. Prescribed fire reduces fire risk partly by removing small trees, shrubs, and surface litter; it is also assumed there is less competition among remaining trees after a fire so they are more resistant in the face of additional stressors, such as drought. Yet this proposition remains untested. The severe and ongoing drought across much of the southwestern U.S. provides a remarkable natural experiment to test whether prescribed fire helps trees survive stressful conditions. If current practices for modifying forest conditions through fire are found to increase drought resistance, this project could help forest managers apply these methods across western forests more broadly. The results of this study may change management policy to maximize resource benefit from fire.

## Hydrologic Response of Atmospheric River Events in the Salt and Verde River Basins: Climatology and Possible Future Changes

Principal Investigator: Francina Dominguez and Juan Valdes, University of Arizona

Cooperators/Partners: Eleonora Demaria, University of Arizona; The White Mountain Apache Tribe; The Nature Conservancy; City of Chandler; City of Peoria; Salt River Project; Henry F. Diaz, NOAA-CIRES; Erick Nieves-Rivera, USGS

The Salt and Verde river basins in northeastern Arizona are a vital source of fresh water for the greater Phoenix metropolitan area and for two tribal reservations that rely on the basins' natural resources for their livelihood. Winter precipitation in this region is modulated by the occurrence of narrow river-like corridors of water vapor in the atmosphere, or atmospheric rivers (ARs), that replenish reservoirs, maintain natural





ecosystem health, and alleviate droughts. However, these ARs are also linked to the basins' most intense storms that can cause flooding, resulting in turbid waters that are not treatable for human consumption. This project will examine how the hydrology of the Salt and Verde river basins have responded to extreme AR events in the past, how these events are affected by natural climate variability, and how they might be affected by future warmer temperatures. The project's outputs will give natural resource managers and local tribes improved seasonal predictability and a better understanding of the possible changes that ARs might bring to their watershed as the result of climate change.

## Impact of Drought on Waterbird Wetland Habitats, Bioenergetics, and Movements in the Central Valley of California

**Principal Investigators:** Joseph Fleskes, USGS, and Matthew Reiter, Point Blue Conservation Science

**Collaborators:** Michael L. Casazza, Elliott L. Matchett, Cory T. Overton, Josh T. Ackerman, and Mark P. Herzog, USGS; Sam Veloz, Point Blue Conservation Science; Gregory S. Yarris, Central Valley Joint Venture; Rebecca Fris, Mike Wolder, California LCC; Rachel A. Esralew, USGS; John Eadie, University of California, Davis; Mark Petrie, Ducks Unlimited

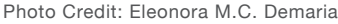
Wetland managers in the Central Valley of California require information regarding the amount and location of existing wetland habitat to make decisions on how to best use water resources to support multiple wildlife objectives, particularly during drought. Scientists from the USGS's Western Ecological Research Center, Point Blue Conservation Science, and the USFWS are partnering to learn how the flooded wetland habitats, which are often agricultural lands that are used by waterfowl and shorebirds, change through the year. During extreme drought conditions, the ability to provide sufficient water for wildlife often depends on the timing of water deliveries and decisions whether to fallow croplands. Waterfowl and shorebirds may be particularly affected by these decisions because they typically rest and feed in flooded habitats. Poor habitats resulting from improper water deliveries could reduce waterfowl hunting opportunities and body condition. The research team will develop near real-time tracking of waterbird habitats and connect it with near real-time tracking of waterfowl throughout the valley to learn which habitats the birds use and why. This information can be used to show how wetlands can be managed to provide the best possible habitat for waterbirds, even during extreme drought.

## Tribal Adaptation Initiative

**Principal Investigators:** Katharine Jacobs, University of Arizona

**Collaborators:** Chad Marchand, Karletta Chief, Alison Meadow, Edward Schuyler Chew, and Lynn Rae, University of Arizona

Native Nations face unique challenges related to climate change. Native Americans have a deep connection to the natural environment within which their livelihoods, cultural identity, and spiritual practices are rooted. Changes to hydrologic regimes, landscapes, and ecosystems, in combination with socioeconomic and political factors, amplify tribal vulnerabilities to climate change. In the Southwest, tribes are already experiencing a range of impacts that are at least partially related to climate change. These impacts include serious water supply and water quality issues in the context of prolonged drought; loss of ecosystem services and reduced ability to grow or collect important traditional crops and raw materials; increased impacts to forest resources from large and landscape-transforming wildfires because of drought, aridity, and insect infestations; health impacts from heat waves, dust storms, and smoke from wildfires; and the potential spread of infectious diseases from geographic shifts in disease vectors. The remoteness of many villages also compounds difficulties in aiding tribal members during extreme weather events such as floods and heat waves, leading to over-stressed emergency management systems. This project seeks to help develop a partnership that leverages previously existing and newly developing tribal engagement capacity within the Center for Climate Adaptation Science and Solutions (CCASS) and identifies emergent opportunities now possible with enhanced investment.



