

*The National Climate Change and Wildlife
Science Center Annual Report for 2012*

Circular 1387
Version 1.1, November 14, 2013

**U.S. Department of the Interior
U.S. Geological Survey**

Cover photograph. Aerial view of Louisiana wetland habitat—the Gulf of Mexico is seen in the top right corner of the image (Ryan Hagerty, U.S. Fish and Wildlife Service).



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By Elda Varela-Acevedo and Robin O'Malley

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**U.S. Department of the Interior
U.S. Geological Survey**



U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013
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Abbreviations



ACCCNRS	Advisory Committee on Climate Change and Natural Resource Science
AK CSC	Alaska Climate Science Center
ASCE	American Society of Civil Engineers
CCRUN	Consortium for Climate Risk in the Urban Northeast
CLIMAS	Climate Assessment for the Southwest
CLU	USGS Climate and Land Use Mission Areas
CSC	Climate Science Center
DOI	Department of the Interior
FY	Fiscal Year
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Center
LCCs	Landscape Conservation Cooperatives
USGS	U.S. Geological Survey
NASA	National Aeronautics and Space Administration
NC CSC	North Central Climate Science Center
NCCWSC	National Climate Change and Wildlife Science Center
NCPP	National Climate Projections and Prediction Platform
NCSU	North Carolina State University
NE CSC	Northeast Climate Science Center
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NW CSC	Northwest Climate Science Center
OCCRI	Oregon Climate Change Research Institute
OSU	Oregon State University
PI	Principal Investigator
PI CCC	Pacific Islands Climate Change Cooperative
PI CSC	Pacific Islands Climate Science Center
RISA	Regional Integrated Sciences and Assessments
SAC	Stakeholder Advisory Committee
SC CSC	South Central Climate Science Center
SE CSC	Southeast Climate Science Center
SW CSC	Southwest Climate Science Center
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
UCLA	University of California, Los Angeles
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
UMass	University of Massachusetts



Looking downstream from Paria Riffle on the Colorado River, Grand Canyon, Arizona (Justin Pressfield, U.S. Geological Survey).



Sandy Stream Pond, Baxter State Park, Maine (Lauren Holbrook, U.S. Geological Survey).

The National Climate Change and Wildlife Science Center Annual Report for 2012

A Word From the Director

Welcome to the inaugural edition of the annual report for the U.S. Geological Survey (USGS) National Climate Change and Wildlife Science Center (NCCWSC) and the Department of the Interior (DOI) Climate Science Centers (CSCs). More than three years ago, I was asked to come on a detail to organize and get the NCCWSC/CSC enterprise up and running. Little did I know that I would still be leading this enterprise today (at the time I was fairly convinced I would go back to being the Fisheries Program Coordinator at the U.S. Geological Survey). Three or four weeks later, Robin O'Malley joined this effort and along with Hardy Pearce, the three of us spent most of the first year figuring out how this whole enterprise was supposed to run. After some sleepless nights and very long days, I am very proud to say that the NCCWSC is almost fully staffed (one Research Grade Scientist vacancy remains with the retirement of Bruce Jones in July 2012), all eight CSCs are operational, seven of eight CSC directors have been hired, and we have hired our first research scientist at the Alaska CSC (and plan to hire a research scientist in the Southeast CSC). We have funded 69 new research projects in fiscal year (FY) 2012 whereby various aspects of climate change effects on fish, wildlife, and their habitats will be examined. I am also excited that the NCCWSC was able to help orga-

nize and produce the biodiversity, ecosystem and ecosystems services technical input to the [National Climate Assessment](#), develop a [webinar series](#) to highlight the science outcomes of projects funded by NCCWSC, and will convene, in 2013, the first meeting of a Federal Advisory Committee to provide external advice and guidance to the program. There was no guidebook to start the NCCWSC/CSC enterprise and, although it is loosely modeled after the Cooperative Fish and Wildlife Research Units, we are still developing processes, procedures, guidelines, and approaches to implementing this initiative. We have made some mistakes along the way and had some successes, and I am quite certain there will be more bumps in the road, but I am very excited about how far we have come in a fairly short period. And I still get to dabble with fish and aquatic systems, which is the reason I got in this business in the first place and is one reason I care so much about the long-term sustainability of our natural systems. The NCCWSC and CSCs can provide world class science to support the long-term sustainability of our natural systems.



T. Douglas Beard, Jr., Ph.D., National Climate Change and Wildlife Science Center Director.

Quick Year in Review

- Northeast, Pacific Islands, and South Central Climate Science Centers (CSCs) were established – All eight Department of the Interior CSCs are now operational.
- Three CSC directors were hired (a total of seven permanent directors):
 - Southwest CSC: Dr. Stephen Jackson, formerly University of Wyoming
 - South Central CSC: Dr. Kim Winton, formerly U.S. Geological Survey (USGS) Oklahoma Water Science Center
 - Northeast CSC: Dr. Mary J. Ratnaswamy, formerly USGS Patuxent Wildlife Research Center
- Staff scientists have been hired at the Alaska, North Central, and Southeast CSCs, with recruitment underway at the National Climate Change and Wildlife Science Center and other CSCs.
- Climate Science Centers funded a total of **69** projects, totaling approximately \$10 million, for fiscal year 2012.

NCCWSC Headquarters Staff

The NCCWSC staff is located at the U.S. Geological Survey's (USGS) headquarters in Reston, Virginia. This team guides and supports the CSCs in accomplishing their science agenda goals.

NCCWSC Director

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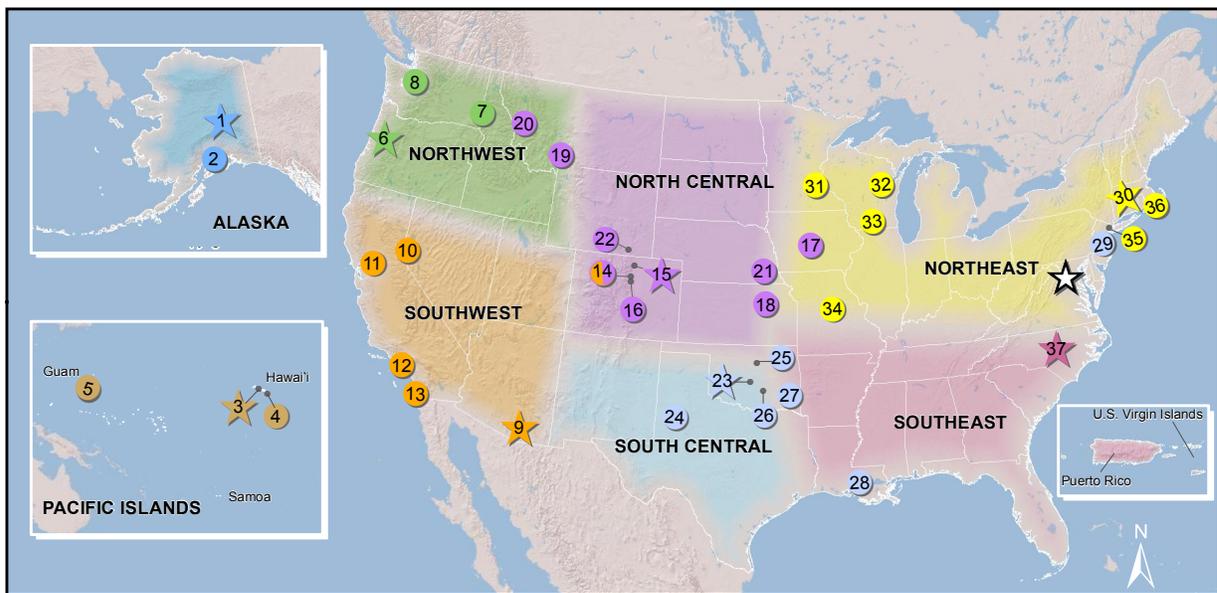
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The History of the NCCWSC and CSCs in Brief

In 2008, Congress created the National Climate Change and Wildlife Science Center (NCCWSC) within the U.S. Geological Survey (USGS). The center was formed to respond to the demands of natural resource managers for rigorous scientific information and effective tools for assessing and responding to climate change. Located at the USGS National Headquarters in Reston, Va., the NCCWSC has invested more than \$70 million in cutting-edge climate change research and, in response to [Secretarial Order No. 3289](#), established and is managing eight regional Department of Interior (DOI) [Climate Science Centers \(CSCs\)](#) (fig. 1).

The mission of the NCCWSC is to provide natural resource managers with the tools and information they need to develop and execute management strategies that address the impacts of climate and other ongoing global changes on fish and wildlife and their habitats. The DOI CSCs are joint Federal-university partnerships that focus their scientific work on regional priorities identified by [DOI Landscape Conservation Cooperatives \(LCCs\)](#) as well as Federal, State, Tribal, and other resource managers. The CSCs provide access to a wide range of scientific capabilities through their network of university partners along with USGS and other Federal agency scientists. The focus of the NCCWSC on multiregion and national priorities complements the regionally focused agendas of the CSCs.



