August 2012

USDA Forest Service

GSD Update

Rocky Mountain Research Station

Grassland, Shrubland and Desert Ecosystems Science Program

It Works Both Ways: How Scientists and Managers Join Forces to Conserve Today's Natural Resources

"Too many people fail to realize that real communication goes in both directions." Lee Iacocca spoke these wise words about the failings of business, but clearly there is a lesson here for management of natural resources as well. Scientists are doing research every day that improves our understanding of our valued resources. But work does not stop at simply conducting an experiment, but needs to include effective communication of results that are relevant to managers. Scientists listen closely to what managers have to say and design studies to address questions across the diverse array of issues that challenge management goals today.

IN THIS ISSUE

Helping managers to promote sustainability on the Nation's forests and grasslands has been an overarching goal of US Forest Service Research and Development from the agency's beginnings in 1905. Major advances in resource management have been made with the help of science, from increasing yields of commodities like timber and cattle to providing services such as camping and clean water. But what steps should be taken to protect the public's resources? Some traditional applications of science in management are the development of best management practices to balance resource utilization with ecological function and support for decisions made in environmental assessments.

Jan Engert, RMRS Assistant Director for Science Application and Integration, notes, "An emerging challenge for land management today is climate change. Climate change in particular is full of complexity and uncertainty, which makes decision-making and planning more difficult. A scientific approach is a powerful way to help tease apart that complexity, reduce critical uncertainties, and pinpoint effective solutions."

The Forest Service is committed to addressing climate change and each National Forest and Grassland will use a new 10-point performance scorecard to report accomplishments and plans for improvement as outlined under the National Roadmap for Climate Change. By 2015, each management unit is expected to answer yes to at least seven of the scorecard questions, with at least one yes in each of four dimensions – organizational capacity, engagement, adaptation, and mitigation.

Cave Creek Canyon in the Chiricahua Mountains, a sky island range in southeastern Arizona.

Credit: B. Alvarius (Wikimedia Commons)

*The Elegant Trogon (*Trogon elegans*) was identified as highly vulnerable to climate change compared to many other bird species.*

Credit: Dominic Sherony (Wikimedia Commons).

*The Tarahumara Frog (*Rana tarahumarae*) had the largest vulnerability score of the amphibian species assessed.*

Credit: Jim Rorabaugh (Wikimedia Commons).

The Grassland, Shrubland and Desert Ecosystems Science Program (GSD) of the Rocky Mountain Research Station (RMRS) is well positioned to assist managers to achieve a "yes", with experts across a broad set of disciplines, an established relationship with diverse partners, and a shared vision of sustaining forest and grassland resources. To begin with, RMRS scientists from across 6 western states teamed together to summarize the literature and identify needs for addressing climate change in grassland, shrubland and desert ecosystems of the interior American West. They prepared climate change chapters on projections and models, adaptation and mitigation, interactions with other disturbances, responses of plants, animals and invasive species, and decision support. Their resulting general technical report is now available online at RMRS GTR-285. New RMRS studies and ventures with managers were implemented in relation to this united effort.

Read more about how scientists are helping managers fulfill requirements of the climate change scorecard and how managers are helping scientists find answers to their most pressing problems.

Vulnerability Assessment in Practice: Assessing What Managers Need

The Coronado National Forest encompasses more than 720,000 ha (1.8 million acres) on the southeastern edge of Arizona. Here the Rocky Mountains transition to the Sierra Madre Occcidental in a complex of small mountain ranges that support forests separated by desert, grassland, and strips of riparian forest. This unique location has contributed to a diverse flora and fauna as well as diverse land ownership and cultures. If that didn't make managing species difficult enough, the already arid local climate is expected to shift towards increasing droughts and more extreme temperatures. Thus, managers on the Coronado National Forest have a particularly tricky situation for managing species.

