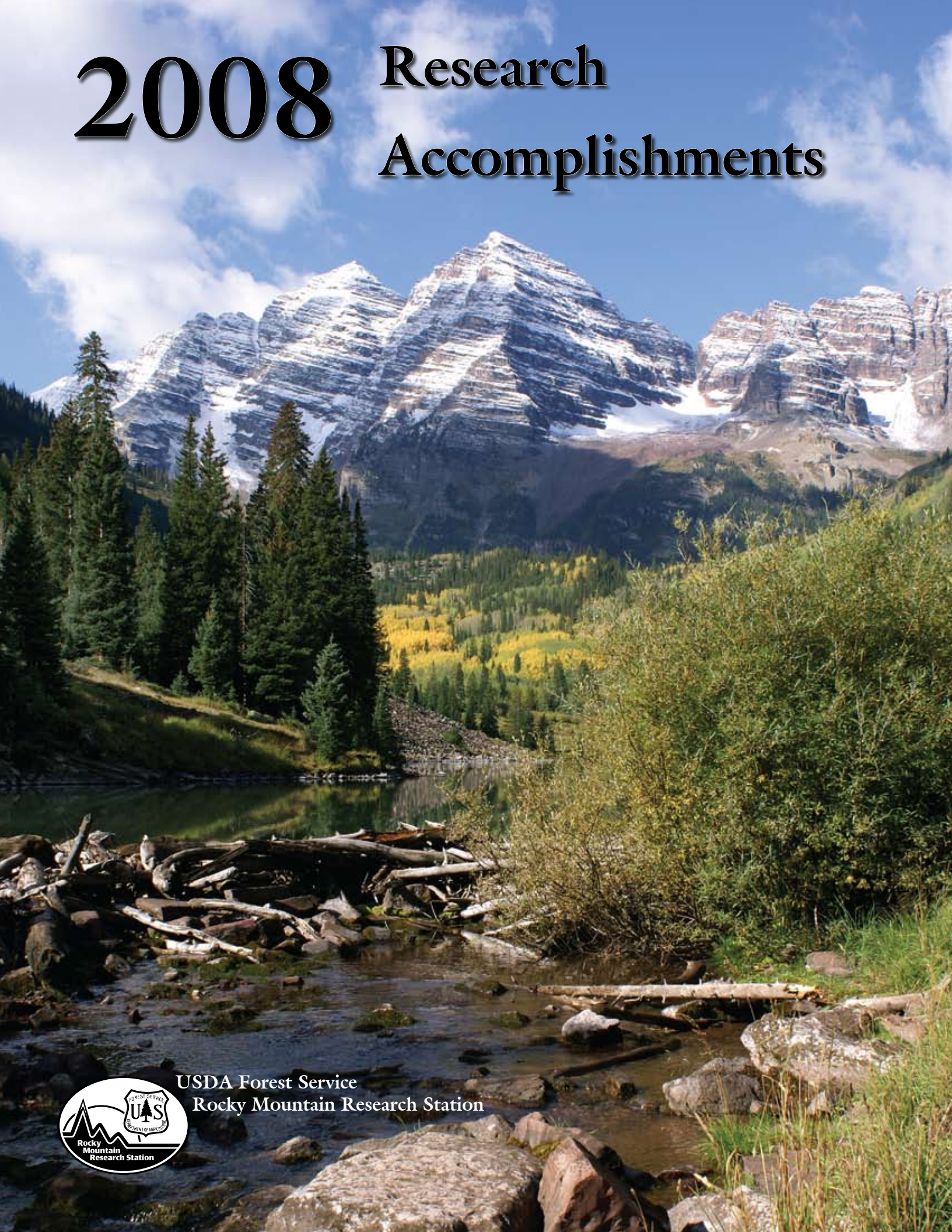
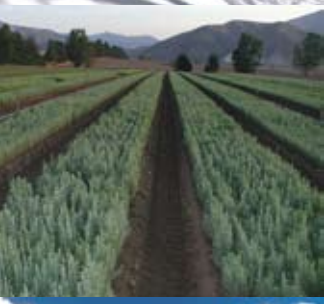
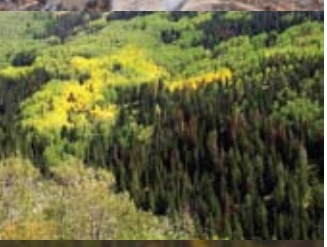
2008 Research Accomplishments

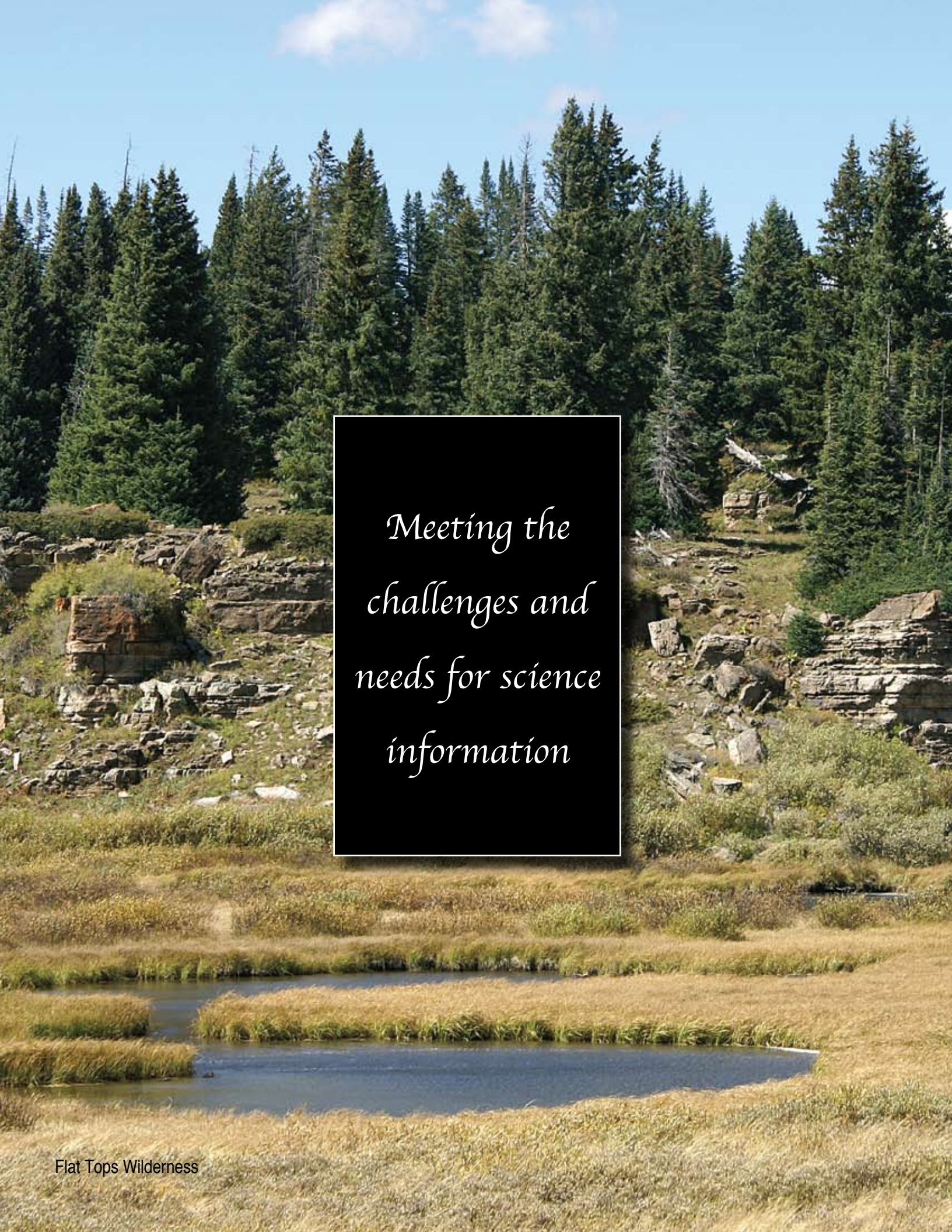


USDA Forest Service
Rocky Mountain Research Station



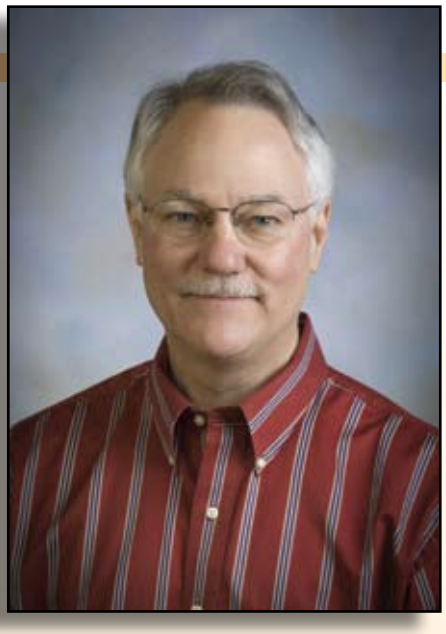


Front cover photo: Maroon Bells Scenic Area, White River National Forest, Colorado. (photo by Lisa Parresol)