Base from ESRI, 2009, Albers Equal Area Conic Projection, North American Datum of 1983

EXPLANATION

★ National Climate Change and Wildlife Science Center

★ CSC lead institutions

② CSC institutions

Alaska CSC

1. University of Alaska Fairbanks
2. University of Alaska Anchorage

Pacific Islands CSC

3. University of Hawai'i at Mānoa
4. University of Hawai'i at Hilo
5. University of Guam

Northwest CSC

6. Oregon State University
7. University of Idaho
8. University of Washington

Southwest CSC

9. University of Arizona
10. Desert Research Institute (Nevada)
11. University of California, Davis
12. University of California, Los Angeles
13. Scripps Institute of Oceanography
14. University of Colorado

North Central CSC

14. University of Colorado
15. Colorado State University
16. Colorado School of Mines
17. Iowa State University
18. Kansas State University
19. Montana State University
20. University of Montana
21. University of Nebraska, Lincoln
22. University of Wyoming

South Central CSC

23. University of Oklahoma
24. Texas Tech University
25. Oklahoma State University
26. Chickasaw Nation
27. Choctaw Nation of Oklahoma
28. Louisiana State University
29. NOAA Geophysical Fluid Dynamics Laboratory

Northeast CSC

30. University of Massachusetts, Amherst
31. University of Minnesota
32. College of Menominee Nation
33. University of Wisconsin, Madison
34. University of Missouri, Columbia
35. Columbia University
36. Marine Biological Laboratory

Southeast CSC

37. North Carolina State University

Figure 1. Map showing the locations of the Climate Science Centers and their university-led consortia.

What Are the CSCs and What Do They Do?

Climate Science Centers are joint Federal-university collaborations (fig. 1). CSCs are located at major universities, have Federal and university staff, train graduate students and post-doctoral researchers, and undertake scientific activities designed to meet the needs of natural and cultural resource managers. Several regions have university-led consortia that include several tribes (and a Tribal college) as well as Federal laboratories that have personnel with key skills and expertise.

The CSC enterprise has been shaped by the following principles:

- **Meet the scientific needs of resource managers.** NCCWSC and CSCs receive their scientific direction through consultations with those managers whose work involves decisions about natural and cultural resources. Landscape Conservation Cooperatives are primary partners, along with other Federal, State, Tribal, local, and nongovernmental partners.
- **Foster partnerships aggressively.** Effectively responding to landscape-scale changes requires ongoing engagement of multiple management partners (such as Federal and State) as well as collaboration among science providers to ensure efficient use of resources. These partnerships require conscious development and dedicated resources.
- **Maximize resources for science.** NCCWSC and CSCs have been implemented in ways that minimize staff and facility costs and maximize the amount of funding to science.
- **Utilize the strengths of both university and government.** The scientific expertise required to address climate change is growing and changing rapidly, and strong government-university collaborations enable the public to access state-of-the-science tools and expertise.
- **Focus on ecosystems, not jurisdictions.** Management of natural resources can only truly be effective if it is based on a rich understanding of the full setting, context, and extent of a species, habitat, or other ecological element.

Science Agenda—Summary and Highlights

The NCCWSC National Science Agenda was drafted on the basis of input from the newly formed CSCs and was presented in initial form in 2012 to NCCWSC stakeholders and USGS Climate and Land Use (CLU) Change senior staff. Relevant organizational goals from the USGS Ecosystems and CLU Mission Areas were also incorporated into the document. This agenda will be vetted through an ad hoc Science Subcommittee from the DOI Advisory Committee on Climate Change and Natural Resources Science in 2013 before being finalized. As a complement to the broader national agenda, a mid-term Strategic Science Plan has also been developed, with input from CSC directors, which builds upon both funded research projects for 2012 as well as near-term research priorities identified in CSC Regional Science Agendas. The mid-range Strategic Science Plan lists the overarching science infrastructure and capacity building goals as follows:

1. Collaboration, communication, and translation of science results to managers, stakeholders, and the public interested in climate change activity.
2. Creation of a shared information and data management platform.
3. Education and training of a core of climate scientists that will provide expertise in the future.
4. Evaluation of the impacts of the NCCWSC/CSC enterprise.

The mid-range Strategic Science Plan lists the project science goals as follows:

1. Assess and synthesize our state of knowledge about climate and land-use change impacts on natural and cultural resources.
2. Perform vulnerability assessments of species and ecosystems.
3. Understand the social-ecological impacts of climate and land-use change.
4. Understand the interactions between climate and the physical, biological, and chemical forces that influence the structure and functioning of ecosystems and the goods and services they provide.

This past year, the NCCWSC science staff completed a technical report entitled "*Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services*" and a series of companion manuscripts to be published in a special issue of "Frontiers in Ecology and the Environment." Federal law requires that the U.S. Global Change Research Program submit an assessment of climate change and its impacts to the President and Congress once every 4 years. This technical report, in addition to other supporting articles and books, provides a foundation for the corresponding chapters of the U.S. Global Change Research Program's Third U.S. National Climate Assessment, which is scheduled to be released in 2014. The report supports assertions about biological responses

to climate change with several case studies and research from across the United States (fig. 2). NCCWSC scientists Michelle Staudinger and Shawn Carter were lead authors on the report, along with Stuart Chapin III, University of Alaska Fairbanks; Peter Kareiva, The Nature Conservancy; and Mary Ruckelshaus, Natural Capital Project.

The NCCWSC also put together a national [webinar series](#) highlighting the research findings of projects funded by NCCWSC and the DOI CSCs. This series is co-sponsored with the U.S. Fish and Wildlife Service's (USFWS) National Conservation Training Center and features talks highlighting climate impacts and corresponding management issues.

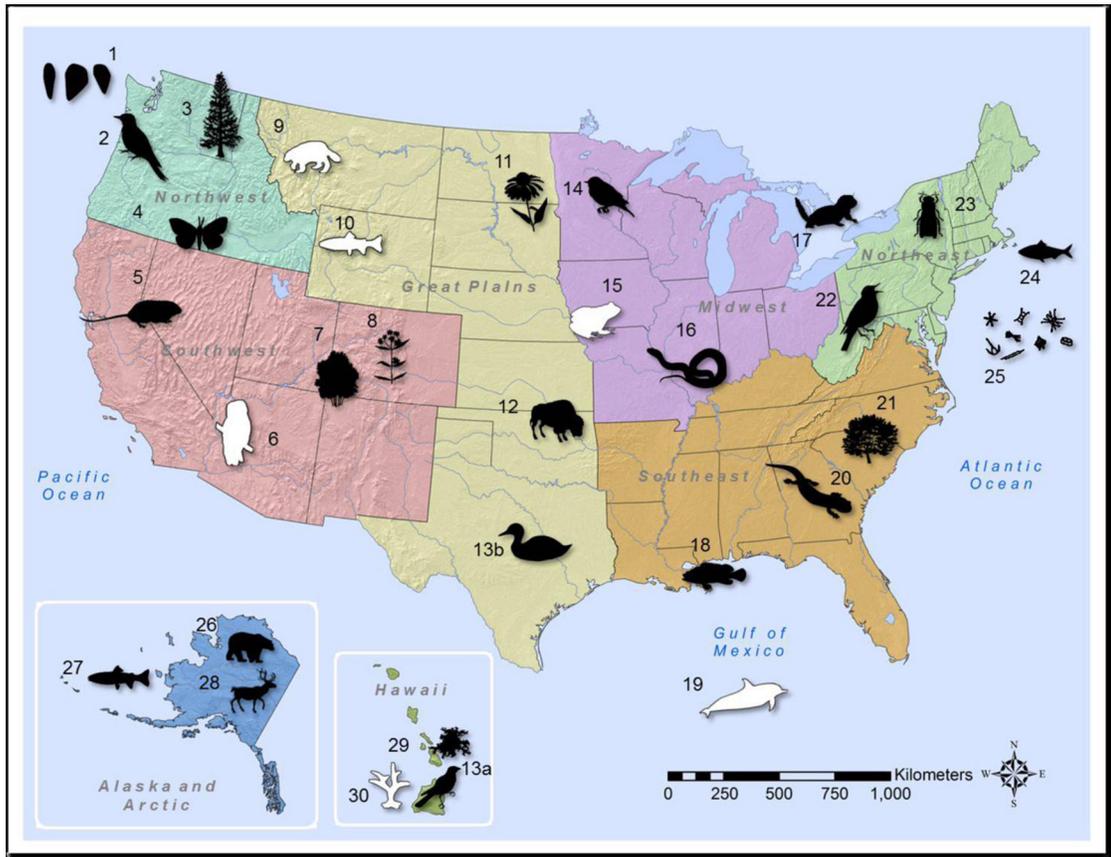


Figure 2. Map showing examples of observed (black icons on map) and projected (white icons on map) biological responses to climate change across the United States. Case study information can be found in Staudinger and others, 2012.

User-Driven Science—Stakeholders, NCCWSC, and CSCs

The NCCWSC enterprise was established to provide scientific information to managers with respect to a changing climate. CSCs and NCCWSC rely heavily on input and guidance about what science questions are most pressing and how results need to be presented to be helpful in making decisions. Each CSC has a formal Stakeholder Advisory Committee (SAC) that includes States, Federal agencies, tribes, and the LCCs (fig. 3) in the respective region. Input from these key partners shapes the CSC's strategic science agenda and annual project priorities, and provides feedback on the utility, timeliness, and responsiveness of both individual research activities and the CSC as a whole. While SACs may not legally include nongovernmental partners, each CSC will also solicit input from regional conservation and science organizations as well as farmers, foresters, and other producers. The efforts of each CSC are focused on a modest number of high-priority topics to ensure maximum impact and that science is directly responsive to the needs of decisionmakers, and to work across CSC boundaries to address regional and national impacts of climate change.