GSD scientists created a tool for managers in situations where species may be vulnerable to changing climates. The tool is SAVS, a System to Assess Vulnerability of Species, and it uses a questionnaire to provide numerical scores to rank the vulnerability of terrestrial vertebrate species. Case studies were needed to test and apply the tool and further refine scoring options. Several areas in the Southwestern U.S. were identified, and the first application that was completed focused on the sky islands of the Coronado National Forest. The Coronado NF seemed to be an ideal locality and, in 2009, a meeting was convened with GSD scientists and Coronado NF staff biologists to discuss the process and identify species of interest. Postdoctoral Biologist Sharon Coe explained, "The Coronado NF employees were enthused about an assessment of species potentially affected by climate change. They expressed to us how important having this information would be to them."

The list of species was pared down to 30 and the assessment process began. What the results of the assessment showed was that riparian species, like the elegant trogon (*Trogon elegans*) and Tarahumara frog (*Rana tarahumarae*), were found to be the most vulnerable to populations declines associated with climate change, but there were also many non-riparian species found to be highly vulnerable as well. Not only were the predictions for the 30 species of interest to the Coronado NF, but the assessment is a useful teaching tool for staff on climate change issues and addresses public concerns about the National Forest commitment to seeking solutions. Larry Jones, Biologist and Climate Change Coordinator with the Coronado NF, described the value of the vulnerability assessment. "The climate change species vulnerability assessment prepared by the RMRS scientists provided very useful information to us about potential impacts to species on our Forest to climate change, since we have to address climate change in work we do as managers. We have provided the publication to our own staff for training on climate change, and we have been incorporating the information from the assessment into our management documents and into our partnerships with managers in other agencies."

You can read about the results and implications for management in the new general technical report, "An Assessment of Climate Change and the Vulnerability of Wildlife in the Sky Islands of the Southwest" by Sharon Coe, Deborah Finch, and Megan Friggens. The report can be downloaded at RMRS-GTR-273. The SAVS tool

Dragoon Mountains are one of the sky island ranges of the Coronado National Forest, Cochise County, Arizona.

Credit: Mark A. Wilson (Wikimedia Commons)

"Forest Service managers want assessments at landscape scales so that management actions designed to address climate change can target the needs of many species in a large area simultaneously"

and tutorial is available at http://www.fs.fed.us/rm/grassland-shrubland-desert/products/species-vulnerability/.

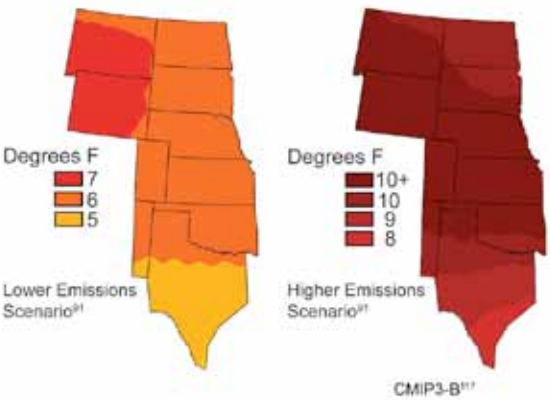
According to GSD program manager, Deborah Finch, "Assessments on individual species are valuable and fill an important knowledge gap, but many regional Forest Service managers want assessments at landscape scales so that management actions designed to address climate change can target the needs of many species in a large area simultaneously." To address this idea, the Coronado assessment results were taken to this next step using a GIS approach. Jennifer Davison, a graduate student at the University of Arizona, along with GSD collaborators, combined vulnerability scores with occurrence data on a subset of the 30 species to create a landscape of vulnerability where hotspots of species vulnerability could be visualized spatially. The authors note the value of this approach to not only discern landscape patterns of vulnerability but also to take into account other relevant information such as protected areas, land ownership, or recreational use. You can read the full article at http://www.treesearch.fs.fed.us/pubs/39879.

Great Plains Workshop: What Does Climate Change Mean for Me?

National grassland resources and ecosystems may be under greater threat than national forests and yet receive less attention from policy makers, researchers, and the public at large. Much of the recent climate change science support and products delivered to the Forest Service has been on forested ecosystems, leaving many grassland managers without adequate information to guide decisions. In response, a team of GSD scientists, RMRS leadership and staff, and managers from the Rocky Mountain Region hosted two events last year to assist grassland managers with climate change challenges in the Great Plains: a day-long science webinar and a workshop via video teleconference with a group of invited managers. The team won a 2012 Research and Technology award from the National Grassland Council for their efforts.