Meeting the challenges and needs for science information

Flat Tops Wilderness



Greetings

Another year has come and gone and was marked by several milestones for the Rocky Mountain Research Station (RMRS). It was a year of many exciting breakthroughs in our science, effective applications of science tools, starts for new employees, the move of our Station headquarters, reinvigorating existing partnerships, and co-hosting the celebration of the Nation's first experimental forest. In short, we were busy and productive meeting the challenges and needs for science information and tools for our stakeholders and customers. Here are a few of my reflections on this past year:

Exciting Year of "Science First" Results

Our mission is *to develop and deliver scientific knowledge and technology that will help people sustain our forests, rangelands, and grasslands.* We achieve this through a focus on *Science First*—a strong recognition in the Station that quality science is what we are chartered to produce. This past year was one of true successes, several of which are described in this report. To tease you a bit… it was a year of science breakthroughs on the effects of climate change on natural resources, biocontrol of invasive weeds, mountain pine beetles, decision support tools to help manage wildland fire, monitoring trends in wilderness character, and aspen decline. These are just a few of our outstanding successes in knowledge and technology produced this year. To find out more about our science programs, continue reading, and for additional information, visit our Station web site at www.fs.fed.us/rmrs.

Our mission is to develop and deliver scientific knowledge and technology that will help people sustain our forests, rangelands, and grasslands.

Science Application and Integration

A hallmark of the RMRS restructuring last year was the creation of a Science Application and Integration staff, which is one of the first of its kind in a Forest Service research station. This staff serves as a visible linkage of our science and tool development process with our customers and stakeholders. We strive to not only create new knowledge and technology, but to also *effectively deliver it to people who need it in a form in which they can use!* To date, we have housed in this staff the coordination of our Experimental Forests and Rangelands and Research Natural Areas, the Wildland Fire Management RD&A (Research, Development & Application) program, the LANDFIRE program, and the proposed Human Factors and Risk Management RD&A program. We are developing a charter which will allow us to explicitly demonstrate the breadth of activities that we envision. Stay tuned as we move to flesh out more aspects of science application and integration!

Partnerships

Modern science is conducted in partnership with others, across divisions within organizations, and across organizations. In this spirit, the RMRS has greatly elevated its efforts this year to welcome traditional as well as non-traditional partners to help us determine what science knowledge and applications are needed, and also to join us in planning and conducting research

and applications. The response has been impressive. We have renewed and enhanced partnerships with the National Forests and Grasslands and State & Private Forestry in the U.S. Forest Service, Bureau of Land Management, Tribal Governments, U.S. Geological Survey, National Park Service, Agricultural Research Service, 12 State Foresters throughout our Station territory, numerous universities, and many conservation groups. Wow! What a powerful force for enhancing sustainable natural resource management. By working together, we will achieve great accomplishments for natural resources.

Fort Valley Experimental Forest Centennial Celebration

A major milestone this year was the celebration of the 100th anniversary of the first Experimental Forest in the U.S. Forest Service system. Fort Valley Experimental Forest was established in 1908 just outside Flagstaff, Arizona, to conduct research on watershed management and ponderosa pine regeneration. Over the century, many scientists worked at Fort Valley on a wide variety of issues. The Centennial Celebration was held both in Flagstaff and Fort Valley on August 7-9, 2008, and combined presentations by scientists who had worked at Fort Valley with tours of the Experimental Forest. Approximately 100 people attended. Nationwide, new energy and focus is being infused into the network of 80 Experimental Forests and Ranges, and RMRS is proud to be home to the first one!

Headquarters Relocation

Due to numerous factors, including significant cost savings, the Headquarters of the RMRS moved from the Natural Resources Research Center (NRRC) at 2150 Centre Avenue, back to 240 West Prospect Road in Fort Collins, Colorado. Employees of the RMRS were still located in the Prospect building even though the Director and other Station employees had moved to the NRRC several years ago. This relocation back to Prospect signifies a move back to the historic location of Headquarters and a consolidation of Station employees in Fort Collins. Twenty employees still remain in the NRRC building and plans are to move them to the Prospect Road facilities as soon as office space is made available. So please join us in celebrating this move!

New Faces

We have seen many new faces this year, both permanent hires and those in Acting assignments! New hires include: Dr. Cindy Swanson, Program Manager for the Human Dimensions Program; Dr. Tom Crow, Program Manager for the Forest and Woodland Ecosystems Program; Dr. Colin Hardy, Program Manager for the Fire, Fuel, and Smoke Program; Dr. Janine Powell, Assistant Director for Strategic Management and Accountability; and Dr. G. Sam Foster, Director for RMRS. The people on acting assignments have graciously covered several vacant positions, providing crucial management while the positions were being filled, and we want to express our deepest gratitude to them for these duty assignments.

Conclusion

In conclusion, please join the employees of the Rocky Mountain Research Station in celebrating a successful year of creation of science knowledge and applications, and partner with us as we grow and become even better at creating and delivering science that will help ensure sustainability of our region and planet.

Station Director

Contents

A Look at RMRS

The Forest Service Research and Development mission, "develop and deliver knowledge and innovative technology to improve the health and use of the nation's forests and rangelands," guides the work we do. Our priorities are to:

- Create credible, innovative, science-based solutions for resource management problems.
- Identify relevant needs and quickly and efficiently convert science gaps into findings and products for managers and citizens.
- Anticipate and respond to emerging issues.
- Enhance the ability of our customers and partners to more easily find, participate in, and use products of the RMRS research program.

The Rocky Mountain Research Station is one of five regional units that make up the USDA Forest Service Research and Development organization—the most extensive natural resources research organization in the world. We maintain 12 field laboratories throughout a 12-state territory encompassing the Great Basin, Southwest, Rocky Mountains, and parts of the Great Plains. The Station employs a diverse workforce of nearly 400 permanent full-time employees, of which approximately one-fifth are research scientists.

We administer and conduct research on 14 experimental forests, ranges and watersheds, while maintaining long-term databases for these areas. We also oversee activities on more than 260 Research Natural Areas (http://rna.nris.state.mt.us) and lead four ecosystem management and research partnership projects in Arizona, Colorado, Montana, New Mexico, and Nevada.

Our research program serves the Forest Service as well as other Federal agencies, State agencies, international organizations, private groups, and individuals. Research results and products are made available through a variety of technical reports, journals, and other publications, seminars, symposia, demonstrations, exhibits, and personal consultations. These help resource managers and planners balance economic and environmental demands for forest and rangeland resources worldwide.

Communicating With Stakeholders

Credible, useable, and effective scientific information is our product. We recognize that the scientific information we produce must be packaged, promoted, and delivered so that our stakeholders can use it effectively. As we disseminate information, we solicit feedback on its relevance and usefulness, monitor the success of our communication efforts, and adapt strategies as needed.

