FY 2012 Climate Science Center Funded Projects

SOUTHWEST

Downscaled Climate and Hydrologic Response for California and the Great Basin
Principal Investigator: **Lorraine Flint**, U.S. Geological Survey California Water Science Center
Cooperators & Partners: **Alan Flint**, U.S. Geological Survey California Water Science Center; **Michael Moran**, U.S. Geological Survey Nevada Water Science Center**; John Dingman**, Bren School for the Environment, University of California; **James Thorne**, Information Center for the Environment, University of California; **Lisa Micheli**, Dwight Center for Conservation Science at Pepperwood; **Healy Hamilton**, University of California, Berkeley; **Stuart Weiss**, Bay Area Open Space Council; **Bridget Thrasher** and **Claudia Tebaldi**, Climate Analytics Group; **Deanne DiPietro**, Sonoma Ecology Center and California Climate Commons; and **Grant Ballard** and **Sam Veloz**, PRBO Conservation Science
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 based information upon which to base these management plans and decisions consistently across California and the Great Basin. This project will apply historical, current, and projected climate data to a regional water model to examine water availability, biodiversity, and conservation. Analysis of this climate and hydrology data will help managers understand areas in the region and landscape where the effects of climate change are expected to be the most profound. The study will also address how the environment is likely to change and how certain the scientific community is about these changes. Collaboration among managers, scientists, conservation organizations, and others will guide the utility, understandability, relevance, and accessibility of the findings from this project.

Effects of Sea-Level Rise and Extreme Events on California Coastal Habitats
Principal Investigators: **John. Y. Takekawa,** U.S. Geological Survey (USGS) Western Ecological Research Center and **Glen M. MacDonald**, University of California, Los Angeles (UCLA) Institute of the Environment
Cooperators & Partners: **Rich Ambrose**, UCLA Environmental Science and Engineering Program; **Patrick Barnard**, USGS Pacific Science Center; **Michael Casazza**, **Susan De La Cruz,** and **Steven Schwarzbach,** USGS Western Ecological Research Center; **Glenn Guntenspergen**, USGS Patuxent Wildlife Research Center; **Alex Hall**, UCLA Department of Atmospheric and Oceanic Sciences; **Bruce Jaffe**, USGS Pacific Coastal & Marine Science Center; **Cory Overton** and **Karen Thorne**, University of California (UC), Davis; **Susan Ustin**, UC Davis Center for Spatial Technologies and Remote Sensing; **Brian Collins,** U.S Fish and Wildlife Service (FWS) Tijuana River Estuary National Wildlife Refuge (NWR); **Kenneth Griggs** and **Eric Nelson**¸ FWS Humboldt Bay NWR; **Andy Yuen**, San Diego Refuge Complex
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 be changed in the future. The goal of this project is to provide scientific information to support future planning and conservation of coastal natural resources as the climate changes. The study will examine current weather patterns, elevations, tides, and sediment of connected coastal habitats to determine how they affect plants and animals, as well as to project how climate change may alter that balance. Understanding the physical processes and complex relationships within

these nearshore habitats can be used to develop comprehensive vulnerability assessments for wildlife and ecosystems along the California coast.

Trans-Specific Drivers of Climate-Driven Variation in Forecasted Distributional Changes of Southwest Birds and Reptiles

Principal Investigator: **David J. Mattson**, U.S. Geological Survey (USGS) Southwest Biological Science Center

Cooperators & Partners: **Matthew J. Johnson, Erika Nowak, Jennifer Holmes, Michael Peters,** and **Paul Heinrich,** Northern Arizona University; **Charles van Riper III,** USGS Southwest Biological Science Center; **James R. Hatten**, USGS Columbia River Research Laboratory; and **J. Tomas Giermakowski**, University of New Mexico

Additional Support: USGS National Climate Change and Wildlife Science Center

Biodiversity is declining worldwide in ways that are consistent with previously predicted effects of climate change. Managers are faced with identifying where, when, and how to allocate their limited resources to ensure maximal effect when addressing emerging and evolving societal concerns about climate change. Forecasts of species biodiversity can provide managers with prospective identities and locations of species that are likely to be at future risk because of climate change. This research will address questions related to the use of species distribution models in predicting species' vulnerability to climate change. The project will also examine the connections between factors affecting species variation and species' characteristics, the relations between species-specific distribution forecasts and published vulnerability assessments, and the vulnerability of bird and reptile species to forecasted climate change in the southwestern U.S.