Great Plains experts from the Rocky Mountain Research Station, Agricultural Research Service, US Forest Service, Colorado State University, National Wildlife Federation, and the Wildlife Society presented their findings on climate change via webinar. Topics included range productivity, carbon sequestration, interactions of plague, vegetation response, and disturbance. Demand for the webinar was high with 130 people registering in advance and reached a wide audience of federal and state agencies, non-profit organizations, universities, and private consulting firms. Recordings of the 11 presentations are available on the Rocky Mountain Research website at http://www.fs.fed.us/rm/grassland-shrubland-desert/events/climate-change-webinar.

The following day, 17 scientists, district rangers, and program managers at regional and forest levels from Regions 1, 2, and 3 got together for a workshop to identify products or tools needed to assist managers to comply with Forest Service climate change policies and promote sustainability of national grasslands. Managers identified climate change issues and barriers to management, highlighting concerns about uncertainty in climate projections, effects on watersheds and wetlands, effects of regional demographic changes, increases to pests and diseases, vegetation shifts, and changes in rangeland productivity. Managers noted the importance of changes to adjacent lands including crops, energy development, and urbanization that will affect public lands.



Temperatures in the Great Plains are projected to increase significantly by the end of this century, with the northern part of the region experiencing the greatest projected increase in temperature.

Credit: U.S. Global Change Research Program.

*Pronghorn Antelope (*Antilocapra Americana*) on the Kiowa National Grassland, New Mexico.*

Credit: Larry Lamsa (Wikimedia Commons)

More than 850 wildlife water guzzlers and developments have been constructed by Arizona Game and Fish Department. A guzzler is a potential tool for managing water for wildlife as climate changes because it harvests rainwater, is self-maintaining, refilling itself.

Credit: AZ Game and Fish Dept.

Identifying issues is the easy part. Managers need help with educating staff and the public on climate change and translating science information on projected impacts into on the ground actions. National Grasslands have the added challenge of being isolated units surrounded by many different land ownerships with disparate policies. The workshop conversation focused on products and tools that scientists could provide that would address climate change issues, alleviate management barriers, or help meet requirements of the Forest Service Climate Change Performance Scorecard. There was a desire to promote partnerships and leverage efforts, such as involving the Landscape Conservation Cooperatives. Specific suggestions included education materials targeting grasslands, vulnerability assessments on various targets from recreation and infrastructure to water and ecosystems, programmatic review of climate change integration, contact information for local researchers and ongoing projects, NEPA guidance, and more science-based webinars. Thus far, GSD has prepared a briefing paper on the workshop, is developing web content for the Climate Change Resource Center on grasslands, and has instituted several projects to improve communication on climate change projects and products to managers. Finally, researchers with the Rocky Mountain Research Station and Forest Service managers who participated in the workshop are committed to continued engagement.

Climate Change and the American Southwest: Finding the Right Scale

A collaborative team of scientists and managers in Arizona and New Mexico were awarded a grant to examine vulnerability assessments in the Southwest by the Western Wildland Environmental Threat Assessment Center. Megan Friggens, Deborah Finch, and Karen Bagne make up the GSD team and are working together with Jack Triepke, a vegetation ecologist with the Southwest Region of the Forest Service, Don Falk, University of Arizona, Ann Lynch, an RMRS entomologist in Tucson, and Esteban Muldavin at the University of New Mexico.

Part I covers the underlying components that comprise a vulnerability assessment and summarizes practical applications. The material is focused on providing managers with the necessary background needed to select and use published vulnerability assessments. Part II is a compilation of the available climate change vulnerability assessments, methodologies, and related research findings applicable to natural resources in the Southwest. Preliminary review of the content of over 80 assessments revealed that each assessment offered unique results with few topics or methods repeated and, because relatively few assessments were at a small scale, there will be many gaps for managers at all but the largest scales (i.e., whole state or region wide). Many summary tables are included and provide a wealth of information on available vulnerability assessments. The project is ongoing with the final report expected by the end of this year.