Administration and Support Services Staffs

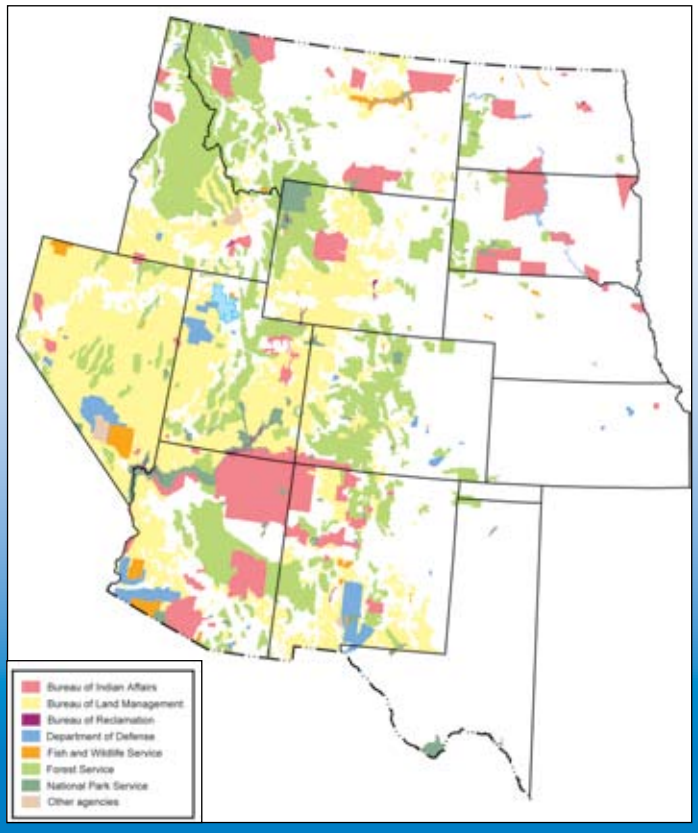
The success of our research programs would not be possible without the critical team support provided by our nearly 400 administrative and technical employees. Most are located at Station headquarters in Fort Collins, Colorado, and at the Ogden, Utah, Service Center; others work at laboratory locations. These staffs include: Civil Rights; Budget; Public Affairs; Science Application and Integration; Acquisition Management; Facilities Management; Financial Management; Library Services; Publishing Services; Web Services; Safety, Health and Environment; Senior, Youth and Volunteer Program; and Statistics. The Station also receives Human Capital Management and budget and financial support from the Albuquerque Service Center.

Partnerships

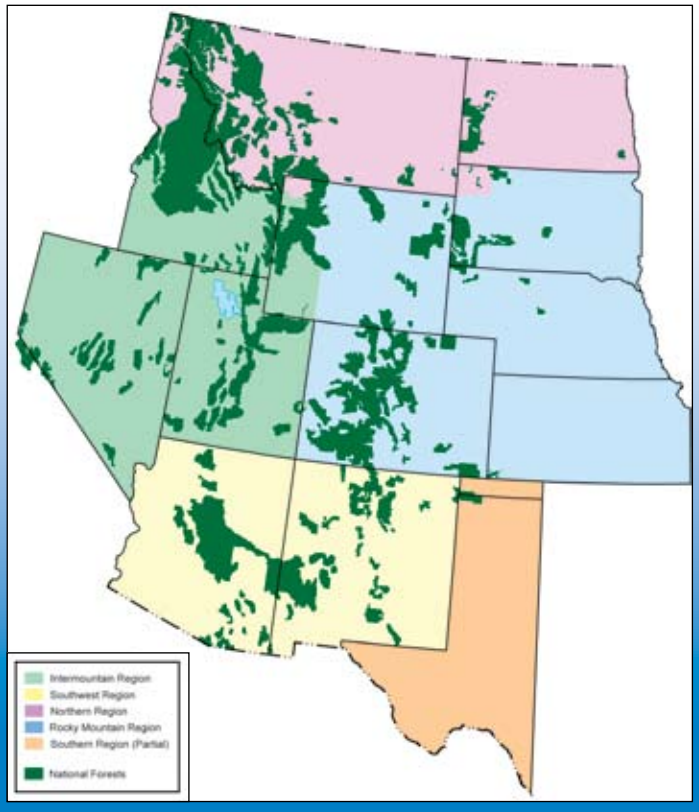
To help advance solutions to pressing natural resource problems, the Rocky Mountain Research Station maintains key partnerships with:

National Forest Systems. Forest supervisors and managers comprise the Station's largest customer segment or stakeholder group. The Station supports several national missions, including the Fire Sciences Laboratory and the Aldo Leopold Wilderness Research Institute, both in Missoula, Montana. National Forest Systems rely heavily on Station staffs to provide scientific information and assistance in implementing the

Within the Rocky Mountain Research Station Territory



Federal Lands



Forest Service Regions and National Forests

Endangered Species Act, Clean Water Act, Clean Air Act, and other environmental legislation. In 2008, the Station teamed with the Agency's Rocky Mountain and Intermountain Regions to sponsor the 2nd Aspen Summit in Fort Collins, Colorado. The event focused on ways to address the decline of aspen forests in the Rockies.

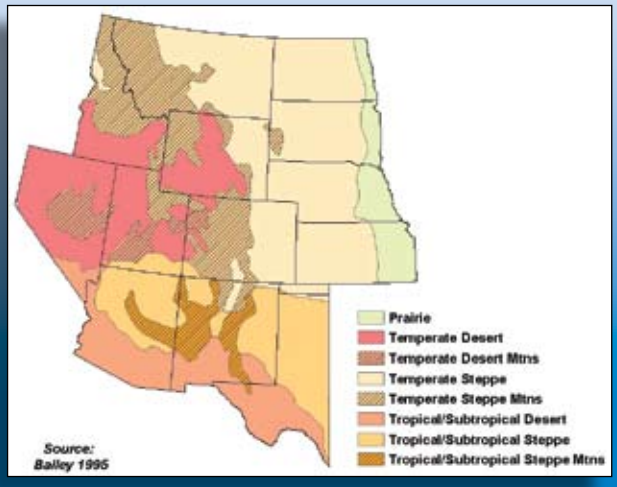
Other Federal Land Management Agencies. The Station serves managers of the largest public land holdings in the lower 48 states, including the Bureau of Land Management, National Park Service, Bureau of Reclamation, U.S. Fish and Wildlife Service, and Department of Defense.

Other Federal Non-land Management Agencies. We provide regular consultation to the Environmental Protection Agency, National Marine Fisheries Service, Natural Resources Conservation Service, and Bureau of Indian Affairs.

State, Local and Other Public Agencies. Our Inventory and Monitoring science program is the Station's largest program and provides eight Western States with resource inventory and monitoring data for use by state, county and urban planners, State resource agencies, industry, and others.

University and Non-university Cooperators. We maintain an active cooperative research program with universities and other partners in order to share expertise and facilities to assist Forest Service research and development projects.

Rivers and Lakes



Ecoregions

Industry. The forest products industry is an important customer for tree improvement, forest productivity, insect and disease, and engineering technology research. We collaborate with the Forest Products Laboratory in Madison, Wisconsin, to link utilization researchers with forest products research opportunities. Summer recreation and winter ski area development and expansion make these industries major customers for Station research programs.

Non-government Organizations (NGOs). Citizens representing themselves and special interest groups in land management planning efforts are a significant group requesting research information, and special interest groups are becoming increasingly aware of, and are valuing, research information for their uses. Some of these groups include: The Nature Conservancy, The Wilderness Society, Northern Colorado Bark Beetle Cooperative, American Forest and Paper Association, Society of American Foresters, Malpai Borderlands Group, American Fisheries Society, the Front Range Fuels Treatment Partnership, and the Soil and Water Conservation Society of America.

Tribal Governments. The Station supports a number of working relationships with several Tribal governments in many parts of our territory. For example, scientists are cooperating on a fuels treatment study to help restore ecosystem health on the Flathead Indian Reservation in Montana.

International Cooperation. Station scientists often travel to other countries to cooperate with scientists, universities, institutions, and government agencies on a variety of natural resources projects and issues. For instance, Station researchers visited the Republic of South Africa in 2008 to assist that country in fire management decision making. Scientists are also involved in a cooperative ecotourism study in Kamchatka in eastern Russia. International partners also come to the United States to cooperate with our scientists.