**Working Group:** Richard Moss, Pacific Northwest National Laboratory; Mary Black, University of Arizona; Erika Rowland, Wildlife Conservation Society; Cat Hawkins Hoffman, NPS; Gregg Garfin, University of Arizona; Carolyn Enquist, USGS; Anne Waple, Second Nature; Jonathan Star, Scenario Insight

Decision makers and natural resource managers are increasingly being asked to make decisions in the context of uncertainty, with climate change adding new sources of complexity. Scenario planning approaches are being used as a means of providing managers with insights into options for responding appropriately to change in the near and long term. A workshop held at the University of Arizona in April 2015 brought together a group of 30 experts and practitioners to explore two things: lessons learned in applications of a variety of specific scenario planning techniques, and connections between the different methods that have emerged relative to how they frame uncertainty and how they function in a decision-support context. This project aims to harvest the knowledge that resulted from the workshop with the development of a report and scholarly article(s), and scope the production of a range of outputs that include:

- A broader toolkit of scenario methods and techniques for decision makers and improved connections with local and regional planners
- Practical suggestions for practitioners on how to use these techniques and in what combinations
- A list of research, institutional, and resource needs to improve the information available and the flow of information across methods in specific applications
- Curriculum development and training opportunities.



# PROFESSIONAL DEVELOPMENT 22

An essential part of the SW CSC mission is training the next generation of climate scientists. SW CSC-funded projects provide an essential training ground for doctoral and graduate students as well as postdoctoral fellows, providing opportunities for students and early-career professionals to work with leading climate science researchers.

Teresa Krause, a USGS postdoctoral fellow at SW CSC, participated in the 2015 Climate Boot Camp, which took place in Pack Forest, Washington. An annual week-long retreat organized by the Northwest CSC, Climate Boot Camp is designed to prepare the next generation of scientists, educators, policymakers, and resource managers for the opportunities and challenges of climate change.

The following students and postdoctoral researches were involved with SW CSC projects in 2014–15:

## GRADUATE STUDENTS

Christine Albano, University of California, Davis  
Lauren Brown, University of California, Los Angeles  
Jesse Dickinson, University of Arizona  
Katie Gibble, Boise State University  
Mary Glueck, University of Arizona  
Matthew King, University of Arizona  
Rajarshi Mukherjee, University of Arizona  
Lynn Rae, University of Arizona  
Jordan Rosencranz, University of California, Los Angeles  
Yareli Sanchez, University of California, Los Angeles  
Edward Schuyler Chew, University of Arizona  
Robert Shepard, University of Arizona  
Matthew Switanek, University of Arizona  
Matthew Williams, University of California, Davis  
Katherine S. Willis, University of California, Los Angeles

## POSTDOCTORAL RESEARCHERS

Dr. Soumaya Belmecheri, University of Arizona  
Dr. Seethala Chellappan, Scripps Institution of Oceanography  
Dr. James Holmquist, University of California, Los Angeles  
Dr. Teresa Krause, U.S. Geological Survey  
Dr. Julie Loisel, University of California, Los Angeles  
Dr. Suraj Polade, Scripps Institution of Oceanography

# A Framework for Stewardship: Identifying Lands with High Conservation Values

In the face of rapid global change, how can land managers better determine which lands are most suitable for conservation? Sound science helps. A research team, supported by the SW CSC and led by Brett Dickson and Luck Zachmann of Conservation Science Partners, Inc., and Christine Albano of the University of California, Davis, recently created a framework to identify lands with high conservation value in the West and elsewhere.

Protected areas such as wilderness areas and national parks often have been created to protect scenic beauty and other social values. Creating a system of beautiful places has been insufficient to stem the long-term loss of biodiversity.

Developing a protected area system that will secure that nation's natural heritage and biodiversity in the face of global change may require prioritizing the conservation of land on the basis of ecological factors.

The research team conducted a systematic analysis of lands administered by the Bureau of Land Management (BLM) in 11 contiguous western states. The BLM is responsible for the management more public lands than any other federal agency, and some 70 percent of BLM lands are found in these 11 states.

Seven ecological indicators were mapped to identify those lands with high biodiversity, potential resilience to climate change, and substantial landscape connectivity. This study specifically examined contiguous roadless BLM lands that are larger than 5,000 square acres and outside of existing special land-management designations, including national monuments, wilderness areas, and wilderness study areas.

Almost 17,000 square miles of land with relatively high conservation value and 117 potential conservation priority areas were identified. Overall, these potential priority areas had higher species richness, vegetation community diversity, topographic complexity, and surface water availability than existing BLM protected areas. In total, the 117 potential priority areas represent some 240 square miles of BLM lands primarily located in Utah, Colorado, Arizona, Oregon, and Nevada.

"This study represents the type of research that Climate Science Centers were created by the Department of the Interior to provide," said Jonathan Overpeck, the university director of the SW CSC. "Identifying the most ecologically valuable lands is one step toward ensuring the stewardship of the West's wildlife and natural systems."

These conservation priority areas represent a diverse set of places that present substantial opportunities for conservation. Land managers, policymakers, non-governmental organizations, and citizens can use the results of this study, which is published in *Biological Conservation*<sup>1</sup>, to inform landscape planning and conservation efforts. The methodological framework developed as the result of this research is readily applicable to other regions within the United States and beyond.