In addition, on October 4, 2012, then Secretary of the Interior Ken Salazar announced the establishment of the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS), a Federal advisory committee to provide input and guidance to the overall NCCWSC/CSC effort. The

first meeting of ACCCNRS will be held in September 2013. This committee includes representatives from DOI and other Federal agencies, States, tribes, nongovernmental organizations, academia, and the private sector. The committee will seek to ensure that the science undertaken by NCCWSC and CSCs is of leading-edge quality and that it is directly relevant and useful to inform managers of the many decisions required in a changing climate.

Finally, NCCWSC and CSCs are making extra efforts to ensure Tribal engagement. Former Secretary of the Interior Ken Salazar made Tribal issues a priority and Secretary of the Interior Sally Jewell has also done so, since tribes are likely to be directly influenced by climate change, often with limited resources with which to respond. In addition, Tribal knowledge will be useful in assessing how climate is changing or how tribes and others may best respond to these changes. Each CSC will have Tribal members on its SAC, and each CSC will offer to convene formal consultation with tribes in the region if desired. The South Central and Northeast CSCs include tribes as formal members of their consortiums, and these CSCs are expected to provide additional insights into Tribal needs and the most effective ways of delivering information to tribes. In fiscal year 2012 (FY12), CSCs responded to this challenge by supporting investigations into traditional Tribal foods (NW CSC) and working with tribes to better understand their needs (SW CSC and SC CSC). As a result, additional projects are being planned.

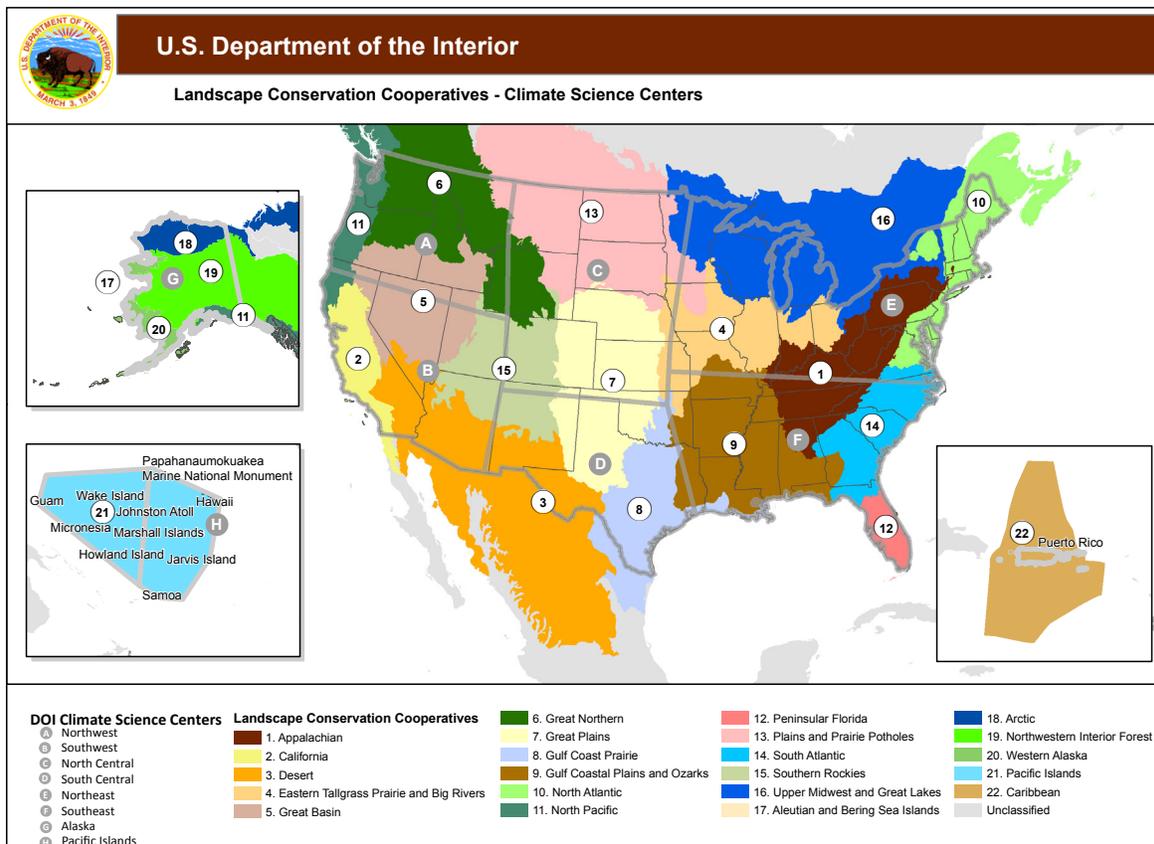


Figure 3. Map overlay of the Department of the Interior Climate Science Centers and Landscape Conservation Cooperatives.

Education and Training—The Next Generation

It is now clear that natural and cultural resources will be affected by climate change for generations, if not centuries, to come. Ensuring that tomorrow's decisionmakers are supported by well-trained scientists with an understanding of how to research and communicate scientific results that are relevant and applicable to these new challenges is a core mission of NCCWSC and the CSCs. Each CSC has a cadre of graduate students or post-doctoral researchers who, while pursuing their academic training, work on high-priority science needs of conservation managers in their region, gaining valuable insight into how management agencies operate and creating networks that will serve them throughout their careers.

Approximately 4 undergraduates, 40 graduate students, and 15 post-doctoral researchers are supported at CSCs (FY12–FY13). In some CSCs, students trained by

CSC-related faculty, but not funded by the CSC, are also contributing valuable time and expertise to our work. In addition, two CSCs piloted special summer education and training events. The Northwest CSC has conducted two "climate science boot camps" for early career scientists and management professionals. The boot camps included field trips, skill-building exercises, and presentations by leading climate scientists, communications experts, and resource managers to give participants an all-encompassing view of the workings of climate impacts science. In 2012, the Alaska CSC hosted a 2-week short course on downscaling climate projections, again for early career scientists at CSCs across the country. Participants in one course created a social media site to facilitate post-course interactions, and NCCWSC and the CSCs are seeking additional ways to foster interactions among these enthusiastic young experts. Discussions are also underway to transition from these two courses to a more structured and regular set of opportunities to foster science-management collaboration as individuals begin their careers.



Sunrise over Kayak Island, Cordova, Alaska (John Crusius, U.S. Geological Survey).

ALASKA CLIMATE SCIENCE CENTER

Host Institution: University of Alaska Fairbanks

Location: University of Alaska Anchorage

Established: March 2010

In early 2011, the **Alaska Climate Science Center (AK CSC)** opened as the first of eight regional **Climate Science Centers**. The Alaska CSC provides scientific information, tools, and techniques that managers and others interested in land, water, wildlife, and cultural resources can use to anticipate, monitor, and adapt to climate change. The AK CSC is hosted by the University of Alaska Fairbanks (UAF) and is physically housed within the University of Alaska Anchorage (UAA).

In addition to its relationship with UAF and UAA, the Alaska CSC has also developed strong **partnerships** with faculty from the University of Alaska Southeast, the USFWS, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture Forest Service (USFS), and the National Park Service, in addition to the Arctic, Western Alaska, Northwest Boreal, Aleutian and Bering Sea Islands, and the North Pacific LCCs. Together these partners provide expertise in climate science, ecology, environmental impacts assessment, modeling, cultural impacts, and advanced information technology. These partnerships are essential for addressing climate issues in Alaska, where changes in temperature and precipitation are already having notable impacts on terrestrial and marine ecosystems.



Valdez Glacier (Alessio Gusmeroli, University of Alaska Fairbanks).

DIRECTORS



USGS CSC Director

Dr. Steve Gray was the Wyoming State Climatologist, director of the Wyoming Water Resources Data System, and an associate research scientist at the University of Wyoming before joining the AK CSC. Dr. Gray has also held various positions at Montana State University and the University of Arizona Laboratory of Tree Ring Research. His research focuses on climate variability, climate change, and their impacts on natural resource management. The tools used in this work range from direct meteorological observations and simulation models to tree-rings and fossilized pollen, with a particular emphasis on drought and other extreme climate events. Dr. Gray is a former National Research Council Research Associate with the USGS, and he received his Ph.D. in paleoclimatology and paleoecology from the University of Wyoming.



University CSC Director

Dr. Scott Rupp is the director of the Scenarios Network for Alaska & Arctic Planning, principal investigator (PI) for the DOI's AK CSC, and co-PI for the NOAA-funded Alaska Center for Climate Assessment and Policy. He is a well-established forest ecologist with specialized experience in ecological modeling. He has authored more than 50 peer-reviewed journal articles and book chapters. Dr. Rupp received a Bachelor of Science (B.S.) in forest management from Pennsylvania State University and a Ph.D. in forest ecology from UAF. He is a professor of forestry and has been a faculty member at UAF since 2001.