Integration

Science First

Partnerships

Science Application

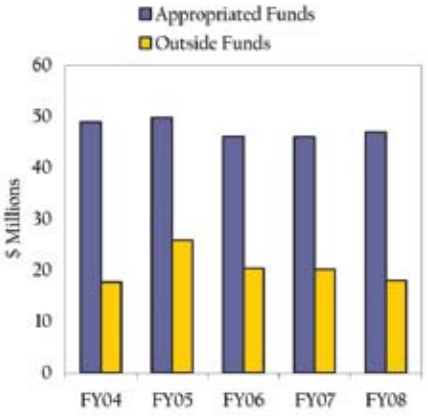
Cooperative Research Programs

Review of Fiscal Year 2008

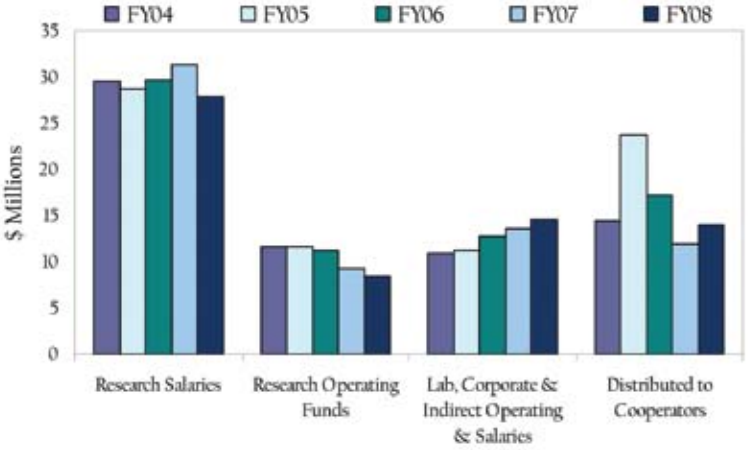
Total Incoming Funding for FY 2008: $65 million
Base Research Appropriations: $39.1 million
National Fire Plan Appropriations: $7.8 million
Lab, Corporate, & Indirect Client Support: $2.9 million
Direct Client Support for Research*: $15.2 million

**Direct client support for research includes funding from: LandFire; universities; federal and state agencies; FS regions, stations and the Washington Office; and, other outside sources. Outside funds calculations do not include Army.*

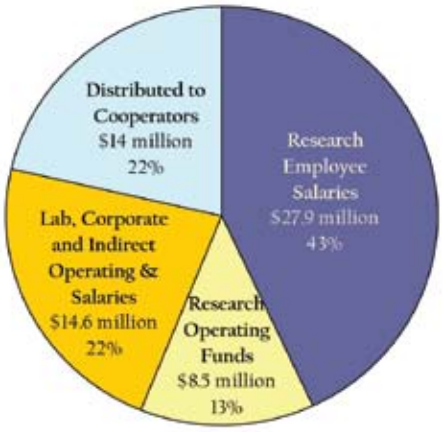
RMRS Incoming Funding Trends (FY04-08)



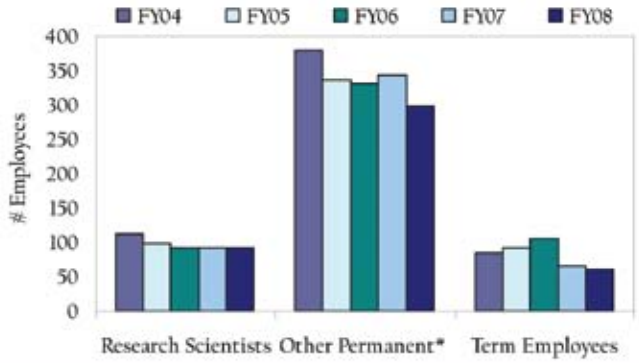
RMRS Funding Distribution Trends (FY04-08)



FY08 RMRS Funding Distribution



RMRS Workforce Trends (FY04-08)



FY08 Workforce Statistics

Total Station workforce: 559 employees
Permanent paneled scientific workforce (RGEG): 91
Permanent (non-RGEG) workforce: 298
Term workforce: 61
Temporary workforce: 109

Publishing Statistics

- Filled requests for 102,160 hardcopies of Station series publications
- Provided access to 3,053 publications online via Station website (www.fs.fed.us/rmrs) and TreeSearch (www.treesearch.fs.fed.us)

*Includes administrative, professionals, student career experience program, and post-docs

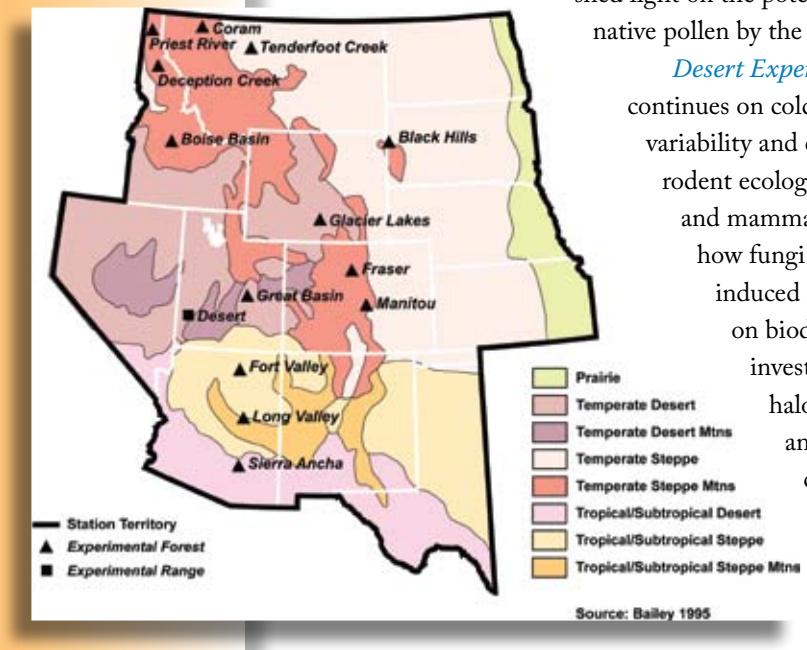
Long-term Research at Experimental Forests and Ranges

A unique and valuable part of the infrastructure within which we conduct research is a network of experimental forests, ranges, and watersheds. They are living laboratories where Forest Service scientists conduct studies and demonstrate research results for our stakeholders. Experimental sites remain as some of the few places where ecological research can be maintained over the long term—often longer than an individual scientist's career. Experimental areas are extremely varied and are located throughout the United States and Puerto Rico.

The Rocky Mountain Research Station administers and conducts research on 14 experimental forests, ranges, and watersheds (http://www.fs.fed.us/rm/main/expfor.html). The Fort Valley Experimental Forest, located near Flagstaff, Arizona, was established in 1908, and is the site of the first Forest Service research investigations in the Nation. A sampling of current work at our experimental forests and ranges includes:

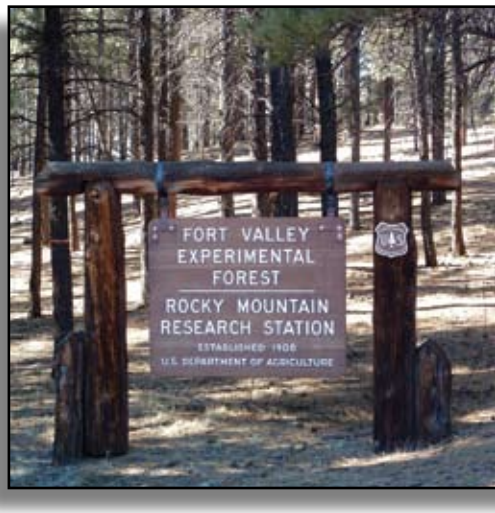
Boise Basin Experimental Forest (Idaho)—Ongoing investigations include old-growth restoration, prescribed fire, and root-system structures. A current study is evaluating how forest treatments will modify both wildfire intensity and burn severity in dry ponderosa pine forests. In October 2007, a wildfire treatment was applied to four small drainages in the Bannock Creek watershed to look at sediment migration, nutrient cycling, and vegetation recovery after simulated wildfire, salvage logging, and commercial thinning in the granitic soils of central Idaho.

Deception Creek Experimental Forest (Idaho)—Studies are examining erosion from skid trails, forest genetics, root disease, small tree utilization, and fire effects. Investigations are underway on the effect of commercial thinning of mixed conifer forests on pollen from white pine infected with blister rust. Research results should shed light on the potential improvement in the genetic quality of native pollen by the harvest of trees susceptible to blister rust.



Desert Experimental Range (Utah)—Research continues on cold desert plant communities, climate variability and change, desertification, sheep management, rodent ecology, pronghorn antelope, soils, and bird and mammal populations. Current work examines how fungi helps plants adapt to drought and salt-induced stress. The impact of grazing systems on biodiversity will be examined, along with investigations on how the invasive plant halogeton displaces shrubland communities, and how best to restore halogeton-dominated sites to shrubland communities. Species selection trials are underway to develop plant materials and seed production methods to improve opportunities for restoration plantings.