<sup>1</sup>Dickson, B. G., Zachmann, L. J., & Albano, C. M. (2014). Systematic identification of potential conservation priority areas on roadless Bureau of Land Management lands in the western United States. *Biological Conservation*. 178: 117–127.



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Photo Credit: Erica Fleishman

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Ward, P.J., B. Jongman, M. Kummerow, M.D. Dettinger, F.C. Sperna-Weiland, and H.C. Winsemius. 2014. Strong influence of El Niño/Southern Oscillation on flood risk around the world. *Proceedings of the National Academies of Sciences* 111(44):15659–15664.

Wright, A.N., R.J. Hijmans, M.W. Schwartz, and H.B. Shaffer. 2015. Multiple sources of uncertainty affect metrics for ranking conservation risk under climate change. *Diversity and Distributions* 21(1):111–122.







## REPORTS

Albano, C.M., D.A. Cox, M.D. Dettinger, K.D. Schaller, T.L. Wellborn, and M.I. McCarthy. 2014. *ARkStorm@Tahoe: Stakeholder Perspectives on Vulnerabilities and Preparedness for an Extreme Storm Event in the Greater Lake Tahoe, Reno, and Carson City Region*. University of Nevada Cooperative Extension Special Publication- 14–16, 43 p. [http://environment.unr.edu/publications/ARkStorm\\_Final\\_web.pdf](http://environment.unr.edu/publications/ARkStorm_Final_web.pdf)

Fejtek, S., M. Gold, G. MacDonald, D. Jacobs, and R. Ambrose. 2014. *Best management Practices for Southern California Coastal Wetland Restoration and Management in the Face of Climate Change*. University of California Los Angeles, Institute of the Environment and Sustainability. 49 pp.  
[http://docs.ballonarestoration.org/Fejtek%20et%20al.%20%282014%29%20-%20Wetland%20Restoration%20BMP%20Guide\\_sm.pdf](http://docs.ballonarestoration.org/Fejtek%20et%20al.%20%282014%29%20-%20Wetland%20Restoration%20BMP%20Guide_sm.pdf)

Glover, K.C., G.M. MacDonald, M.E. Kirby, and A. Chaney. 2015. “Paleohydrology, Native Vegetation, and Fire regime during Marine Isotope Stages 2–3 in the San Bernardino Mountains, California.” In: Rosen, M.R., A. Cohen, M. Kirby, E. Gierlowski-Kordesch, S. Starratt, B.L. Valero Garcés, and J. Varekamp. (eds.). 2015. *Sixth International Limnogeology Congress—Abstract Volume*, Reno, Nevada, June 15–19, 2015: U.S. Geological Survey Open-File Report 2015–1092, 244 p. <http://dx.doi.org/10.3133/ofr20151092>

Huber, P.R., and M.W. Schwartz. 2015. *A spatial prioritization assessment of natural resource vulnerabilities for Sequoia and Kings Canyon National Parks*. Report for the National Park Service.

## ANALYSIS, OPINION, AND DEBATE: NON-PEER REVIEWED PUBLICATIONS

Belmecheri, S., F. Babst, E.R. Wahl, D.W. Stahle, and V. Trouet. 2015. Mid-century evaluation of Sierra Nevada snowpack. *Nature Climate Change*. doi:10.1038/nclimate2809

MacDonald, G.M. 2015. Beyond the perfect drought. *Yale Environment* 360. [http://e360.yale.edu/feature/beyond\\_the\\_perfect\\_drought\\_californias\\_real\\_water\\_crisis/2885/](http://e360.yale.edu/feature/beyond_the_perfect_drought_californias_real_water_crisis/2885/)

California-Nevada Climate Applications Program. 2015. California heat waves. [http://cnap.ucsd.edu/pdf/CNAP\\_CA\\_heat\\_waves.pdf](http://cnap.ucsd.edu/pdf/CNAP_CA_heat_waves.pdf)



# PRESENTATIONS & OUTREACH

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Albano, C.M. ARkStorm@Tahoe: Exploring vulnerabilities to extreme winter storms in the Greater Lake Tahoe region. Invited presentation. Geography Colloquium, University of Nevada, Reno. Reno, NV. February 2015.

Albano, C.M., M.D. Dettinger, M.I. McCarthy, D.A. Cox, and T.L. Welborn. ARkStorm@Tahoe: Addressing social and ecological resilience to extreme winter storm events in the Sierra Nevada. Ecological Society of America Conference, Sacramento, CA, August 2014.

Albano, C.M., M.D. Dettinger, and 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. April 2014.

Blois, J.L., and S.T. Jackson. Biodiversity across varying environments: Mechanisms of compositional stasis and change. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Brice, R. Antecedent soil moisture reconstruction from tree rings in the Colorado River Basin. Association of American Geographers Meeting, Chicago, IL. April 2015.

Brown, L.N., G.M. MacDonald, and J.R. Holmquist. Long term (>100 years) carbon sequestration in California coastal salt marshes. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Carroll, R., J. Huntington, A. Lutz, K. Snyder, and R. Niswonger. Vegetation and hydrologic response to climate in the Great Basin. Invited presentation. American Geophysical Union Fall Meeting, San Francisco, CA. December 2015.