Climate, Genes and Topography Reveal a Surprising Story

What factors affect the distributions of individual species are some of the foundational questions in the discipline of ecology. Two GSD scientists, Bryce Richardson and Susan Meyer, examined DNA across populations of a desert shrub species, blackbrush (*Coleogyne ramosisima*), of the Colorado Plateau and Mojave Desert. This shrub dominates the transition from warm to cold deserts and provides cover for bighorn sheep as well as winter forage for a variety of herbivores. Richardson and Meyer synthesized the findings of their genetic analysis with previous studies to create a picture of how blackbrush populations responded to warming following the last glacial period.

Besides examining the pattern of genetic variation, evidence for past distributions comes from ancient packrat middens where packrats deposit debris that represents local plant and animal communities. These middens contain a wealth of information and under the right conditions may contain a record of the local environment going back more than 50,000 years. They found populations that belong to two disjunct groups that likely formed because of their past distribution during cooler periods and migration barriers formed by the high elevation plateaus of the Four Corners region.

Walking a blackbrush common garden at the Desert Experimental Range in Pine Valley, Millard County, Utah.

Credit: Bryce Richardson

Examining plant variation at a blackbrush common garden, NRCS Los Lunas Plant Materials Center, New Mexico. From left to right: Sam Foster, Burt Pendleton, Rosemary Pendleton.

Credit: Deborah Finch

Blackbrush is a shrub species that has adapted to climate change, according to findings by RMRS researchers. Tonto Platform, Arizona.

Credit: J. Brew (Wikimedia Commons)

Regional ecological differences, studied by GSD scientists Burt and Rosemary Pendleton, Stan Kitchen, Susan Meyer and Bryce Richardson also reveal adaptations to local conditions such as winter temperatures and monsoonal rains. While their studies are at an early stage, Richardson comments, "Understanding how plants have responded to changes in climate in the past can help predict how they may respond to changes in the future which will help managers to conserve gene pools". Genetic diversity may help this species adapt to future conditions, but, as in the past, physical barriers will limit dispersal. In addition, this species establishes poorly following fire. Interactions among temperature, precipitation, genetic adaptations, topography, and disturbance and their effect on the observed distribution of this species illustrate the complexity of predicting response to climate change.

Because of the importance of this shrub regionally and the narrow range of climate conditions occupied, managers can use these kinds of detailed predictions along with local topographical information to plan for climate change effects. Richardson and Meyer's work is published in the journal, Botany, and was selected as "Editor's choice" in 2012 for the issue (access the full article here: http://www.treesearch.fs.fed.us/pubs/40435.

There's No Place Like Home: Taking Stock of Native Plant Transfer Guidelines

The practice of restricting native plant movement to environments similar to their source has a long history in forest management. General transfer guidelines developed by the USDA in 1939 have since improved for most commercially important native tree species and a few other native plants, but seed transfer research will need to factor in the complications of a changing climate. Under the current rate of climate change, adaptive responses of native plants will likely fall behind. A consequence is that plant materials from current or static planting zones will be growing in unfavorable conditions by the end of this century.

Mary Williams, postdoc research assistant, and R. Kasten Dumroese, plant physiologist, have gathered more than 500 articles directly and indirectly related to plant transfer guidelines. One major goal is to connect all pieces of information from peer-review journal articles to decision-support tools in an annotated bibliography made available in print and online. The collection focuses on transfer guidelines as related to genetic studies, nursery operations, seed collection and storage, climate change, and emerging concepts such as assisted migration.

The researchers have already identified knowledge gaps such as a lack of genetic information for determining conditions that grasses, forbs, and shrubs can be transferred from their original location. Genetic approaches are commonly used to determine if existing populations will be adapted to future climate scenarios or if current seed transfer zones need modification. Common garden studies and genetic mapping are the tools of choice for delineating seed zones but there may not be enough time or resources to conduct these studies on all native plants. Although they are sound, guidelines based on geographic boundaries and ecoregions are not suitable, especially in areas without supporting genetic information, climate change projections, and species vulnerability data.