Fort Valley (Arizona)—The research conference celebrating the founding of the Fort Valley Experimental Forest took place in August 2008 in Flagstaff, Arizona, and included a review of research accomplishments in silviculture, range, watershed-hydrology, wildlife, forest pathology and entomology, ecology, and geology as both invited presentations and offered posters. Proceedings of the technical conference are published as RMRS-P-53 (http://www.fs.fed.us/rm/pubs/rmrs_p053.html).



Fraser Experimental Forest (Colorado)—Researchers are studying the influence of mountain pine beetle outbreaks on streamflow and water chemistry in previously managed and unmanipulated watersheds. Work is also underway on snow accumulation, water use, and nutrient dynamics at the hillslope, stand, and individual tree levels.

In response to extensive lodgepole pine mortality caused by mountain pine bark beetle, forest harvesting was conducted at multiple sites during the winter of 2007-2008. Initial post-harvest surveys compared the degree of soil disturbance relative to preharvest conditions, site characteristics and harvesting intensity. Scientists, field crews and graduate students are evaluating tree seedling and understory recovery following bark beetle infestation and associated management operations. During the winter of 2008-2009, RMRS scientists and crews will assess the influence of residual surface roughness on snow accumulation and snow water storage. These activities represent the first stand manipulations to occur at Fraser since the 1980s and are designed as long-term research studies.

Glacier Lakes Ecosystem Experiments Site (GLEES) (Wyoming), Fraser (Colorado), and Sierra Ancha (Arizona) Experimental Forests—As part of the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests), instrumentation for measuring critical loads of nitrogen and sulfur deposition has been installed at three Station experimental forests through national funding. The term "critical load" refers to the amount of atmospheric pollutant below which no significant harmful effects on the forest ecosystem are expected in the long run. Data from the Programme will help determine the sensitivity of world forest ecosystems to deposition in excess of the critical load.

Glacier Lakes Ecosystem Experiments Sites, Wyoming.

Priest River Experimental Forest, Idaho.

Great Basin Experimental Range (Utah)—Studies continue on plant adaptation and succession, nutrient cycling, revegetation, restoration ecology, and game habitat. Great Basin was one of thirteen sites in the states of Utah and Nevada in which watershed-scale reconstructions of historic fire regimes were completed. Information will help understand the relationships among climate, fire regimes, and forest structure.

Manitou Experimental Forest (Colorado)—BEACHON Southern Rocky Mountain site, The Bio-hydro-atmosphere interactions of Energy, Aerosols, Carbon, H2O, Organics & Nitrogen (BEACHON) project, is a broadly collaborative and interdisciplinary research effort by researchers at the National Center for Atmospheric Research in Boulder, Colorado, and the Interior West university community. The BEACHON project focuses on water-limited landscapes across the monsoon gradient in southwestern North America from western Mexico (Jalisco) into the Rocky Mountains (Colorado). It will provide a detailed and measurable characterization of biosphere-hydrosphere-atmosphere interactions to improve regional and global models of the earth system. The Southern Rocky Mountain component was initiated in 2008 at the Manitou Experimental Forest.

Ozone Monitoring—Interest in ozone monitoring is particularly high as the national standards are tightening and Colorado has seen increased oil and gas activity. As part of this state-wide effort, scientists installed an active and a passive ozone monitor at the Manitou Experimental Forest. The passive ozone monitor is portable, battery powered, and continuously monitors for nitrogen compounds that are used to estimate ozone concentration. The active ozone monitor directly measures ozone concentrations and is used to calibrate the passive ozone measurements. A briefing paper describing the ozone project is at: http://www.fs.fed.us/rm/boise/AWAE/briefing/Musselman-AirQuality.pdf.

Priest River Experimental Forest (Idaho)—Ongoing studies include woody debris/decomposition/soil productivity, fuel treatments in the wildland-urban interface environment, seedling development/genetic variability, and host/pest interaction. A current study is evaluating how forest treatments will modify both wildfire intensity and burn severity in mixed conifer forests. A project identical to one just established on the Boise Basin Experimental Forest will look at sediment migration, nutrient cycling, and vegetation recovery after simulated wildfire, salvage logging, and commercial thinning in the mixed conifer forests of northern Idaho.

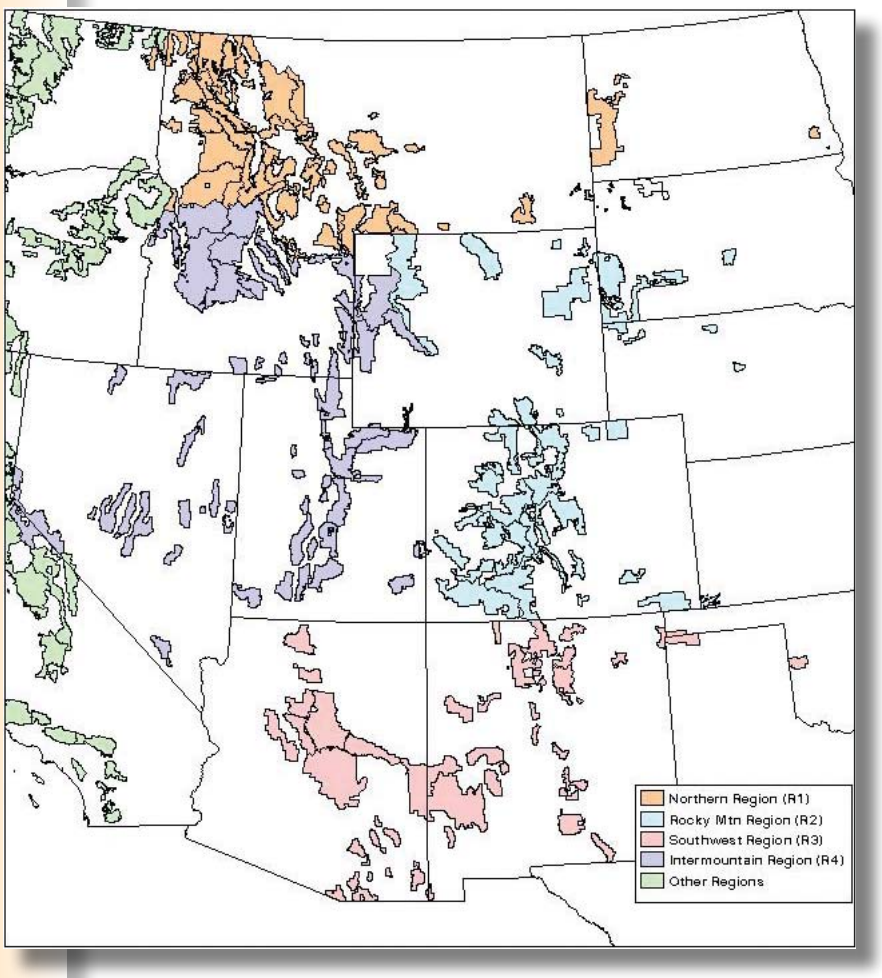
Ecological Research
Ongoing Investigations
Living Laboratories
Long term
Science Application

Research Natural Areas: Conserving Biological Diversity

The Rocky Mountain Research Station oversees activities on more than 200 Research Natural Areas (RNA). This network of natural ecosystems has been set aside for the purposes of scientific study and education, and for maintenance of biological diversity.

These areas represent a wide variety of habitats and ecosystems from alpine ecosystems to lowlands, and from coniferous forests of the Northern Rockies to semiarid deserts of the Southwest and prairie ecosystems of the Great Plains.

The Forest Service Research Natural Areas (RNAs) System represents a valuable ecological resource for scientists, managers and educators. The Forest Service encourages scientific and educational use of Research Natural Areas. Scientists, land managers and educators who are interested are asked to submit a request to the Rocky Mountain Research Station. Additional information is available on our website at http://rna.nris.state.mt.us/.



Research Natural Areas within the Rocky Mountain Research Station territory.

Manti-La Sal National Forest, Utah.