Carroll, R., J. Huntington, G. Tang, R. Niswonger, A. Lutz, K. Snyder, and T. Stringham. Integrated modeling in the Great Basin to investigate linkages between vegetation and hydrology. Great Basin Consortium Conference, Boise State University, Boise, ID. February 2015.

Chief, K., W.J. Smith, Jr., A. Serrat-Capdevila, E.S. Chew, D.E. Busch, and B. Bryson. Tribal climate change resiliency and collaborative water management and adaptive strategies: Pyramid Lake Paiute Tribe. 9th Biennial Association of Natural Resources Extension Professionals Conference, Sacramento, CA. May 2014.

Chief, K., E.S. Chew, A. Serrat-Capdevila, and C.N. Joseph. Collaborative and resilient water management planning under climatic and non-climatic stressors for southwestern tribes. University Council on Water Resources Conference, Tufts University, Medford, MA. June 2014.

Csank, A., C. Woodhouse, G. Pederson, J. Danloe, and S. Leavitt. Using tree-ring isotopes to understand hydroclimate variability in the upper Colorado River Basin. Annual Pacific Climate Workshop (PACLIM 2015), Pacific Grove, CA. March 2015.

Dawson, A., S. Goring, C.J. Paciorek, J.W. Williams, J. McLachlan, and S.T. Jackson. Quantifying uncertainty in spatio-temporal forest composition changes inferred from fossil pollen records. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Dettinger, M.D. Drought in California—It's all about the biggest storms. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Dettinger, M.D. Droughts, storms and the future of Nevada's water resources. Keynote address. Nevada Water Resources Association Annual Conference, Reno, NV. January 2015.

Dettinger, M.D. Regional-pattern scaling in mountainous terrains—where and will downscaling perform well in the Southwest? Mountain Climate Research Conference (MtnClim2014), USDA Forest Service, Midway, UT. September 2014.

Dettinger, M.D., M. Ralph, A. White, M. Anderson, J. Florsheim, D. Cayan, and A. Hinojosa. Severe storms and California's fragile delta—historical impacts and a new monitoring network. 8th Biennial Bay-Delta Science Conference, Sacramento, CA. October 2014.

Dettinger, M.D. Latest updates to climate change projections for Tahoe region. Tahoe Climate Science Symposium, Incline Village, NV. November 2014.

Dettinger, M.D., and F.M. Ralph. Landfalling atmospheric rivers in California—historical and future impacts. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Dettinger, M.D. Cold-air pooling in the mountains—what do we need to know? George Wright Society Conference, Oakland, CA. March 2015.

Dettinger, M.D. California water supplies in a changing climate. California Municipal Utilities Association Annual Conference, Carlsbad, CA. April 2015.

Dickinson, J.E., and T.P.A. Ferré. Damping of multi-frequency infiltration with depth in the vadose zone. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Dickson, B.G., K. Rait, L.J. Zachmann, C.M. Albano, and L.A. Duncan. Systematic identification of potential conservation priority areas on roadless BLM lands in the western United States. National Workshop on Large Landscape Conservation, Washington, D.C. October 2014.

Enquist, C. Toward optimizing the delivery and use of climate science for natural resource management: Lessons learned from recent adaptation efforts in the southwestern U.S. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Enquist, C. The LCCs and the SW CSC: Key partnerships for climate change adaptation in the southwestern U.S. National Research Council of the National Academies Review of the LCC Network. Irvine, CA. April 2015.

Gershunov, A., and S.T. Jackson. Chasing the tail: The importance of extremes in a changing climate. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Gibble, K. The use of vulnerability assessments in the Boise River Basin: A policy network approach. 5th Annual Pacific Northwest Climate Science Conference, Seattle, WA. September 2014.

Gill, J.L., J.W. Williams, S.T. Jackson, and A. Ordóñez. Disequilibrium vegetation dynamics in response to climate change: Lessons from the late glacial no-analog communities. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.



Glover, K.C., G.M. MacDonald, M.E. Kirby, and A. Chaney. Paleohydrology, native vegetation, and fire regime during Marine Isotope Stages 2-3 in the San Bernardino Mountains, California. U.S. Sixth International Limnogeology Congress, Reno, NV. June 2015.

Glover, K.C., G. MacDonald, E. Rhodes, E. Silveira, M. Kirby, and A. Whitaker. Insight into Southern California paleohydrology since Marine Isotope Stage 5c (c. 96 ka) from Baldwin Lake, San Bernardino Mountains. Annual Pacific Climate Workshop (PACCLIM 2015), Pacific Grove, CA. March 2015.

Goring, S.J., J.W. Williams, A.E. Dawson, D.J. Mladenoff, J.S. McLachlan, M. Dietze, S. Record, J. Hattala Mathes, E.R. Kujawa, C.V. Cogbill, and S.T. Jackson. From pollen to carbon: Lessons learned by tying vegetation, land use and climate change from the past to the present and into the future. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Holmquist, J.R., L.N. Brown, and G.M. MacDonald. A meta-analysis of vertical accretion data in North American coastal marshes. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Jackson, S.T. The fossil record and the future: Using the past to assess climate-change vulnerability and adaptation. Plenary keynote address, International Biogeography Society 7th Biennial Meeting. Bayreuth, Germany. January 2015.