Comparative Analysis of Downscaled Climate Simulations: Providing Guidance to End Users

Principal Investigator: **Daniel Cayan,** Scripps Institution of Oceanography, University of California, San Diego (UCSD) and Water Resources Division, U.S. Geological Survey (USGS)

Cooperators & Partners: **Bridget Thrasher**, Climate Analytics Group; **Alex Hall**, Institute of the Environment and Sustainability, University of California, Los Angeles; **Alexander Gershunov,** Scripps Institution of Oceanography, UCSD; and **Mike Dettinger**, Water Resources;, USGS

To understand potential climate change impacts on ecosystems, water resources, and numerous other natural and managed resources, climate change data and projections must be downscaled from coarse global climate models to much finer resolutions and more applicable formats. This project will conduct comparative analyses to better understand the accuracy and properties of these downscaled climate simulations and climate-change projections. Interpretation, guidance and evaluation, including measures of uncertainties, strengths and weaknesses of the different methodologies for each simulation, will also be provided to enable potential users with the necessary information to select and apply the models.

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 (UA) Hydrology and Water Resources

Cooperators & Partners: **Jesse Dickinson**, U.S. Geological Survey (USGS) Arizona Water Science Center; **Christopher Castro**, UA Atmospheric Sciences; **Peter Troch, Rafael Rosolem** and **Hoshin Gupta**, UA Hydrology and Water Resources; **Stan Leake**, **Pamela Nagler** and **Randy Hanson**, USGS

Additional Support: UA Water, Environmental and Energy Solutions, the USGS National Institutes for Water Resources, USGS Office of Groundwater

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 United States. Long-term decreases

in precipitation will result in lowered regional groundwater levels, loss of groundwater storage for communities, stream flow depletion, and loss of riparian (near-river) vegetation. This project will examine how hydrologic systems in the Southwestern U.S. respond to climate changes and how this response depends both on the frequency of the changes and the properties of the system. Existing hydrologic models of the Upper San Pedro Basin and the Upper and Middle Verde watersheds will be used with global climate models to simulate and project causes and impacts of climate change. An improved understanding of the vulnerability of hydrologic and riparian areas to future climate will inform managers about which systems may be most sensitive to trends and periodic variations in climate.

Climate Change Vulnerabilities and Adaptation Strategies to Wildfire in the Southwestern U.S.
Principal Investigator: **Mark W. Schwartz**, John Muir Institute of the Environment, University of California (UC), Davis
Cooperators & Partners: **Mark Lubell** and **Jim Thorne**, UC Davis; **Patrick Gonzales**, National Park Service; **Nate Stephenson**, U.S. Geological Survey; **Max Moritz**, UC Santa Barbara; **Tim Brown**, Desert Research Institute; and **Gregg Garfin**, University of Arizona
Additional Support: U.S. Geological Survey, and the National Park Service
Differing, often negative, responses to wildfire occur in plant communities in the southwestern U.S. under stress caused by climate change. This project aims to create a climate, fire, and vegetation vulnerability assessment for forests and woodlands in the Southwest to assist in strategic land management decision-making. This study will analyze the impact of climate change on wildfires, and assess where and when plant communities are predicted to exhibit stress as a consequence of unusual climatic conditions. Understanding fire behavior probabilities and forest vulnerabilities will provide decision support for the deployment of fuels management (prescribed fire and mechanical fuels reduction), as well as for appropriate management responses to wildfire events. Moreover, an understanding of how vegetation is likely to change with climate will allow proactive land management decisions to guide forested ecosystems toward stable, functioning future states.

Climate Change Vulnerability of Native Americans in the Southwest
Principal Investigator: **Karletta Chief,** University of Arizona, Department of Soil, Water, and Environmental Sciences
Native Americans in the Southwest United States are thought to be particularly vulnerable to climate change. Tribal resiliency to climate change can be affected by multiple climate-related threats and by tribal communities' close reliance on natural resources for sustenance, economic development, and maintenance of cultural traditions. A scientifically rigorous assessment of such threats to Native Americans is a pressing need across southwestern landscapes. This project will examine factors affecting Native American tribes, including water rights for fish and wildlife, protection of wetlands, and enhancement and recovery of the Pyramid Lake, Nevada fishery, and protection of important fish species. This project aims to help manage potential conflicts among stakeholders by providing a better understanding of system dynamics and climate projections in the region. This project will also identify and test best practices in collaborating with and delivering climate science to Native American tribes within the Southwest Climate Science Center's region.