Recent activities within the Station's Research Natural Areas (RNA) include:

A proposal was funded to establish permanent vegetation impact data plots and photopoints to monitor the potential progressive recreation impacts on sensitive alpine turf and alpine turf-rock communities in the Mt. Peale Research Natural Area on the La Sal Mountains (Manti-La Sal National Forest) near Moab, Utah. Work was completed in the summer of 2008. The project was partially funded by the Canyonlands Natural History Association.

The newly established Butler Fork Research Natural Area was dedicated in honor of Walter F. Mueggler, a former aspen scientist who worked at the Station's Forestry Sciences Laboratory in Logan, Utah, for much of his career. This Research Natural Area, located on the Uinta-Wasatch-Cache National Forest, southeast of Salt Lake City, provides a much-needed source for studying aspen ecosystems in near-pristine condition.

Butler Fork Research Natural Area.

Natural Areas
Ecosystems
Biological Diversity
Scientific Study

Conservation Education

Station employees regularly leave their laboratories and offices to take science to people in the community. They give presentations to landowners and school, church, and civic groups; lead field trips for the public; help with education programs in the classroom; and contribute their expertise in museums, visitor centers, and other public forums. Employees also volunteer their time to work at a variety of Station-sponsored events that help underrepresented segments of society. For example:

Each year, the Station proudly sponsors the **Flagstaff Festival of Science**, held in Flagstaff, Arizona, an event that gives families a chance to see what the science organizations in the community are working on.

The Station is a primary sponsor and organizer of the **Annual Tu B'Shevat Festival** in Scottsdale, Arizona. Tu B'Shevat is the "Birthday of the Trees" in Israel. The event reflects cooperation between the Forest Service and the Jewish National Fund, which is responsible for forestry and land development in Israel.

The Station annually hosts, co-hosts or participates in a variety of camps, conferences and other events aimed at introducing students and minority youth to Forest Service programs. These include: the **Hispanic Natural Resources Career Camp**, held annually to introduce high school students to natural resource subjects such as hydrology, forestry, wildlife, entomology, climate, and forest surveying; and the **Nature High Summer Camp**, held at the Great Basin Experimental Education Center in Ephraim, Utah. It introduces high school students from the State to natural resources, careers in resource management, the real life work of professionals, and the latest techniques and technology being used by today's resource specialists.

Station scientists volunteer their time to instruct students at the Hispanic Natural Resources Career Camp.

The Station also co-sponsors the **Minority Youth Environmental Training Institute**, held near Santa Fe, New Mexico. This is an intensive, hands-on, science-based educational 10-day national program designed to inspire, engage, and train Latino and minority teens on environmental and natural resource issues, and to give them information about college degrees and careers in these fields.

Station researchers in Albuquerque, New Mexico, volunteer their time to provide classroom and field instruction to youngsters from **Joy Junction**, Albuquerque's largest homeless shelter. The Albuquerque lab has a large experimental thinning research site near Joy Junction, providing scientists a great opportunity to engage urban youth in nature-based learning.

In Boise, Idaho, Station scientists are involved in **Salmon Days**, an annual event that teaches kids about the Idaho Salmon and what they go through to survive the trip from the ocean to their freshwater homes. They also participate in the "Kids in the Woods" program that introduces students, teachers and parents to the critters that are found in the local river.

In 2008, through its **Conservation Education Program**, the Station funded the following projects: 1) A partnership with the Roaring Fork Conservancy to develop a riparian ecology short course and design and implement a field riparian monitoring study aimed at high school students; 2) An invasive plants puppet show, designed for grades K-3, teaching students about the impacts of invasive plants on ecosystems;
3) The Class in the Creek program, which teaches fourth graders through adults about river habitats and watershed functions; and 4) The More For Youth program, which funds the purchase of mammal and forestry education kits for Native American students.

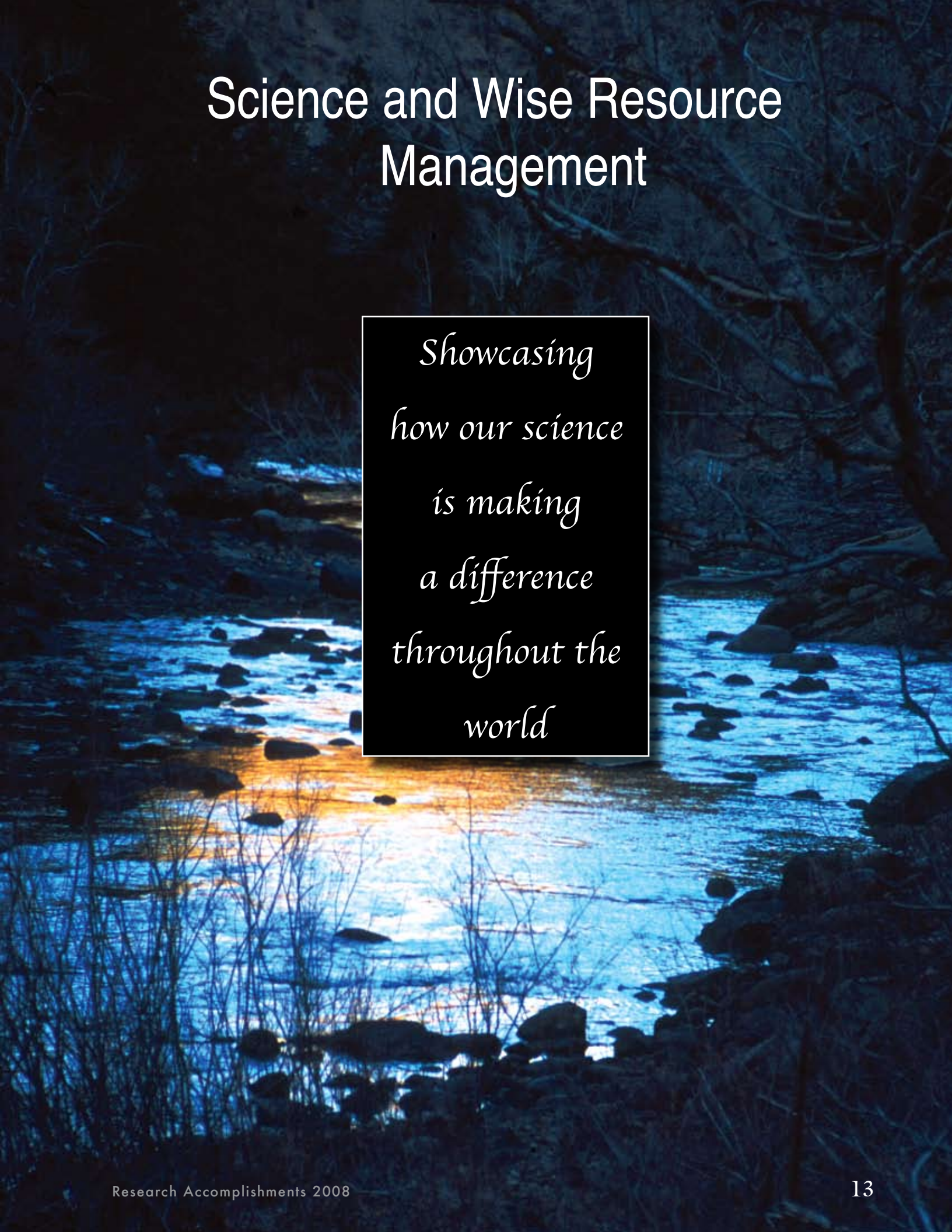
Introduction to Programs

Education

Environmental Issues

Inspire & Engage

Science and Wise Resource Management



Showcasing how our science is making a difference throughout the world

Scientists and support personnel with the Rocky Mountain Research Station work to efficiently and effectively increase the understanding of Interior West ecosystems and management strategies, and provide the best service and tools possible to our customers. To help focus our strategy, formulate budgets, and enhance our collaboration with stakeholders, our research is organized under eight Science Program Areas:

- **Grassland, Shrubland and Desert Ecosystems**
- **Forest and Woodland Ecosystems**
- **Fire, Fuel and Smoke**
- **Air, Water and Aquatic Environments**
- **Wildlife and Terrestrial Ecosystems**
- **Inventory, Monitoring and Analysis**
- **Human Dimensions**
- **Aldo Leopold Wilderness Research Institute**

The following pages introduce each of our Science Program Areas, highlight just a few of the many studies underway throughout our 14-state territory, and showcase how our science is making a difference throughout the world. For a more comprehensive look at what we do at the Rocky Mountain Research Station, please visit our website at www.fs.fed.us/rmrs.