Jackson, S.T. Challenges and opportunities for resource management and conservation science in a changing climate. Keynote address. Great Basin Consortium Conference, Boise State University, Boise, ID. February 2015.

Jackson, S.T. The roles of mountain refugia in past and future climate changes. Mountain Climate Research Conference (MtnClim2014), USDA Forest Service, Midway, UT. September 2014.

Jackson, S.T. Biology, chance, and environment: Three contrasting perspectives on community structure and composition. Symposium on External Influences on Ecological Theory. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Jackson, S.T. Natural is not enough: Expanding Leopold's Quadrant in a world of change. Symposium on Coupled Natural and Human Systems Science: The Need, Challenges, and Rewards. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Jackson, S.T. Biodiversity consequences of climate change: Some forecasts from the past. Symposium on Biological Extinctions and Climate Change. Washington University, St Louis, Missouri. September 2015.

Jackson, S.T. Conserving nature in a world of change. Symposium on Biology, Paleobiology, and Conservation, University of California, Berkeley. September 2015.

Janousek, C.N., C. Mayo, K. Thorne, and J.Y. Takekawa. Interspecific and geographic variability in elevation-productivity relationships in northeast Pacific tidal marshes. Joint Aquatic Sciences Meeting, Portland, OR. May 2014.

Janousek, C., K. Thorne, J. Takekawa, G. Guntenspergen, K. Buffington, T. Edgarian, and K. Spragens. Sea-level rise impacts on salt marsh vegetation in the San Francisco Bay estuary. 8th Biennial Bay-Delta Science Conference, Sacramento, CA. October 2014.

Janousek, C.N., T.K. Edgarian, G.R. Guntenspergen, J.Y. Takekawa, and K.M. Thorne. Species-specific flooding effects on plant growth and decomposition in a San Francisco Bay salt marsh. Western Society of Naturalists Annual Meeting, Tacoma, WA. November 2014.

Krause, T.R., V. Iglesias, and C. Whitlock. Climatic and nonclimatic controls shaping early postglacial conifer history in the Greater Yellowstone Ecosystem, USA. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Loisel, J., and G.M. MacDonald. Late-Holocene changes in climate variability, variance, and periodicity in the US Southwest, and effects on landscape dynamics. Annual Pacific Climate Workshop (PACCLIM 2015), Pacific Grove, CA. March 2015.

McAfee, S., C. Woodhouse, K. Morino, and G. Pederson. Changing station coverage in the upper Colorado River Basin: Is this a problem? American Geophysical Union Fall Meeting, San Francisco, CA. December 2015.

MacDonald, G.M., L. Brown, and J. Holmquist. Response of coastal marshes to past and future sea-level rise. American Association of Geographers Annual Conference, Chicago, IL. April 2015.

McCarthy, M.I., M.D. Dettinger, C.M. Albano, D.A. Cox, D. Kauneckis, and T.L. Welborn. ARkStorm@Tahoe: Science as a foundation for discussing, recognizing and mitigating storm-disaster vulnerabilities in mountain and downstream communities. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Pulwarty, R., L.S. Darby, J. Verdin, V. DeHeza, C. Nierenberg, K. Bogan, C. McNutt, R.S. Webb, and K.T. Redmond. The National Integrated Drought Information System (NIDIS). Invited presentation. 21st Conference on Applied Climatology, American Meteorological Society, Westminster, CO. June 2014.

Thomson, M.J., and G.M. MacDonald. Reconstructing conditions for Fremont Zea mays horticulture Annual Pacific Climate Workshop (PACCLIM 2015), Pacific Grove, CA. March 2015.

Thorne, K., J. Takekawa, B. Dugger, G. MacDonald, G. Gutenspergen, and R. Ambrose. A regional multidisciplinary approach to assess climate change impacts to Pacific coast wetlands for informing adaptation strategies. National Workshop on Large Landscape Conservation, Washington, D.C. October 2014.

Reynolds, L., J. Holmquist, L. Brown, J. Southon, A. Simms, and G.M. MacDonald. Radiocarbon reservoir variability in California estuaries. Radiocarbon in the Environment Conference, Belfast, Northern Ireland, United Kingdom. August 2014.

Redmond, K.T. A year in review + a forecast for the future. Panel discussion. 42nd Conference on Broadcast Meteorology, American Meteorological Society, Olympic Valley, CA. June 2014.

Redmond, K.T. A perspective on accelerating change. Tyndall History of Global Environmental Change Lecture. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Redmond, K.T. A Plethora of Partnerships, and Observational Examples. Regional Integrated Sciences and Assessments Annual Principal Investigators Meeting. Charleston, SC, January 2015.

Redmond, K.T. Regional climate partnerships pertinent to Great Basin Consortium. Great Basin Consortium Conference, Boise State University, Boise, ID. February 2015.

Redmond, K.T. Western weather of PACCLIM year 2014 – 15. Annual Pacific Climate Workshop (PACCLIM 2015), Pacific Grove, CA. March 2015.