STUDENTS

University of Alaska Fairbanks

Dr. Stephanie McAfee, Post-Doctoral Fellow: Climate model downscaling

Dr. Alessio Gusmeroli, Post-Doctoral Fellow: Permafrost hydrology

Dr. Jacob LaCroix, Post-Doctoral Fellow: Wildlife habitat modeling

Katrina Bennett, Doctoral Research Assistant: Influence of climate change on regional hydrologic extremes in interior sub-Arctic Alaskan watersheds

Carson Baughman, Graduate Research Assistant: Controls and consequences of peat in a permafrost landscape on Alaska's North Slope

Winslow Hansen, Graduate Research Assistant: Linked disturbance interactions in Alaska: Implications for ecosystems and people

Rick Lader, Graduate Research Assistant: Intercomparison and validation study of reanalysis models for Alaska

Earnest Eckerson, Undergraduate Research Assistant: Freshwater discharge from Alaska glaciers

Brittany Bennett, Undergraduate Research Assistant: Population-level responses of Alaska wildlife species to short- and long-term effects of climate change on the environment

PROJECT HIGHLIGHT

Assessing the sensitivity of Alaska's coastal rainforest ecosystems to changes in glacier runoff

PI: Shad O'Neel, USGS Alaska Climate Science Center

The coastal temperate rainforests of Alaska receive large amounts of precipitation each year. Much of this precipitation falls as snow, and it is not uncommon for Alaska's coastal mountains to receive hundreds of inches of snowfall each winter. As a result, extensive areas of southcentral and southeast Alaska are covered in glaciers and ice fields that contribute substantially to regional water runoff and are among the highest on Earth. This glacier runoff strongly influences the chemistry and ecology of freshwater and marine ecosystems along the Gulf of Alaska, while also affecting a number of ocean-atmosphere processes across a variety of scales.

This project will produce a strong foundation for understanding the influence of glaciers on past hydrological conditions and for predicting future impacts of glacier change on regional ecosystems. This work includes a significant component of "upscaling" whereby observations from individual glaciers are combined with satellite measurements and model output to produce region-wide time series of freshwater discharge. This work will also highlight the importance of glacier changes to important socioeconomic systems, including the highly productive salmon fisheries in the region. Likewise, the project is designed to foster working partnerships between physical and biological scientists, thereby enhancing interdisciplinary research on the impact of regional glacier change.

Key glacier mass balance programs at Mendenhall (left) and Columbia (right) glaciers will be supported and expanded by the AK CSC effort.



Mendenhall Glacier (Todd Paris, University of Alaska Fairbanks).



Columbia Glacier (Kristin Timm, University of Alaska Fairbanks).

NORTH CENTRAL CLIMATE SCIENCE CENTER

Location: Colorado State University—Fort Collins

Established: 2011

The **North Central Climate Science Center (NC CSC)** is hosted by a consortium of nine institutions: Colorado State University, Fort Collins (lead institute); University of Colorado; Colorado School of Mines; University of Nebraska, Lincoln; Montana State University; University of Wyoming; University of Montana; Kansas State University; and Iowa State University. Colorado State University in Fort Collins serves as the central location and administrative center for the NC CSC. In addition to the host institutions, the NC CSC also includes important **partner institutions**, including the Plains and Prairie Potholes, Great Northern, Great Plains, and Southern Rockies LCCs and USGS science centers.

These partner institutions provide expertise in climate science, ecology, impacts assessment, modeling, urban environments, and advanced information technology. This expertise is needed to address climate issues in the North Central United States, where changes in temperature and precipitation could have significant effects on streams, forests, agricultural lands, and mountain ecosystems, in addition to the fish, wildlife, and human communities supported by these environments.



Greater Sage Grouse (Stephen Ting, U.S. Fish and Wildlife Service).

DIRECTORS



USGS CSC Director

Dr. Jeff Morisette is the director of the NC CSC where he manages and conducts research on how natural and cultural land management can respect the ever changing nature of climate. A current research theme is how dynamic species distribution models can contribute to vulnerability assessment and adaptation planning. Dr. Morisette's prior positions include head of the Invasive Species Science Branch and the assistant center director for science at the USGS Fort Collins Science Center. Before transferring to the USGS, Dr. Morisette was at NASA's Goddard Space Flight Center for 10 years. Dr. Morisette received a Bachelor of Arts (B.A.) degree from Siena Heights University in Adrian, Michigan, a Master of Science (M.S.) degree in statistics from Oakland University in Rochester, Michigan, and a Ph.D. from North Carolina State University. In 2006, he won NOAA's National "David Johnson Award for Outstanding Innovative Use of Earth Observation Satellite Data."



University CSC Director

Dr. Dennis Ojima is a professor in the Department of Ecosystem Science and Sustainability and a senior research scientist in the Natural Resource Ecology Laboratory in the Warner College of Natural Resources at Colorado State University. His research addresses climate and land-use changes on ecosystems, carbon accounting methods for forest carbon sequestration, and adaptation and mitigation strategies to climate change. Dr. Ojima is co-leading the Great Plains climate change assessment for the U.S. National Climate Assessment, is an Aldo Leopold Leadership Fellow, and is serving on two National Research Council Boards, the Board on Environmental Change and Society and the Board for International Scientific Organizations. From 2007 to 2009, he was resident senior scholar at the H. John Heinz III Center for Science, Economics, and the Environment in Washington, D.C.

Dr. Ojima was recognized for his international contributions in the Millennium Ecosystem Assessment, which received the 2005 Zayed International Prize for the Environment and the IPCC 2007 Nobel Peace Prize. Dr. Ojima received his B.A. and M.S. in botany from Pomona College (1975) and the University of Florida (1978), and his Ph.D. from the Rangeland Ecosystem Science Department at Colorado State University (1987).

STUDENTS

Amber Childress: Graduate Student, Colorado State University, Natural Resource Ecology Laboratory

Shannon McNeely: Post-Doctoral Fellow, Colorado State University, Natural Resource Ecology Laboratory

Karen Cozzetto: Post-Doctoral Fellow, University of Boulder, Colorado

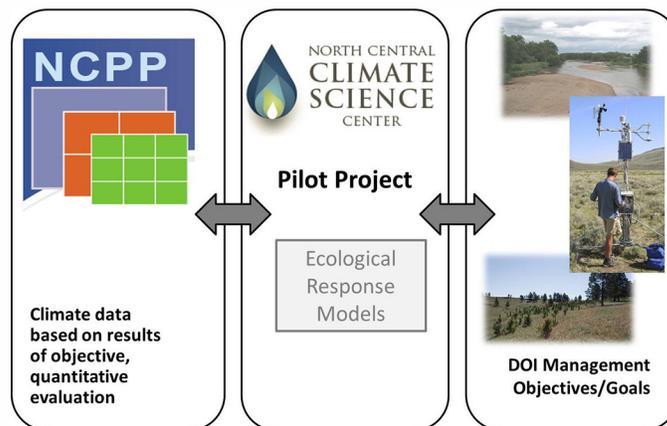
PROJECT HIGHLIGHT

The North Central Pilot Program for the National Climate Projections and Prediction Platform

The overarching goal of this pilot is to explore together the best available climate information to support key land-management questions and how to provide that information. The four projects funded through this pilot will develop a deliberate, ongoing interaction to prototype how National Climate Projections and Prediction Platform (NCPP) will work with CSCs to develop and deliver needed climate information products. The projects are:

1. **The value of climate information for supporting management decisions within the Plains and Prairie Potholes LCC.**
PI: Max Post van der Burg, USGS Northern Prairie Wildlife Research Center
2. **Projecting climate change effects on cottonwood and willow seed dispersal phenology, flood timing, and seedling recruitment in western riparian forests.**
PI: Patrick Shafroth, USGS Fort Collins Science Center
3. **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.**
PI: Richard S. Sojda, USGS Northern Rocky Mountain Science Center
4. **Projecting future effects of land management, natural disturbance, and carbon dioxide on woody encroachment in the northern Great Plains in a changing climate.**
PI: Amy Symstad, USGS Northern Prairie Wildlife Research Center

These projects will build data capabilities in the NC CSC by providing NCPP’s translational information for climate data used as input to USGS-based ecological modeling efforts. The ultimate goals of this pilot are to (a) explore ways in which the climate information can help inform land managers’ decisions through ecological response models and (b) develop approaches for ecological response modeling to be informed and enhanced by the translational climate information provided by NCPP.



NORTHEAST CLIMATE SCIENCE CENTER

Location: University of Massachusetts, Amherst

Established: 2012

The **Northeast Climate Science Center (NE CSC)** is hosted by the University of Massachusetts, Amherst, and also works with a consortium of institutions: the College of Menominee Nation; Columbia University; Marine Biological Laboratory; University of Minnesota; University of Missouri, Columbia; and the University of Wisconsin, Madison. In addition to the host and consortium institutions, the NE CSC also collaborates with other important **partner institutions**, such as regional LCCs, USGS science centers, and research institutes.

The NE CSC consortium and partners provide expertise in climate science, ecology, impacts assessment, modeling, urban environments, and advanced information technology. This expertise is needed to address climate issues in the Northeast, where changes in temperature and precipitation are forecasted to have significant effects on streams, forests, agricultural lands, and the Atlantic Coast, in addition to the fish, wildlife, and human communities supported by these environments.



Aerial view of Louisiana wetland habitat—the Gulf of Mexico is seen in the top right corner of the image (Ryan Hagerty, U.S. Fish and Wildlife Service).

DIRECTORS



USGS CSC Director

Dr. Mary J. Ratnaswamy is originally from St. Paul, Minnesota. She completed her B.A. in biology at Carleton College in Northfield, Minnesota, and subsequently obtained an M.S. in oceanography from the University of Rhode Island and a Ph.D. in forest resources (wildlife ecology and management) from the University of Georgia. Since 2008, Dr. Ratnaswamy has been a research manager at the USGS's largest biological science center, the USGS Patuxent Wildlife Research Center in Laurel, Maryland. There she directed the Migratory Birds, Coastal and Wetlands, and Ecosystems programs, and supervised 15 research scientists as well as other staff. Prior to joining the USGS, Dr. Ratnaswamy supervised the Endangered Species Program at the USFWS Chesapeake Bay Field Office for 8 years, with special emphasis on recovery of the endangered Delmarva fox squirrel.