NORTH CENTRAL

Projecting Future Effects of Land Management, Natural Disturbance, and CO_2 on Woody Encroachment in the Northern Great Plains in a Changing Climate

Principal Investigator: **Amy Symstad**, U.S. Geological Survey Northern Prairie Wildlife Research Center
Co-Investigators: **Dominique Bachelet**, Conservation Biology Institute and Oregon State University (OSU); **David King**, OSU; and **Ken Ferschweiler**, Conservation Biology Institute

Maintaining the native prairie lands of the Northern Great Plains (NGP), which provide an important habitat for declining grassland species, requires anticipating the effects of increasing atmospheric carbon dioxide (CO_2) concentrations and climate change on the region's vegetation. Specifically, climate change threatens NGP grasslands by increasing the potential encroachment of native woody species into areas where they were previously only present in minor numbers. This project will use a dynamic vegetation model to simulate vegetation type (grassland, shrubland, woodland, and forest) for the NGP for a range of projected future climates and relevant management scenarios. Comparing results of these simulations will illustrate the sensitivity of woody encroachment projections to climate change factors. Improved understanding of the effects of increasing CO_2, climate change, and land management practices on potential woody encroachment will be used to guide management practices to be most effective in protecting grassland habitat in the NGP into the future.

Projecting Climate Change Effects on Cottonwood and Willow Seed Dispersal Phenology, Flood Timing, and Seedling Recruitment in Western Riparian Forests

Principal Investigator: **Patrick Shafroth**, U.S. Geological Survey (USGS) Fort Collins Science Center
Co-Investigators: **Laura Perry**, Colorado State University (CSU) Biology Department; **Lauren Hay**, **Roland Viger,** and **Steven Markstrom**, USGS Modeling of Watershed Systems, National Resource Program; **Glen Liston**, CSU Cooperative Institute for Research in the Atmosphere; and **David Blodgett** and **Nathaniel Booth**, USGS Center for Integrated Data Analytics

Throughout western North America, warming associated with climate change is leading to both earlier spring peak streamflows and earlier seed dispersal, potentially reducing seedling establishment and in turn reducing the quality of riparian (near-river) forests, which provide critical habitat for diverse birds, mammals, reptiles, amphibians, and insects, and food and shade for fish and other aquatic animals. This project aims to predict these effects of climate change on cottonwood and willow tree regeneration in western forests by linking models of seed dispersal timing, streamflow hydrology, and seedling establishment, focusing on the upper South Platte River Basin as a study area. Results will help land managers anticipate future changes in riparian wildlife habitat quality, and potentially to respond to these changes by actively re-vegetating high-priority areas, or by working with water management agencies to schedule dam releases that favor cottonwood and willow establishment.

Integrating Climate and Biological Data into Land Management Decision Models to Assess Species and Habitat Vulnerability: A Collaboration for Greater Sage-Grouse and their Habitats

Principal Investigators: **Richard S. Sojda**, **Erik A. Beever**, **Kathryn M. Irvin**, and **Gregory T. Pederson,** U.S. Geological Survey (USGS) Northern Rocky Mountain Science Center (NOROCK)
Cooperators & Partners: **Cathy Whitlock**, Montana State University (MSU) Institute of Ecosystems (IoE); **Yvette Converse, Tom Olliff,** and **Sean Finn**, Great Northern Landscape Conservation Cooperative (LCC); **Rick Nelson** and **Mike Olson**, Plains and Prairie Potholes LCC; **Jeff Warren**, U.S. Fish & Wildlife Service; **Rock Potts**, Charles M. Russell National Wildlife Refuge; **Sten Benes** and **Kate Kitchell**, Bureau of Land Management; **Andrea Ray**, National Oceanic and Atmospheric Administration; **John Sheppard, Michael Reilly, Donald Greer,** and **Elizabeth Shanahan,** MSU; and **Linda Vance**, University of Montana

Climate affects both the demographics of the Greater sage-grouse bird and the condition and long-term viability of their habitats, including sage-steppe communities. This project builds on collaboration among federal land managers, state wildlife biologists, scientists, and other organizations to create a long-term framework for implementing adaptive management for the sage-grouse. The study will examine factors that might be limiting grouse numbers and will investigate components of weather patterns in relation to projected climate change models. Precipitation and temperature, as well as variables such as evaporation and soil moisture, will be considered. Overall, the project will be focused on (1) providing workshops to foster collaboration and interpretation of climate information, (2) developing a sage-steppe habitat map, and (3) suggesting recommendations for an adaptive management framework.

The Value of Climate Information for Supporting Management Decisions within the Plains and Prairie Potholes LCC

Principal Investigators: **Max Post van der Burg**, U.S. Geological Survey (USGS) Northern Prairie Wildlife Research Center, **Cathy Cullinane Thomas** and **Tracy Holcombe**, USGS Fort Collins Science Center

Climate scientists need better and more information about the needs of decision-makers and managers, while decision-makers need better information about how a changing climate may affect their management and conservation objectives. The goal of this project is to build connections between the Plains and Prairie Potholes Landscape Conservation Cooperative (PPP-LCC), the North Central Climate Science Center (NC CSC), and the National Oceanic and Atmospheric Administration Climate Prediction and Projection Pilot Platform (NCPP) to facilitate a link between the users and producers of climate information, as well as to identify gaps between available and desired data. This project will develop a conceptual model of the interactions between climate change, land use change, and conservation and adaptation in the Plains and Prairie Potholes (PPR) region of the North-Central U.S. Relating climate variations to the prevailing land use and socioeconomic issues in the region will produce a framework that will enable climate scientists to guide managers towards currently available and useful climate information and design future research to address remaining key uncertainties affecting conservation decisions in the region.