Redmond, K.T. Great Basin weather and climate: Winter recap, current status, summer prospects. Great Basin Climate Forum, Reno, NV. April 2015.



Redmond, K.T. Interior Columbia Basin and Northern Great Basin 2014–15 Weather and Climate Recap. Pacific Northwest Drought Outlook. Boise, ID, May 2015.

Trouet, V., F. Babst, and J. Betancourt. North Pacific Jet Variability over the last 600 years. 9th International Conference on Dendrochronology, Melbourne, Australia. January 2014.

Trouet, V., F. Babst, and J. Betancourt. A tree-ring based reconstruction of north Pacific jet variability and its influence on Sierra Nevada fire regimes. Invited presentation. Mountain Climate Research Conference (MtnClim2014), USDA Forest Service, Midway, UT. September 2014.

van Mantgem, P.J., and M. Keifer. FMH: Long-term fire effects data and research opportunities. George Wright Society Conference, Oakland, CA. March 2015.

van Mantgem, P.J. Climate, fire and forests in the Klamath region. Presentation to park managers, Lava Beds National Monument, CA. April 2015.

van Mantgem, P.J. Are recent increases in forest mortality a drought symptom? Ecological Society of America Conference, Sacramento, CA. August 2014.

van Mantgem, P., M. Madej and J. Seney. Estimating ecosystem carbon stocks at Redwood National Park using inventory and fire effects monitoring data. Conference on Ecological and Ecosystem Restoration (CEER), New Orleans, LA. July 2014.

Williams, J.W., S.J. Goring, M. Ruid, C.V. Cogbill, M. Dietze, S.T. Jackson, J.S. McLachlan, D.J. Mladenoff, C.J. Paciorek, and S. Record. Shifts in climate niches for major tree genera in eastern US caused by historic land use and climate change. Ecological Society of America Annual Meeting, Baltimore, MD. August 2015.

Woodhouse, C.A. Use-inspired hydroclimatic research in the upper Colorado River Basin. Biennial Conference of Science & Management on the Colorado Plateau & Southwest Region, Flagstaff, AZ. October 2015.

Woodhouse, C.A., G.T. Pederson, K. Morino, and G. McCabe. Investigating the role of temperature in mediating relationships between cool season precipitation and water year streamflow in the Upper Colorado River Basin. Annual Pacific Climate Workshop (PACCLIM 2015), Pacific Grove, CA. March 2015.

Woodhouse, C., S. McAfee, G. McCabe, W. Miller, and G. Pederson. Evaluating the influence of precipitation, temperature, and soil moisture on upper Colorado River Basin streamflow and drought. American Geophysical Union Fall Meeting, San Francisco, CA. December 2014.

Woodhouse, C. Collaborative research on Upper Colorado River Basin streamflow and drought. Association of Pacific Coast Geographers Annual Meeting, Tucson, AZ. September 2014.

## WORKSHOPS

**California Drought Planning Workshop** brought together a number of SW CSC scientists, other researchers, and stakeholders to discuss pressing needs and research strategies for examining the conservation impacts of the current California drought. Davis, CA, March 2015.

**Christopher Castro** and other team members on the project, “Colorado River Basin Streamflow Projection Under IPCC CMIP5 Scenarios,” organized a stakeholder engagement workshop that included representatives from agencies directly participating in the project—Bureau of Reclamation, Central Arizona Project, and Salt River Project—and other representatives from water resource agencies. The workshop included presentations

and an open discussion designed to obtain feedback from stakeholders about the project's methodological approach and how to generate deliverables useful for water resource decision making. March 28, 2014.

**Carolyn Enquist and Stephen T. Jackson** co-organized and convened a combined symposium and panel discussion titled "Federal climate science and adaptation programs in the southwestern United States: Identifying pathways for synergistic coordination and collaboration." Speakers and panelists included representatives of USFWS Landscape Conservation Cooperatives, NOAA Regional Integrated Science Assessments, DOI Climate Science Centers, and USDA Regional Climate Hubs. National Adaptation Forum, St. Louis, May 2015.

**Carolyn Enquist** worked with the Society of Conservation Biology and the Association of Fish and Wildlife Agencies (AFWA) to co-host a climate adaptation workshop for regional stakeholders at the University of Arizona, held in conjunction with AFWA's annual meeting. The one-day workshop consisted of 25 participants representing county, state, and federal agencies, in addition to non-governmental organizations. Tucson, AZ, September 2015.

**Karen Thorne** and other USGS staff hosted estuarine sea level rise workshops in California at San Pablo Bay National Wildlife Refuge (September 2014), Humboldt Bay National Wildlife Refuge (October 2014), and San Diego National Wildlife Refuge (December 2014). Workshop participants included research managers from USFWS, California Department of Fish and Wildlife, Ducks Unlimited, county and city officials, Caltrans, academic researchers, and interested citizens. More than 100 participants attended the workshops. Workshop website: <http://climate.calcommons.org/article/SLR-workshops>

**Kelly Redmond** participated in the Winter Outlook Workshop sponsored by the National Oceanic and Atmospheric Administration and California Department of Water Resources at Scripps Institution of Oceanography, La Jolla, CA, November 2014.