Grassland, Shrubland, and Desert Ecosystems

This program develops and delivers scientific knowledge, technology and tools that help to understand, restore and sustain grasslands, shrublands and deserts under increasing threats from expanding human-related uses, invasive species, changing disturbance patterns and climate changes. Studies focus on understanding the effects of natural and human-caused disturbances on grasslands, shrublands, deserts and associated riparian ecosystems; developing tools, techniques and plant materials to evaluate and manage the spread of invasive plants, and to restore disturbed uplands and riparian areas; developing knowledge and tools to manage and sustain ecosystems to provide ecosystem services and wildlife habitat; and creating a better understanding of how climate change affects grassland, shrubland and desert flora and fauna. Learn more at www.fs.fed.us/rmrs/research/programs/grassland-shrubland-desert.

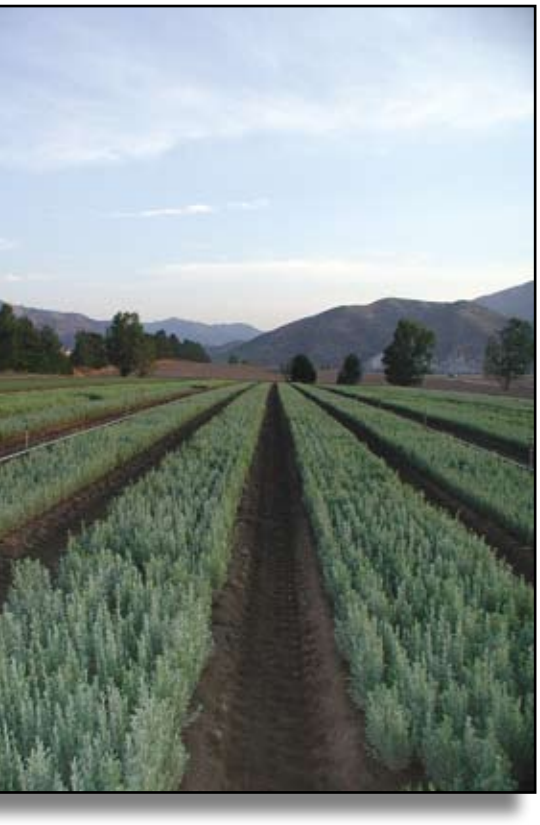
Research and Management Team to Address Great Basin Issues

The Great Basin is one of the most endangered ecoregions in the United States. The population is expanding at the highest rate in the nation, and major sociological and ecological changes are occurring. These changes can be attributed to several interacting factors including urbanization, changing land use, climate change, limited water resources, altered fire regimes, and invasive species. Managers across the Great Basin are increasingly challenged to maintain or improve the ecological condition of these systems and the services that they provide, while meeting the needs of a growing number of user groups with diverse and often opposing interests. Sustaining the ecosystems, resources and human populations of the Great Basin requires strong collaborative partnerships among the major research and management organizations in the region.

In November of 2006, the Station cosponsored a workshop on Collaborative Watershed Management and Research that was held in Reno, Nevada. The results of that workshop are available in a Station General Technical Report (GTR), Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action, available at http://treesearch.fs.fed.us/pubs/viewpub.jsp?index=29293l. The report includes issue papers on the many critical research and management problems within the region, many of which were authored by Station scientists. It also includes a summary of the workshop's sessions on developing collaborative management and research programs, and devising mechanisms for organization and communication among collaborators. The information contained in this publication serves as a first step in the process of developing more effective and larger-scale collaborations in the Great Basin.

The Woody Plant Seed Manual

Station scientists have authored or coauthored chapters of the recently published Agriculture Handbook 727, The Woody Plant Seed Manual, a comprehensive review of seed biology and technology for 236 genera and nearly 1,300 taxa of trees and shrubs of the United States and its Territories. The manual serves those involved in wildland seed collection and marketing, production of bareroot and container nursery stock, seed testing, and certification and planting. Earlier versions of this manual, published in 1948 and 1974, were focused primarily on reforestation species. Recent advances in seed technology and increasing use of trees and shrubs to restore diverse forest and shrubland ecosystems, as well as in conservation and landscape plantings, led to compilation of the current manual. Many of the additions to this manual are woody genera of tropical regions or shrub genera of western wildlands.



The Manual evaluates seeding technology and cultural practices for production of nursery stock.

In addition to the earlier focus on nursery production and planting of seedlings, the current manual also reviews literature on direct seeding. Objectives for planting seed or seedlings on forested and nonforested areas have expanded to include ecosystem restoration and more specific goals such as mined land reclamation, carbon sequestration, riparian improvement, wetland mitigation, and post-fire revegetation. Some exotic species are widely used conservation plantings, while others have become invasive on private and public lands. Inclusion of genera and taxa from each of these categories was deemed necessary to provide users the knowledge required to establish and maintain desired species and control invasives.

The manual begins with seven introductory chapters that cover the general principles of seed biology, genetics, seed harvesting and conditioning, storage, testing, seed certification and nursery practices.

The second section of the book includes chapters for each of 236 genera presented in alphabetical order. Authors address taxonomy, synonomy, growth habit, distribution, uses, and problematic characteristics in the case of invasives. Reviews of flower, fruit and seed morphology and phenological development, breeding systems, pollination requirements, seed predators, minimum seed-bearing age, and years between large seed crops, aid in evaluating the potential for crop production. Collection, cleaning and storage techniques and requirements, expected seed yields from bulk collections, and data on seed longevity in storage provide guidelines for seed harvesting and handling to maintain seed quality. Authors also synthesize literature on seed dormancy and affecting factors, pregermination treatments, germination requirements, seed testing procedures, cultural practices for production of nursery stock, and prescriptions for planting or seeding. Photographs are provided for most seed species, while line drawings illustrate the characteristics of the fruit, seed and early seedling stage for typical species of nearly all genera.

The appendices include a comprehensive glossary on seed terminology based primarily on International Union of Forest Research Organizations (IUFRO) definitions. This is followed by a list of the genera categorized by plant family and an author list identifying the contributions of each to the manual.

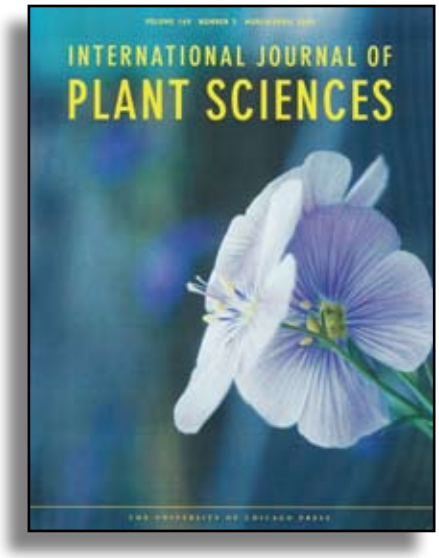
For more information see: The Woody Plant Seed Manual. USDA Forest Service Agriculture Handbook 727. Washington, DC: USDA Forest Service. 1223 p. A limited number of copies are available from the Rocky Mountain Research Station and the Government Printing Office. The manual is also online at: http://www.nsl.fs.fed.us/Front%20matter.pdf. Future updates to the manual are expected to be in the form of online revisions made on a chapter-by-chapter basis.

Flax Cultivars: Native and Introduced

Land disturbances, such as catastrophic wildfire, weed control, mining, and unrestricted grazing, have often created large areas that lack sufficient vegetation to retain ecosystem function and prevent soil erosion. The need to restore these sites has led to the development and production of plant materials named cultivars and source-identified seeds and seedlings.

Appar, originally released in 1980 as a cultivar of Lewis flax (*Linum lewisii*), has proven to be widely adapted, a good seed producer, and easy to establish. It has been used extensively in roadside plantings, for wildlife habitat improvement, and erosion control. On closer examination, however, Station scientists noticed that Appar had a different pollination system than was reported for native Lewis flax. Through a series of experiments looking at plant growth characteristics, genetic relatedness, and between-flower pollinations and seed production, they determined that Appar belonged to the closely related European species, *Linum perenne*. This finding, therefore, restricts the use of Appar to areas where the use of native species is not mandatory.