University CSC Director

Dr. Richard Palmer is department head and professor in the Department of Civil and Environmental Engineering at the University of Massachusetts, Amherst. Dr. Palmer was a PI in the Climate Impacts Group at the University of Washington and is currently the PI for the University of Massachusetts (UMass) part of the NOAA Regional Integrated Sciences and Assessments (RISA) Consortium for Climate Risk in the Urban Northeast (CCRUN) that is based at Columbia University. Over the past 25 years Dr. Palmer has performed extensive research on water resources and the impacts of climate change. He is also engaged in studies of drought planning, real-time water resource management, and the application of decision support to civil engineering management problems. Dr. Palmer received his Ph.D. from the Johns Hopkins University in 1979 and his M.S. in environmental engineering from Stanford

University in 1973. He was awarded the Huber Award for Research Excellence by the American Society of Civil Engineers (ASCE) in 1992 and received the "Service to the Profession" Award from the Water Resources Planning and Management Division of the ASCE in 1998. In 2006, he received the Julian Hinds Award from ASCE for his contributions to water resources planning and his research related to the impacts of climate change on water resources.

STUDENTS

Post-Doctoral Associates

Eleonora Maria Demaria (FY13): Department of Civil and Environmental Engineering, UMass Amherst; Impacts of climate change on water resources.

Fan Fangxing (portion of FY12, FY13): Department of Geosciences, UMass Amherst; Modeling of the Northeastern U.S. climate.

Liang Ning (portion of FY12, FY13): Department of Geosciences, UMass Amherst; Modeling regional climate change and climate variability.

Jane Foster (portion of FY12, FY13): Department of Forest Resources, University of Minnesota; Effects of climate and disturbance on the growth and dynamics of temperate and sub-boreal forest ecosystems within the upper Lake States.

David McKenzie (FY13): Department of Forest Resources, University of Minnesota; Influence of annual climate variability, forest management, and harvest techniques on tree growth and stand-level resistance and resilience to periodic drought.

William Andrew Cox (portion of FY12, FY13): Department of Fisheries and Wildlife Science, University of Missouri; Effects of the interaction of climate and landscape factors on Midwestern forest birds.

James Nelson (portion of FY12, FY13): The Ecosystems Center, Marine Biological Laboratory; Effects of the interaction of climate and land-use change on forage and top predatory fish in coastal ecosystems.

Graduate Students

Jocelyn Anleitner (FY12): Department of Civil and Environmental Engineering, UMass Amherst; Impacts of climate change on water resources.

Lynn Brennan (FY13): Department of Civil and Environmental Engineering, UMass Amherst; Impacts of climate change on stream temperature.

Paul Damkot (FY13): Department of Environmental Conservation, UMass Amherst; How climate change will affect brook trout populations.

Alex Joste (FY13): Department of Environmental Conservation, UMass Amherst; Impacts of climate change on water resources.

Kyle Gill (portion of FY12, FY13): M.S. candidate, Department of Forest Resources, University of Minnesota; Climate factors affecting shifts between grassland and forest biomes over the past century within the upper Midwest.

Megan Haserodt (FY13): MS candidate, Department of Geology and Geophysics, University of Wisconsin; Assessment of climate change impacts on watershed hydrology and policy implication implications.

Zachary Schuster (FY12, FY13): Environment and Resources Program in the Nelson Institute for Environmental Studies, University of Wisconsin; Assessment of climate change impacts on watershed hydrology and policy implication implications.

Wenchi Jin (portion of FY12, FY13): M.S. candidate, Department of Forestry, University of Missouri; Comparison of the performance of different ecosystem models for assessing climate impacts on tree establishment and growth.

Evan Murdoch (FY12): Environment and Resources Program in the Nelson Institute for Environmental Studies, University of Wisconsin; Assessment of climate change impacts on groundwater recharge and policy implications.

Undergraduate

Thomas Rogg (portion of 2012): Department of Civil and Environmental Engineering, UMass Amherst.

PROJECT HIGHLIGHT

Bringing people, data, and models together—Addressing impacts of climate change on stream temperature

PI: Dr. Austin Polebitski, University of Massachusetts, Amherst

Research Questions and Objective

Few previous studies have focused on how climate change may impact headwater systems, despite the importance of these areas as aquatic refugia.

A critical and timely research question is "*What data and modeling frameworks are needed to provide scientists reliable, climate-informed, water temperature estimates for freshwater ecosystems that can assist watershed management decision making?*" The project will answer this through two primary activities: (1) gathering and compiling existing stream temperature data within the DOI NE CSC region and subsequent deployment of data loggers to areas where additional data are needed, and (2) an intercomparison of state-of-the-art statistical and deterministic stream temperature models to evaluate their ability to replicate point stream temperature measurements and model scalability to non-gaged sites within the Northeast region.

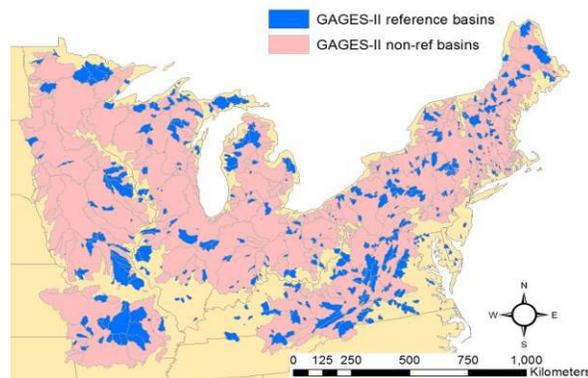
Methodology

This study will use the recently (2011) developed USGS GAGES-II database for inputs to stream temperature modeling efforts in two major project phases.

- The team will gather all local, State, and Federal stream temperature data within the region shown in figure 1 by leveraging existing relations with State agencies, consortia members, the LCCs, USFWS, USGS, USFS, and the USEPA (Phase I).
- The model intercomparison will evaluate the ability of multiple models to replicate stream temperature at point locations and estimate temperatures at ungaged locations over variable temporal resolutions (Phase II).

Expected Results

The expected results for this project are (1) a web-accessible database containing stream temperature data from across the Northeast domain, (2) identification of critical areas in need of long-term monitoring efforts, (3) deployment of temperature loggers to enhance existing long-term monitoring network, and (4) a comprehensive model intercomparison, focusing on model accuracy, flexibility, and parsimony.



The USGS GAGE-II reference basins in the Northeast region.



Rogue River Canyon in southwest Oregon (Ruth Jacobs, U.S. Geological Survey).

NORTHWEST CLIMATE SCIENCE CENTER

Location: Oregon State University
Established: 2010

The **Northwest Climate Science Center (NW CSC)** was established in 2010 by the **DOI** to address the challenges presented by climate change and climate variability in the Northwestern United States. The CSC is a federally led research collaboration hosted by three major universities: Oregon State University (OSU), University of Washington, and University of Idaho. OSU serves as the central location and administrative center for the NW CSC. In addition to the host institutions, the NW CSC also works with important **partner institutions**, including the Great Basin, North Pacific, and Great Northern LCCs and Tribal groups. The NW CSC receives advice and guidance from an **Executive Stakeholder Advisory Committee**.

The NW CSC and its partner institutions provide expertise in climate science, ecology, impact assessments, modeling, urban environments, and advanced information technology. This expertise is needed to address climate issues in the Northwest, where changes in temperature and precipitation could have significant effects on streams, forests, agricultural lands, and the Pacific Coast, in addition to the fish, wildlife, and human communities supported by these environments.

Early in 2012, the NW CSC released its first **Strategic Plan** for the period 2012–2015. The plan offers a practical blueprint for operation and describes five core services that the NW CSC provides to the Northwest community. These core services emphasize (1) bringing together the regional resource management and science communities to calibrate priorities and ensure efficient integration of climate science resources and tools when addressing practical issues of regional significance; (2) developing and implementing a stakeholder-driven science agenda that highlights the NW CSC's regional leadership in generating scenarios of the future environment of the Northwest; (3) supporting and training graduate students at the three consortium universities, including support of an annual 'climate science boot camp'; (4) providing a platform for effective climate-change-related communication among scientists, resource managers, and the general public; and (5) providing national leadership in data management and climate scenario development.



Coastal cutthroat trout from Camp Creek, western Oregon (David Leer, Oregon State University).

DIRECTORS



USGS CSC Director

Dr. Gustavo Bisbal previously served in the Office of Ocean and Polar Affairs in the Bureau of Oceans, Environment and Science, at the U.S. Department of State. Dr. Bisbal helped advance U.S. foreign policy objectives related to ocean sciences and resource management by holding leadership roles as the Department's Officer to the Commission

for the Conservation of Antarctic Marine Living Resources and as Alternate Head of the U.S. delegation to UNESCO's Intergovernmental Oceanographic Commission. Between 2002 and 2006, he was the Manager of the Columbia River Basin and Water Development Branch at the Oregon Office of the USFWS. As senior science and policy analyst with the Northwest Power and Conservation Council (1994–2002), he was responsible for the integration of scientific information into policy decisions to protect and restore fish and wildlife resources in the Columbia River Basin. Dr. Bisbal's graduate education at the University of Rhode Island includes both a Ph.D. and an M.S. in Biological Oceanography and a Master of Marine Affairs.