**Kelly Redmond** participated in the Climate Prediction Applications Science Workshop in Las Cruces, NM, in March 2015, serving as a panelist for a session about Regional Climate Partnerships. During the same workshop, Redmond and his research group gave a presentation about the California Climate Outcome Likelihood Tool.

**Connie Woodhouse** and her colleagues conducted a workshop for the water management partners of the project "Disentangling the Influence of Cool Season Temperature and Precipitation on Colorado River Water Resources Using Paleo Data" in Denver, CO, in September 2015. This group, known as the Water Manager Advisory Board, provides feedback to the research team and helps to ensure that the project's research is driven by stakeholder questions. The four presentations made during the workshop are available online from the project website: <http://www.nrmssc.usgs.gov/ColoradoRiverWater>

## OUTREACH AND COMMUNICATION

Given the heightened concern about and awareness of drought and its impacts throughout the Southwest, particularly in California, SW CSC principal investigators and affiliates were actively involved in outreach efforts in 2014–15 to resource managers, policymakers, the business community, and the public.

**Dan Cayan** presented on possible climate change effects on precipitation, temperature, and other wildfire related measures at the CalFire/California State University Workshop on Wildfire in the Wildland-Urban Interface, Sacramento, CA, June 2014.

**Cayan** gave a presentation on projected climate change influences on ecosystem-related measures, including longer-term shifts and possible changes in extreme events, at the Camp Pendleton Marine Base Climate Informed Monitoring Workshop, Oceanside, CA, November 2014.



**Cayan** discussed climate variability and climate change effects on the Sacramento/San Joaquin Delta, with particular emphasis on loss of snow pack, drought episodes, and flood flows, at the Delta Stewardship Council meeting, Sacramento, CA, November 2014.

**Cayan** presented on climate effects on hydrological extremes in California at the National Hydropower Association California Regional Meeting, Los Angeles, December 2014.

**Cayan** gave a keynote talk and participated in the Chapman Conference on California Drought, which was held at the University of California, Irvine, in April 2015. Cayan addressed both characteristics of California's current drought and challenges to prediction of drought.

**Karletta Chief** and her colleagues met with the director and staff of the Pyramid Lake Paiute Tribe (PLPT) Environmental Department to discuss project outcomes and receive feedback on project progress (August 2014). The team also discussed its 19 adaptation recommendations during a two-hour public meeting at the Wadsworth Community Center (Wadsworth, NV) and presented a summarized list of 10 adaptation recommendations to the PLPT Council for its consideration.

**Chief** gave a series of webinar presentations communicating project findings during 2014–15, including:

- Resilience to climate change: collaborating on adaptive management strategies for the Pyramid Lake Paiute Tribe. Association of Natural Resource Extension Professionals (ANREP), March 2014.
- Climate change impacts on tribal water resources. Institute for Tribal Environmental Professionals, June 2014
- Climate change vulnerability of Native Americans in the Southwest: A case study for tribal climate adaptation among the Pyramid Lake Piute Tribe. USGS National Climate Change and Wildlife Science Center, October 2014.

**Mike Dettinger** spoke to a wide range of groups, updating them on the California drought, climate variability and change, precipitation, and much more:

- New approaches for responding to climate change in the San Francisco Bay-Delta. Panel. University of California, Davis, May 2015.
- Update on the California drought 2012–15. Spirit of the Barrio Community Luncheon, San Diego, May 2015.
- El Niño effects on precipitation and water for San Diego. San Diego County Water Authority, San Diego, August 2014.
- Storms, floods, and the new science of atmospheric rivers. Federal Disaster Med Assistance Team, San Diego, October 2014.
- Climate variability and change, and California water. Lahontan Water Board, Tahoe, CA, January 2015.

**Ty Ferré** and his project team shared their results in September 2014 with wildlife managers at the San Bernardino and Buenos Aires National Wildlife Refuges, using the meetings as an opportunity to brainstorm ideas for applications and future collaboration. Ferré's team also presented their results to BLM in Tucson, AZ, in September 2014. BLM manages the San Pedro Riparian Conservation Area in the San Pedro watershed and has special interest in the effects of climate on the conservation of the San Pedro River. Managers noted that the project's results have immediate applicability for managing both refuges and the San Pedro Basin.

**Ferré** and colleagues presented their project results in May 2014 to the Arizona Land and Water Trust (ALWT), which identifies and prioritizes sensitive ecological areas for conservation. The ALWT is interested in using the project's tools to identify where climate could be strongly affecting water resources.

**Erica Fleishman** is a member of the Science Advisory Team for California's Forest Carbon Action Team (FCAT). FCAT science advisory team met with leadership from the California Air Resources Board in February 2015 in Sacramento, CA, to discuss trade-offs in using Forest Inventory and Analysis data to estimate pools of carbon in forests.