Success of any planting, whether it is restoration, reforestation, or translocation depends upon native plant growers and nurseries. For science to influence the process they must understand the issues faced by the native plant industry. The annotated bibliography assembled by Williams and Dumroese will not only identify the issues, but also provide a central foundation for collaboration in generating research questions, conducting studies, transferring and acquiring data, expanding studies to key species and geographic regions, and guiding native plant transfer.

A message from the Program Manager

This issue features studies focused on climate change, because it is one of five focal areas of the GSD program. We highlight some new reports, publications and activities. Our program mission is to develop and deliver knowledge and tools that will help to sustain and restore grasslands, shrublands and deserts threatened by invasive species, disturbances, urban pressures, and climate change. Scientists in our program study the physiological, behavioral, and demographic responses of plants and animals to climate change, especially in interaction with other stressors such as fire and invasive species. Our research also evaluates the capacity for species to adapt to environmental changes. We provide decision support by developing new plant materials for use in restoring ecosystems under stress, guidance for identifying species at risk from climate change, and assessments and tools for determining species and ecosystem vulnerability.

—Dr. Deborah Finch,
Science Program Manager

Meet Some of the GSD Scientists

Dr. Karen Bagne is a Biologist working for RMRS via a joint venture agreement. She is currently developing products, workshops and tools aimed at assisting natural resource managers. Her research examines how populations of terrestrial organisms respond to climate change, fire and fuel reduction. Results will be useful in informing management decisions regarding risks to and vulnerabilities of species in the face of environmental and climate changes.

Sharon Coe is a Postdoctoral Research Biologist with the RMRS Forestry Sciences Lab in Albuquerque, New Mexico, in collaboration with the University of Arizona. Sharon's interests are in vertebrate ecology and conservation biology. She is researching the vulnerability of wildlife to climate change, and the effects on wildlife from invasive woody plant and fuel removal to reduce fire risk.

Dr. Megan Friggens is a postdoctoral Research Ecologist within the RMRS Forestry Sciences Lab in Albuquerque, NM whose research activities include the development of species vulnerability assessments and climate change tools, climate change effects on vertebrate species and ecosystems, the ecology of prairie dogs and plague, disturbance ecology (fire, drought),, and understanding urban open space decisions.

Dr. Rosemary Pendleton is a research ecologist stationed at the Forestry Sciences Laboratory in Albuquerque, New Mexico. Her current research focuses on reproductive biology and establishment ecology of native plant species. She is also investigating the biology and control of cheatgrass using endophytes.

Dr. Bryce Richardson is a Research Geneticist stationed at the RMRS Shrub Sciences Lab in Provo, UT. His research interests are focused on population genomics, genecology, and phylogenetics of plants and plant pathogens. He is currently studying the genetic capacity of big sagebrush, blackbrush, aspen and other plants to adapt to changing climates and environments using common garden studies. He is the regional contact for the Western Forest Transcriptome Survey, a collaboration to identify climate-related genes from diverse species.

Dr. Mary Williams is a postdoc research assistant at the Rocky Mountain Research Station Moscow Forestry Sciences Laboratory. Her current research includes synthesizing literature on assisted migration, native plant transfer guidelines, and restoration planning as related to future climate scenarios.

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Announcing the publication of 3 new General Technical Reports:

Raising native plants in nurseries: basic concepts. 2012. By R.K. Dumroese; T.D. Landis; T. Luna. Gen. Tech. Rep. RMRS-GTR-274. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 84 p. RMRS-GTR-274

Vulnerability of species to climate change in the Southwest: threatened, endangered, and at-risk species at the Barry M. Goldwater Range, Arizona. 2012. By K.E. Bagne, K.E.; D.M. Finch. 2012. Gen. Tech. Rep. RMRS-GTR-284. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 139 p. RMRS-GTR-284

Climate Change in Grasslands, Shrublands and Deserts of the Interior American West: A Review and Needs Assessment. 2012. Edited by Deborah M. Finch. Gen. Tech. Rep. RMRS-GTR-285. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 140 p.

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