University CSC Director

Dr. Philip W. Mote is a professor in the College of Earth, Oceanic, and Atmospheric Sciences at OSU; director of the Oregon Climate Change Research Institute (OCCRI) for the Oregon University System; and director of Oregon Climate Services, the official state climate office for

Oregon. Dr. Mote's research interests include scenario development, regional climate change, regional climate modeling with a super-ensemble generated by volunteers' personal computers, and adaptation to climate change. He is the co-leader of the NOAA-funded Climate Impacts Research Consortium for the Northwest and also of the NW CSC for the DOI. Since 2005 he has been involved in the Intergovernmental Panel on Climate Change, which was jointly awarded the 2007 Nobel Peace Prize. He is also a coordinating lead author and advisory council member for the U.S. National Climate Assessment, and has served on numerous author teams for the National

Research Council (NRC). Dr. Mote earned a B.A. in physics from Harvard University and a Ph.D. in atmospheric sciences from the University of Washington. Dr. Mote arrived at OSU to establish the OCCRI in 2009.

STUDENTS

2012 NW CSC Fellows (2011–12 academic year, except where noted)

Oregon State University

Sarah Frey-Hadley: Ph.D. student in ecology; Identification of the major drivers of the patterns observed in bird distributions and how changes in climate and land-use might alter them.

Lindsey Thurman: Ph.D. student in wildlife science; Synergistic effects of climate change and other environmental stressors on high-elevation amphibian species in the Cascade Mountain Range.

Sihan (Meredith) Li: Ph.D. candidate in the College of Oceanic and Atmospheric Sciences; Regional climate modeling.

Seth Wiggins (graduated spring 2012): Ph.D. in applied economics; Technical and economic potential of carbon sequestration on Pacific Northwest rangelands.

University of Washington

Ronda Strauch: Ph.D. student in Department of Civil and Environmental Engineering; Vulnerability of transportation to climate change.

Jesse Langdon: Master's student in the School of Environmental and Forest Sciences; Forecasting the influence of climate change on terrestrial biodiversity in protected areas of the Pacific Northwest.

Brittany Jones: M.S. student in the School of Aquatic and Fisheries Sciences; Spatially explicit assessment of natural adaptation and restoration of tidal wetlands under the influence of future climate change throughout Puget Sound.

University of Idaho

Jacob Wolf (graduated spring 2012): Master of Geography student; Exploring a suite of climate change scenarios to develop high-resolution drought metrics that span the 21st century.

Collette Gantenbein: Master of Geography student; Land cover change in relation to climate change through examining burn severity in the Pacific Northwest.



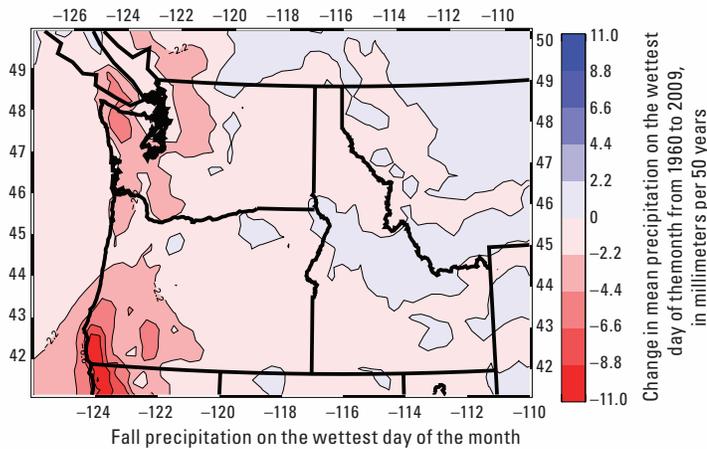
Dominant vegetation in Central Oregon could switch from lodgepole pine (left) to ponderosa pine (right).

PROJECT HIGHLIGHT

Integrated scenarios of climate, hydrology, and vegetation for the Northwest

PI: Phil Mote, Oregon State University

This project will develop a state-of-the-science capability for consistent description of the future environment in the Northwest, using a variety of modeling and statistical approaches including the current generation of global and regional climate modeling. Building on leveraged Federal investments, and in partnership with the NOAA-funded Climate Impacts Research Consortium, a "core set" of 10 global and regional climate models will be evaluated, the models will be downscaled using a new statistical approach, and simulations will be performed with two hydrology models using two socioeconomic scenarios for each of the core set of 10 Global Climate Models (2 x 10 = "the 20 core scenarios").

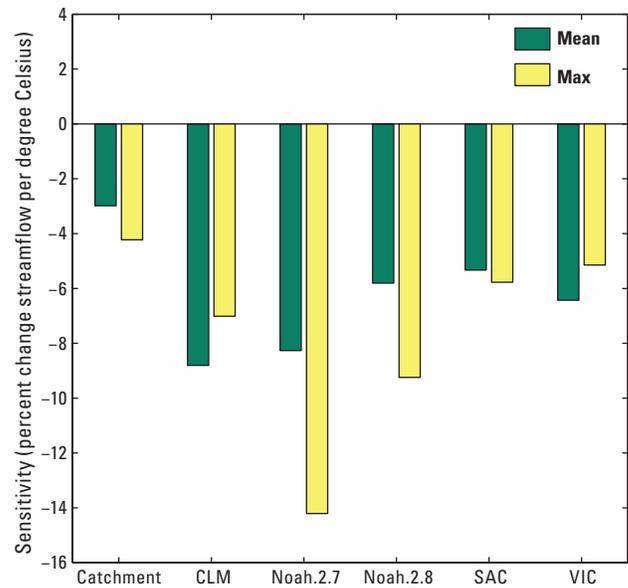


Climate scenario example: Change in extreme daily precipitation

For these core scenarios, the researchers will:

- perform simulations with the MC1 dynamic vegetation model to estimate vegetation distribution, carbon stores and fluxes, and fire occurrence, area burned, and impacts;
- perform simulations with the 3-PG physiological forest growth model to simulate net primary production and wood production over forest succession; and
- lay the groundwork for careful quantification of uncertainty and utilization of regional models.

The resulting datasets will lead to a next generation climate change framework that allows land managers to identify potentially vulnerable areas, prioritize investment in projects to increase the resilience of forests and grasslands, and incorporate projected changes in fire danger into development of water and land-management plans.



Hydrologic analysis: Change in streamflow per degree Celsius for six hydrologic models



Big Island coast, Hawai'i (Courtney Schaneville, U.S. Geological Survey).

PACIFIC ISLANDS CLIMATE SCIENCE CENTER

Location: University of Hawai'i, Mānoa

Established: 2012

In October 2011, the DOI announced the selected location for the **Pacific Islands Climate Science Center (PI CSC)** as the University of Hawai'i, Mānoa in Honolulu, Hawai'i. Along with the University of Hawai'i, Mānoa, the University of Hawai'i, Hilo, and the University of Guam are consortium **partners** for the PI CSC. An additional partner is the Pacific Islands LCC.

The DOI and the USGS are currently (2013) hiring to fill the position of director of the Pacific Islands CSC.



White tern with fish (Celia Cornett, U.S. Fish and Wildlife Service).

DIRECTORS

The USGS is currently recruiting for a director for the PI CSC. Several individuals have assisted NCCWSC by serving as interim directors in the PI CSC startup. The NCCWSC particularly acknowledges the work of Loyal Mehrhoff, with the USFWS in Hawai'i and Cindy Kolar, with the USGS Ecosystems Mission Area, in addition to Pacific Islands Climate Change Cooperative (PICCC) staff Deanna Spooner and Jeff Burgett. The NCCWSC also thanks the staff of both the USGS Pacific Islands Ecosystem Research Center and Hawai'i Water Science Centers for their support.

University CSC Director



Originally from Canada, **Dr. Kevin Hamilton** is a meteorologist and climate scientist now at the University of Hawai'i, Mānoa. Dr. Hamilton received his Ph.D. in 1981 from Princeton University. Before arriving in Hawai'i in 2000, he spent 12 years as a research meteorologist with the NOAA Geophysical Fluid Dynamics Laboratory in Princeton. He is currently professor of meteorology and director of the International Pacific Research Center (IPRC) of the University of Hawai'i. The IPRC is a joint Japan-U.S. research center focused on modeling and diagnostic analyses of the climate variations in the Asia-Pacific region. During his career, Dr. Hamilton's research interests have ranged over somewhat diverse subjects including the dynamics of the stratosphere, dynamics of the Martian atmosphere, tidal oscillations of the atmosphere, numerical modeling of the global atmosphere, ocean waves, global climate change and climate feedbacks, the effects of climate variability on commercial fisheries, and the history of the atmospheric sciences. Recently Dr. Hamilton and his colleagues have concentrated on modeling climate and climate change on a regional scale, work that directly connects with the mission of the PI CSC.