**Sasha Gershunov** made presentations to a wide range of California audiences interested in the state's ongoing drought and its implications:

- California Drought Summit, University of California, Davis, Sacramento, CA, April 2014
- California Drought Forum, National Integrated Drought Information System/National Oceanic and Atmospheric Administration, Sacramento, CA, May 2014
- CalFire/California State University Workshop on Wildfire in the Wildland-Urban Interface, Sacramento, CA, June 2014
- Resilient San Diego Symposium, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, August 2014
- Environmental Protection Agency Region 9 Tribal Conference, Sacramento, CA, October 2014
- Camp Pendleton Marine Base Climate Informed Monitoring Workshop, Camp Pendleton, Oceanside, CA, November 2014
- Delta Stewardship Council November Meeting, Sacramento, CA, November 2014

**Stephen T. Jackson** gave the talk, Challenges and opportunities for resource management and conservation science in a changing climate, at the Howard Baker Jr. Center for Public Policy's Energy and Environment Forum, University of Tennessee, Knoxville, October 2014.

**Jackson** participated in the scenario planning exercise, Alternative Responses to Climate Change in the Adirondack Region, at Paul Smith's College, Paul Smiths, NY, December 2014. Participants included key stakeholders and community leaders in the region.

**Glen MacDonald** was part of a panel of climate experts who spoke to the public, media, and local politicians on the current California drought and the role of extreme weather events in the future of California at the Aquarium of the Pacific's Ocean Science Center, Long Beach, CA, September 2014. Video link: [http://www.aquariumofpacific.org/news/story/video\\_experts\\_discuss\\_extreme\\_weather](http://www.aquariumofpacific.org/news/story/video_experts_discuss_extreme_weather)

**MacDonald** opened the first-ever "Whole Water" conference with a speech titled, "Current Drought, Early 21st Century Drought, and California's Water Future," speaking to some 200 water professionals from around California. The conference was hosted by American Water Works Association California-Nevada Section in Monterey, CA, June 2014.

**MacDonald** spoke on the current California drought to an audience of several hundred water professionals, community leaders, elected officials, educators, students and business and environmental leaders at the 2014 Santa Ana River Watershed Conference, Riverside, CA, October 2014.



**MacDonald** put the current drought in historical and prehistoric perspective for participants at San Gabriel Valley Water Forum, in Pomona, CA, in October 2014. The forum included 350 water professionals, community leaders, elected officials, educators, students, business leaders, labor unions, environmental groups, and employers.

**MacDonald** presented a 40-minute talk on the current drought to approximately 40 real estate professionals at the Coldwell Banker Real Estate Lunch-Time Talk, Westlake Village, CA, March 2015.

**Kelly Redmond** participated in a panel discussion about how to communicate the science of controversial topics such as climate change at a luncheon of the Sierra Nevada Chapter of the Public Relations Society of America, Reno, NV, March 2015.

**Mark Schwartz** and his research team conducted four outreach consultative group exercises in the following places: Davis, CA (April 8, 2014); Reno, NV (April 28, 2014); Tucson, AZ (May 21 and 22, 2014); and Salt Lake City (July 31, 2014). Each meeting involved 15 people from each region to discuss the use of climate change information in decision making. Participant feedback indicated that the meetings were valuable exercises for those who participated.

**Karen Thorne**, SW CSC grantee, spoke to the South Bay Salt Pond managers group in October 2014 in Oakland, CA, about Pacific coast tidal marsh modeling with sea-level rise on Pacific coast refuges.

**Connie Woodhouse** gave a presentation to the Denver Water Board. Her talk, “The role of temperature (and soil moisture) in mediating relationships between cool season precipitation and water year streamflow in the UCRB,” discussing her project’s preliminary findings (Denver, CO, July 2015). The same talk was given as Colorado River District brown bag talk, Glenwood Springs, Colorado, July 2015.

**Phillip van Mantgem** spoke to tribal, state, and federal resource managers and others in California and across the region about fire and forests:

- Climate, fire, and forests in the Klamath region. Presentation to park managers at Lava Beds National Monument, Tulelake, CA, April 2015.
- Climate, fire, and forests in the 21st century at Redwood Creek. Redwood Creek Symposium, Redwood National and State Parks, Orick, CA, December 2014.
- Climate change, fire, and the future of redwood forests. Headwaters Forest Reserve, Eureka, CA, August 2014.
- Long-term monitoring of fire effects across the United States. Mountain Observatories - A Global Fair and Workshop on Long-Term Observing Systems of Mountain Social-Ecological Systems, Reno, NV, July 2014.
- Restoring coastal redwood forests: Carbon costs and savings. Webinar presentation for the North Pacific and California Landscape Conservation Cooperatives, July 2014.
- Drought, fire and tree mortality in the Klamath Mountains. Field trip presentation for the Northern California Fire Science Consortium, Whiskeytown National Recreation Area, April 2014.
- Drought, tree mortality, and climate change: Can our forests take the heat? Strategic Partnership Coalition, which includes tribal, federal, and state land managers, Trinidad, CA, March 2014.
- Drought, tree mortality, and climate change: Can our forests take the heat? Redwood National and State Parks, Orick, CA, March 2014.







#### PARTNERS



#### AFFILIATES



**Federal Site:** [doi.gov/csc/southwest/index.cfm](http://doi.gov/csc/southwest/index.cfm)

**University Site:** [SWCSC.arizona.edu](http://SWCSC.arizona.edu)

## CONTACT

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