Regional Short- and Long-term Climate Impacts on Northern Rocky Mountain's and Great Plain's Ecosystems: NASA DEVELOP program Central U.S. Node

Principal Investigator: **Jeff Morisette**, U.S. Geological Survey, North Central Climate Science Center

With joint funding from the North Central Climate Science Center (NC CSC) and NASA Applied Sciences Program, the NC CSC is supporting resource managers and their decision process through its Resource for Vulnerability Assessment, Adaptation and Mitigation Planning (ReVAMP), a collaborative research/planning effort supported by high performance computing and modeling resources. The NC CSC is focused primarily on climate data as input to the ReVAMP. However, the NASA DEVELOP program is being used to evaluate how remote sensing data sets can contribute to the ecological response models that will be implemented in the ReVAMP system. This work is demonstrating the utility of remote sensing in vulnerability assessment and then making sure the remote sensing data sets are fully embedded in the ReVAMP system. The use of remote sensing products are helping to scale ground-based measurement collected on managed lands to larger regions more suitable for analysis against climate modeling grids. The NASA DEVELOP program is covering the cost of six graduate students and the NC CSC is covering 3 months of time dedicated to faculty advisors for the DEVELOP students.

Regional Extreme Climate Events: Gaining Understanding Through Past and Present Observations and Modeling

Principal Investigator: **Christopher Anderson**, Iowa State University

Climate in the North-Central U.S. is driven by a combination of factors, such as patterns in atmospheric circulation and geographic variations in hydrology, that determine the sustainability of ecosystems in the region as well as the goods and services they provide. This research activity will use a diverse set of region-specific approaches to evaluate efficacy of climate model simulations, provide interpretation of climate change mechanisms, and advance understanding of the relationship between climate, ecosystems, and species of interest. The project aims to 1) develop a model to examine past and present climate variations and assess the ability of climate models to effectively make future climate projections, 2) provide a region-wide evaluation of changes in water flow, and 3) provide climate information to ecosystems scientists, universities, and stakeholders for targeted ecosystem studies.

Vulnerability Assessment of Ecological Systems and Species to Climate and Land Use Change within the North Central Climate Change Center and Partner Land Conservation Cooperatives

Principal Investigator: **Andrew Hansen**, Montana State University

Determining which species, habitats, or ecosystems are most vulnerable to climate change enables resource managers to better set priorities for conservation action. To address the need for information on vulnerability, this research project will leverage the expertise of university partners to inform the North Central Climate Science Center on how to best assess the vulnerability of elements of biodiversity to climate and land use change in order to inform the development and implementation of management options. Outcomes from this activity will include 1) a framework for modeling vegetation type and species response to climate and land use change, 2) an evaluation of existing alternative vegetation and species response models, and 3) a presentation of vulnerability assessments for managers for incorporation into climate adaptation strategies.

Adaptive Capacity and Decision Making Framework

Principal Investigator: **Dennis Ojima**, Colorado State University

While managers are already required to face uncertainty when making natural resource decisions, climate change adds an additional level of complexity to their management considerations. Development of a decision-making approach that acknowledges sources of uncertainty and incorporates the vulnerability of social-ecological systems to climate change is needed for sound natural resource management decisions. This research activity will determine and assess key factors affecting the capacity of social-ecological systems to adapt to climate changes. Moreover, this study will analyze the decision making framework of related and ongoing research efforts and will examine current vulnerability and risk assessment methodologies in the region. Results from this project will help to address natural resource management decisions dealing with climate change dynamics.

Wyoming Rapid Ecoregional Assessment

The North Central Climate Science Center and the National Oceanic and Atmospheric Administration (NOAA) will provide support requested by the Bureau of Land Management (BLM) for the Wyoming Rapid Ecological Assessment. The overall goal of the Bureau of Land Management's (BLM) Rapid Ecoregional Assessments (REA) is to provide information that facilitates the development of ecological region-based conservation strategies on public lands and to facilitate planning, environmental analysis, and decision-making for regional natural resources. This project will enable the North Central Climate Science Center (NC CSC) to provide climate scientist support to the Wyoming Basins REA. This will be done thru the NC CSC in conjunction with the National Oceanic and Atmospheric Administration (NOAA). The objective is to provide a climate scientist team member to work with the BLM REA core science team responsible for producing the REA documents.