STUDENTS

Post-Doctoral Associate

Chunxi Zhang (FY13), International Pacific Research Center, School of Ocean Earth Science and Technology, University of Hawai`i, Mānoa

Graduate Students

Tiffany Anderson (FY 12 and 13), Ph.D. student, Department of Geology and Geophysics, School of Ocean Earth Science and Technology, University of Hawai`i, Mānoa

Ryan Longman (FY13), Ph.D. student, Department of Geography, College of Social Sciences, University of Hawai`i, Mānoa

Jordie Ocnar (FY13), Ph.D. student, Department of Plant and Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawai`i, Mānoa

Mallory Barnes (FY13), M.S. student, Department of Natural Resources and Environmental Management, College of Tropical Agriculture and Human Resources, University of Hawai`i, Mānoa

Margaret McCain (FY13), M.S. student, Department of Geography, College of Social Sciences, University of Hawai`i, Mānoa

Joy Laio (FY13), Ph.D. student, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison

Undergraduate

Megan Russel (FY13), Department of Plant and Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawai`i, Mānoa

PROJECT HIGHLIGHT

Understanding how climate change is affecting Hawai`i's high-elevation ecosystems: An assessment of the long-term viability of Haleakala silverswords and associated biological communities

PI: Paul D. Krushelnycky, Department of Plant and Environmental Protection Sciences, University of Hawai`i, Honolulu

The Haleakala silversword plant forms the foundation of a diverse alpine community, and its behavior likely reflects wider ecological responses to climate. This species is already exhibiting patterns of mortality related to climate-driven movement toward higher altitudes. This project aims to understand patterns and causes of recent declines in the Haleakala silversword population that are associated with decreasing precipitation, increasing temperature, and related climate changes in Hawai`i's high-elevation ecosystems. Building on extensive research and datasets, this study will collect the demographic and climate data needed to construct a robust population model for the silversword and make future population projections under various climate scenarios. In addition, the project will conduct a range of seedling drought tolerance experiments to clarify causes of recent widespread mortality in the species and determine methods most likely to lead to restoration success.

SOUTH CENTRAL CLIMATE SCIENCE CENTER

Location: University of Oklahoma

Established: 2012

The **South Central Climate Science Center (SC CSC)** is hosted by the University of Oklahoma with Texas Tech University, Louisiana State University, The Chickasaw Nation, The Choctaw Nation of Oklahoma, Oklahoma State University, and NOAA's Geophysical Fluid Dynamics Laboratory as full consortium members (the "Consortium"). The endeavor is in cooperation with the following partner organizations: Konza Prairie, Jornada Basin, and Sevilleta Long Term Ecological Research programs hosted by Kansas State University, New Mexico State University, and University of New Mexico, respectively; the State Climatologists of Kansas, Louisiana, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas and the association of State Climatologists; University of Louisiana at Lafayette; Regional Integrated Science Collective, National Center of Atmospheric Research; College of Agriculture and Biological Science, University of Nebraska, Lincoln; South Dakota State University; Ecosystems Science and Management at Texas A&M University; the Oklahoma Water Resources Board; and Federal partners at Department of Energy's Sandia National Laboratory; NOAA's National Severe Storms Laboratory; Department of Defense's U.S. Army Corps of Engineers, Tulsa Division; U.S. Department of Agriculture's Agricultural Research Service Grazinglands Research Laboratory; and U.S. Environmental Protection Agency's (USEPA) Robert S. Kerr Environmental Research Center.



El Capitan, Guadalupe Mountains National Park, Texas
(Alan M. Cressler, U.S. Geological Survey).

DIRECTORS



USGS CSC Director

Dr. Kim Winton is a native of Oklahoma and has a B.S. (zoology) and an M.S. (agronomy) from Oklahoma State University. Her Ph.D. is from University of Arkansas (agronomy). Most of Dr. Winton's professional career (15 years) has been spent in the agrichemical industry where she gained experience in biological research, agricultural practices, and environmental fate and effects of pesticides. She has previous experience conducting field biological research in Greenville, Mississippi, and then from Greensboro, North Carolina, she conducted environmental field, laboratory, and ecochemistry research all over the country. For the past 10 years Dr. Winton has been the director for the USGS, Oklahoma Water Science Center where the Center worked with State and Federal agencies, tribes, cities, etc., to supply them with surface-water and groundwater monitoring data, flood inundation studies, groundwater and surface-water modeling tools, aquifer studies, new technology, and a variety of technical assistance. Dr. Winton is also the Tribal liaison for the south central area as well as a DOI Diversity Change Agent.



University CSC Director

Dr. Berrien Moore III, an internationally recognized Earth scientist who has been awarded honors by NASA and NOAA, joined the Oklahoma University College of Atmospheric and Geographic Sciences as dean designate in May 2010 and dean in July 2010. Dr. Moore also serves as professor of meteorology, the Chesapeake Energy Corporation Chair in Climate Studies, director of the National Weather Center, and vice president for Weather and Climate Programs at the University of Oklahoma. Dr. Moore has published extensively on the global carbon cycle, biogeochemistry, remote sensing, and environmental policy. Prior to heading Climate Central,

a nonprofit and nonpartisan think-tank, Dr. Moore served for 20 years as the director of the Institute for the Study of Earth, Oceans and Space at the University of New Hampshire and held the position of Distinguished University Professor. He received his Ph.D. from the University of Virginia.

PROJECT HIGHLIGHT

Karst and climate change: Understanding linkages between climate, water resources, and ecosystems

PI: Barbara Mahler, USGS Texas Water Science Center

This project assesses the links between climate, ground-water storage, spring flow, and ecosystem response in two contrasting major U.S. karst systems: the Edwards and Madison aquifers. Karst aquifers are a renewable and sustainable water resource, and many of the Nation's urban centers, particularly in the central region, lie within karst terrains and draw water from karst aquifers.

Karst aquifers are uniquely suited for investigating the effects of climate variability at time scales of human interest because they are highly dynamic (fig. 1). Further, some of the best continental paleoclimate records can be obtained from karst aquifers in support of aquatic ecosystems that are highly sensitive to changes in water availability and quality (fig. 2). Because of the interdependence of karst water supply and ecosystems and dynamic system response to climate and land-use change, an interdisciplinary approach that combines hydrology, ecology, and paleoclimatology is being used to forecast future responses. Key metrics of stream and spring flow for past and future flows and the sensitivity of endemic species to projected changes will be evaluated using a meta-analysis incorporating spatial and temporal variability.

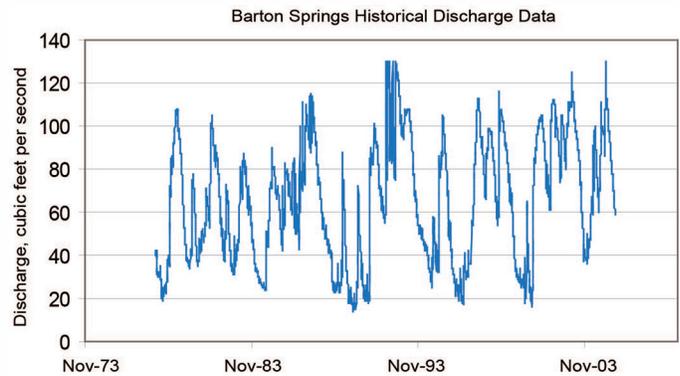


Figure 1. Discharge from Barton Springs, in the Edwards aquifer, varies from less than 20 to more than 130 cubic feet per second and depends on the amount and timing of rainfall. Discharge has a strong effect on the amount of dissolved oxygen in flow from Barton Springs, which is a habitat for one federally listed endangered species and one proposed for listing.



Figure 2. The Barton Springs salamander (*Eurycea sosorum*), a federally listed endangered species, lives only in Barton Springs (Edwards aquifer, central Texas). The salamander is aquatic throughout its lifespan and is highly sensitive to dissolved-oxygen concentrations, which are affected by spring discharge and water temperature. The karst and climate change study is evaluating how dissolved-oxygen levels might respond to projected changes in rainfall and temperature.

SOUTHEAST CLIMATE SCIENCE CENTER

Location: North Carolina State University

Established: September 2012

The **Southeast Climate Science Center (SE CSC)** is hosted by North Carolina State University (NCSU). NCSU serves as the central location and administrative center for the SE CSC. In addition to the host institution, the SE CSC also engages with several important **partner institutions**. These institutions provide expertise in climate science, ecology, impacts assessment, modeling, urban environments, and advanced information technology. SE CSC collaborations are focused on common science priorities, addressing priority partner needs, minimizing redundancies in science, sharing scientific findings, and expanding understanding of climate change impacts in the Southeast. The SE CSC also receives advice and guidance from a **Stakeholder Advisory Council**. Science priorities and projects will also be advised by a **Science Implementation Panel**.

Science products developed at the SE CSC will provide models of potential future climate impacts, assessments of likely impacts, and tools that can be useful in conservation management decisions of their partners, the regional LCCs, USGS science centers, research institutes, and other partners.



Freshwater Everglades (C. Zweig, Florida Co-Operative Fish and Wildlife Research Unit and Department of Wildlife and Conservation, University of Florida)

DIRECTORS



USGS CSC Director

Dr. Gerard McMahon serves as the director of the DOI SE CSC, located at North Carolina State University (NCSU), Raleigh, North Carolina. Previously, Dr. McMahon served as team leader of a national study of the effects of urban development conducted by the USGS National Water-Quality Assessment Program. He joined the USGS in 1992 and also has conducted research in

the sources and processing of nutrients in stream ecosystems and the development and use of mapped ecological regions. Dr. McMahon received a B.A. in economics from the Johns Hopkins University, an M.S. in natural resource economics from the University of Missouri, Columbia, and a Master's and Ph.D. in environmental planning from the University of North Carolina, Chapel Hill.



University CSC Director

Dr. Damian Shea has over 25 years of experience studying and educating others on the fate and effects of wastes and contaminants in the environment. He has operated a Good Laboratory Practices (GLP)-certified laboratory at NCSU for the Interregional Project 4 (IR-4) Program for minor use pesticides. He also has led and managed dozens of

investigations at contaminated sites and has served as PI or Co-PI on over 25 Federal agency academic research grants. Dr. Shea's research interests include the detection, sources, behavior, and adverse effects of chemicals in the environment, with the goal of improving our ability to assess human and ecological risks associated with exposure to chemicals. He has been at the forefront of the development of passive sampling devices for measuring chronic and bioavailable exposure in aquatic and soil systems. Dr. Shea has directed the research of 19 Ph.D. and 7 M.S. students in these areas.

STUDENTS

Global Change Post-Doctoral Fellows

Nathan Putnam: (Sensory Ecology, Phylogeography, Geospatial Ecology, and Numerical Modeling); Migration and dispersal in the marine environment.

Carlos Botero: (Initiative in Biocomplexity at NCSU); Effects of quasi-periodic oscillations in ecological conditions (particularly climate-related variables) on the dynamics and outcome of evolution.

Global Change Fellows (Graduate students)

Lauren Charles Smith: (Fisheries, Wildlife and Conservation Biology); Bridging gaps between multiple disciplines and standardizing how we monitor wildlife movements and interactions in relation to landscape and climate changes through a spatiotemporal database management system (DBMS).

Corey Davis (Marine, Earth and Atmospheric Sciences); Wildfire climatology of North Carolina, focusing on the effect of large-scale climate patterns on seasonal fire risk.

Sarah Fritts (Fisheries, Wildlife and Conservation Biology); Possibilities for using woody biomass as an energy feedstock.

Ernest Hain (Fisheries, Wildlife and Conservation Biology); Impacts of exotic species on native migratory fishes within the framework of watershed land-use and conditions.

Aaron Poteate (Anthropology); How the resource management of ancient populations changed characteristics in the faunal record.

Angela Harris (Anthropology); Understanding how Caribbean populations have responded to climate change in the past.

Jessica Osborne (Anthropology); Mortuary analysis of past populations from the Caribbean islands.

Kara Smith (Marine, Earth and Atmospheric Sciences)

Daniela Magdalena Sorger (Biology)

Siyao, Zhang (Forestry)

Tyson Wepprich (Biology); Effects of climate change on insect phenology, species interactions, and contemporary evolution.

PROJECT HIGHLIGHT

Integrating the effects of global and local climate change on wildlife in North America

PI: Rob Dunn, Department of Biology, North Carolina State University (NCSU)

Overview: Climate in the Southeastern United States is predicted to be changing at a slower rate than other parts of North America; however, land-use change associated with urbanization is having a significant effect on wildlife populations and habitat availability. Little is known about the effect of urbanization on future projections of climate change. The objective of this project is to determine the effect of urbanization on future climate projections and how those projections, including urbanization, affect wildlife habitat and populations in the Southeast. The project goal is to integrate urbanization into climate change models and evaluate the effects of predicting warming on tree pests and diseases and wildlife.

Deliverables: This is a two-year project (FY11 and FY12) that builds upon research already being conducted at NCSU and partner universities and research organizations.

1. North American maps of current ground temperatures and maps and models of future ground temperatures as related to urbanization (in collaboration with NASA and the University of Maryland).
2. Incorporation of urbanization models into regional climate change models.
3. Maps of species (various) distribution through time.
4. Development of a predictive model of future species (various) distribution with increased urbanization and changing climate.
5. Google Earth application that will allow the general public to view the potential consequences of climate change on the landscape (in conjunction with North Carolina Museum of Natural Sciences and linked to globalchangeforum.com).

SOUTHWEST CLIMATE SCIENCE CENTER

Location: University of Arizona, Tucson
Established: Spring 2011

The **Southwest Climate Science Center (SW CSC)** is hosted by a consortium of six institutions that constitute the **Southwest Climate Alliance**: University of Arizona, Tucson; University of California, Davis; University of California, Los Angeles; Desert Research Institute, Reno; University of Colorado, Boulder; and the Scripps Institution of Oceanography at the University of California, San Diego. The University of Arizona serves as the central location and administrative center for the SW CSC. In addition to the host institutions, the SW CSC also includes important **partners**, including the Desert, California, Great Basin, and Southern Rockies LCCs, affiliate institutions (Arizona State University; Northern Arizona University; University of California, Merced; University of Nevada, Las Vegas; National Aeronautics and Space Administration (NASA) Ames Research Center, U.S. Institute for Environmental Conflict Resolution), and several USGS science centers and research institutes.

The Southwest Climate Alliance institutions provide expertise in climate science, ecology, impacts assessment, modeling, urban environments, and advanced information technology. This expertise is needed to address climate challenges in the Southwest, where changes in temperature and precipitation can have significant effects on terrestrial and aquatic habitats and natural resources from the Pacific Coast to the interior deserts and mountains.



The California black rail, a state threatened bird that lives in the salt marsh estuary of San Francisco Bay (D. Tsao, U.S. Geological Survey).

DIRECTORS



USGS CSC Director

Dr. Stephen Jackson comes to the CSC from the University of Wyoming, where he was professor of botany and founding director of the program in ecology. Dr. Jackson received his Ph.D. in ecology and evolutionary biology from Indiana University and his B.A. and M.S. in botany and geology at Southern Illinois University at Carbondale. He is an Aldo Leopold Leadership Fellow, a Fellow of the American Association for the Advancement of Science, and in 2011 he received the University of Wyoming's George Duke Humphrey Distinguished Faculty Medal. Dr. Jackson is past president (2010–2012) of the American Quaternary Association and serves on the Ecological Society of America's governing board and editorial boards for *Ecosystems*, *Frontiers in Ecology & Environment*, and *Trends in Ecology and Evolution*. His research employs tree-rings, fossil rodent middens, and sediments from lakes and bogs to investigate how past climatic changes and human activities have affected species distributions, biodiversity, and ecosystem properties.



University CSC Director

Dr. Jonathan Overpeck, or "Peck" as he prefers to be called, is a founding co-director of the Institute of the Environment, as well as a professor of geosciences and a professor of atmospheric sciences. He received his B.A. from Hamilton College, followed by an M.S. and Ph.D. from Brown University. Dr. Overpeck recently served as a coordinating lead author for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment (2007). He has also received the U.S. Department of Commerce bronze and gold medals, as well as the Walter Orr Roberts award of the American Meteorological Society, for his interdisciplinary research. Dr. Overpeck has also been a Guggenheim Fellow and was the 2005 American Geophysical Union Bjerknes lecturer. Dr. Overpeck

is a Fellow of the American Association for the Advancement of Sciences. Before going to The University of Arizona, Dr. Overpeck was the founding director of the NOAA Paleoclimatology Program and the World Data Center for Paleoclimatology, both in Boulder, Colorado.

STUDENTS

Ruth Cerezo-Mota: Post-Doctoral Fellow at the University of California, Los Angeles (UCLA) Institute of the Environment and Sustainability working on dynamical downscaling of climate models.

Daniel Walton: Graduate Student in the UCLA Atmospheric and Oceanic Sciences department working on CMIP3 and CMIP5 models downscaling and intercomparison.

PROJECT HIGHLIGHT

Southwest Climate Summit

A large group of scientists, managers (of ecosystems, natural resources, and wildlife), Tribal leaders, and scientists gathered at the Southwest Climate Summit in Tucson, June 12–14, 2012, to identify what science and science solutions are needed to help managers address climate challenges in the Southwest. The summit was hosted by the SW CSC, with additional support from the USGS and the Climate Assessment for the Southwest (CLIMAS). The summit was the first big event for the SW CSC. One hundred twenty people participated in the summit. About one-third were

SOUTHWEST Climate Summit

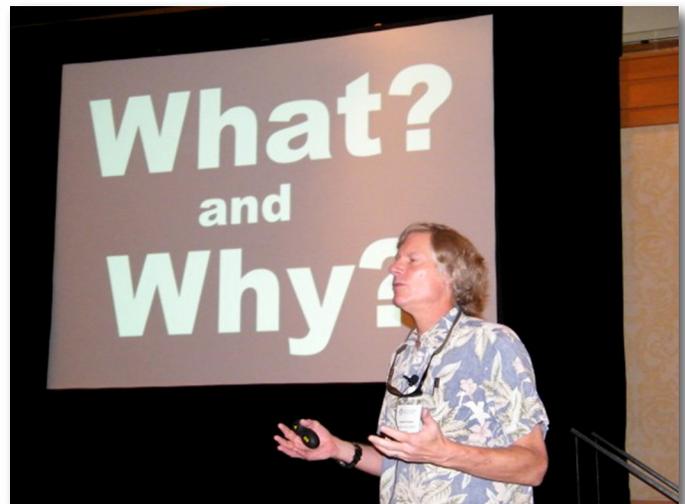


HOSTED BY THE SOUTHWEST CLIMATE SCIENCE CENTER

affiliated with Federal agencies, one-third with universities in the Southwest, and the rest with tribes (10 people), nongovernmental organizations (11 people), LCCs (5 people), and

State and local agencies and governments, private firms, and water utilities. Some of the major themes that emerged from discussions were the need to incorporate climate science into existing planning frameworks, the need for climate science at the spatial and temporal scales at which management decisions are made, and how to incorporate uncertainty about climate projections into planning documents and communicate with both scientists and stakeholders about that uncertainty.

The summit highlighted the release of a product that includes vital contributions from SW CSC scientists: "*Assessment of Climate Change in the Southwest United States: A Technical Report Prepared for the U.S. National Climate Assessment.*" This report focuses on the six states in the Southwestern U.S. (Arizona, California, Colorado, Utah, Nevada, and New Mexico), which is "considered to be one of the most 'climate-challenged' regions of North America" (Overpeck and others, 2012).



Dr. Jonathan Overpeck speaking at the Southwest Climate Summit.

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