Increasingly, the emphasis in plant materials development has been on native species. The search for a native alternative, initiated by the Station's Shrub Sciences Laboratory in Provo, Utah, led to the recent release of the germplasm Maple Grove Lewis flax.



Appar has proven to be widely adapted, a good seed producer, and easy to establish.

Learn more about this research in: Origin of the Flax Cultivar 'Appar' and its Position Within the *Linum Perenne* Complex. *International Journal of Plant Sciences* 169: 445-453;

The 'Appar' Flax Release: Origin, Distinguishing Characteristics and Use; and a Native Alternative. *Native Plant Journal* 9: 8-24.; and

Release of Maple Grove Germplasm Lewis Flax. *Certified Seed Gleanings* 25: 5.

Forest and Woodland Ecosystems

Our science helps resource managers sustain and restore the health and productivity of forest and woodland ecosystems in the West. Increasingly these areas are being impacted by human developments, uncharacteristically large and severe wildfires, insect and disease outbreaks, exotic species invasions, and severe droughts. Scientists conduct basic and applied research to help understand the function, composition, and structure of these complex ecosystems. Research results help provide sources of energy, clean water, esthetic and recreation amenities, and critical wildlife habitat. Additional information is available at http://www.fs.fed.us/rmrs/research/programs/forest-woodlands-ecosystem.

Effects of Climate Change on Land Resources

The U.S. Climate Change Science Program (CCSP) (http://www.climatescience.gov/) integrates federal research on global change and climate change. A primary objective of the CCSP is to provide the best possible scientific information to support public discussion, as well as government and private sector decision-making, on key climate-related issues.

The recent Intergovernmental Panel on Climate Change report demonstrates clearly that climate change is happening and outlines in global and regional terms what the impacts might be, and how to mitigate and adapt to climate change. The report, Effects of Climate Change on Land Resources—Forests and Arid Lands, from the U.S. Climate Change Science Program, focuses strictly on the impacts of climate change on the U.S.

Satellite images of pine beetle attack in lodgepole pine forests in Colorado (left: pre-outbreak 2002; right: post outbreak 2007).

The report's "Land Resources" chapter (a Station scientist and a University of Arizona professor were chapter lead authors) provides several new resources for natural resource managers. First, it is an excellent primer on how climate change will impact forest and arid land ecosystems and how the impacts will differ in different regions of the country. Second, this chapter highlights the role of climate change and disturbance (fire, insect outbreaks and storms) and discusses the challenges for management and also the opportunity for different management options after disturbance. Finally, the chapter summary findings are valuable signposts for managers planning for the next 30-50 years.

For more information, see: Land Resources. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC, USA, 362 pp. (http://www.sap43.ucar.edu/documents/Land.pdf).

Restoration of Aspen in Disturbed Ecosystems

The decline of aspen forests in the western U.S. is an excellent example where managers may want to reconsider policies and ecological restoration changes, especially regarding natural fire cycles. Initial figures show that in Utah alone, approximately 60 percent of aspen-dominated forests have been replaced by conifers in the recent past (150 years), and West-wide aspen decline has been estimated at between 50-90 percent since European settlement. These implications from loss of aspen translate into losses in water quality and quantity (some estimates suggest a 2-7 inch increase in water consumption by conifers, when compared to aspen) with declining species biodiversity, livestock forage, wildlife habitat, recreational opportunities, wood fiber, asesthetics, and others.

Recently, complete die-off of aspen clones has been observed. This phenomenon is referred to as Sudden Aspen Decline (SAD). It is speculated one way that "stable" aspen stands can regenerate themselves without influence of fire is with massive die-off of mature trees that are subsequently replaced through a regeneration event. However, in some cases there is no regeneration surviving and the root system is completely dead, which is the way SAD is being defined. These clones are being lost from the landscape and SAD is quite pronounced in western Colorado, southern Utah, and southwest Wyoming.

A technique called hinging is used to provide barriers to help minimize ungulate damage to aspen regeneration.

Research is being carried out that will complement and bolster existing knowledge of restoration or the reversal of successional processes in aspen systems in the West. Specifically, how can natural succession be reset to an earlier stage under current use by both domestic and wild ungulates, as well as other activities that change plant composition? Station scientists in Logan, Utah, are assessing the effects of various management treatments such as burning, harvesting, etc., in terms of the reproductive success of aspen and other species; determining the frequency of fire required to sustain desired forest products in aspen/conifer stands where fire has been suppressed in the recent past; and the magnitude of SAD on landscapes in the Interior West. Remote sensing is being evaluated in determining the extent and time line associated with SAD. Research is also being conducted on what impacts insects and diseases have on regeneration associated with SAD, and whether drought and other stresses impact aspen.

The Station has been involved in major efforts to restore aspen throughout the West, including numerous workshops, field tours, and discussions. For instance, RMRS and its partners cohosted the Aspen Summit II, dealing specifically with the SAD issue, that was held in Ft. Collins, Colorado, in Februrary 2008, and drew 100 managers and researchers from numerous western states. In September 2008, a three-day Restoring the West Conference, cohosted by RMRS, was held in Logan, Utah, with the main theme of Frontiers in Aspen Restoration. A new memorandum of understanding between Utah State University and the Rocky Mountain Research Station is another stage in the development of a Western Aspen Alliance (WAA). This Alliance is intended to be a clearinghouse for aspen research and technology transfer.

Additional information can be found at http://aspensite.org concerning the Aspen Summit II, Restoring the West Conference, and WAA.

Contaminant Leaching from Shale

At this waste rock dump in southeast Idaho, drainage from the dump flows through the wetland below the dump. Up to 90 percent of inflow Se load is removed by the wetland.

Phosphate mine waste rock in southeast Idaho contains potentially toxic levels of selenium (Se) and other trace elements such as vanadium, chromium, molybdenum, nickel, and cadmium. In this region, dump sites contain millions of cubic yards of mine waste, from which Se is leaching and being taken up by plants. These sites pose risks to grazing livestock, fish and waterfowl, and potentially human health. Selenium levels in creeks have been as high as 900 ppb, far exceeding the cold water biota standard of 5 ppb and the drinking water Maximum Contaminant Level of 50 ppb.

Water draining from beneath the North Maybe Canyon East Mill Dump into East Mill Creek has a fish consumption advisory for children due to high Se. Yellowstone cutthroat and other species are known to reside in the lower reaches of East Mill Creek and it is possible that cutthroats spawn in this tributary to the Blackfoot River. Two environmental groups filed a Notice of Intent to sue mining companies and the Forest Service under the Clean Water Act because Se levels exceed water quality standards at North Maybe Canyon, South Maybe Canyon, and Smokey Canyon.

Wetlands have the potential to remove large quantities of Se in waste rock drainage and thus protect downstream receiving waters. As part of a series of studies in the Permian Phosphoria Formation of southeast Idaho and the western U.S., Station and U.S. Geological Survey scientists are investigating the capacity of wetlands to attenuate Se. Previous research shows that almost 90% of Se leached from a waste rock dump can be attenuated in a wetland via plant uptake and various geochemical immobilization processes.

Studies were initiated to determine rates of Se leaching from waste rock to better predict contaminant loading to wetlands and receiving waters. A new column leaching method was developed to measure chemical weathering and leaching of contaminants from shale. Leaching of two types of shales (Meade Peak and Mancos) was studied. The Meade Peak shale is the major source of Se to watersheds in southeastern Idaho, while the Mancos shale is the principal source of salinity and other contaminants including Se to the Colorado River Basin. Overall, weathering rate and Se release rate of the Mancos shale are about double that of the Meade Peak shale. All of the Se in the Mancos shale could be recovered by leaching, but only about 1 percent of total Se in the Meade Peak shale could be removed by leaching. The Mancos shale is more weathered on the landscape than the Meade Peak, so it more readily delivers salinity and contaminants to the Colorado River basin. Since the Meade Peak shale is still relatively unweathered compared to the Mancos, better engineering and hydrologic design of waste rock dumps could slow or prevent Se release. The slow rate of Se release from the Meade Peak indicates that wetlands' capacity to attenuate Se can be maintained with proper design and establishment. The continuing removal of Se in a wetland below a waste rock dump supports this conclusion.

Research results are helping resource specialists better understand and find solutions to issues related to mine waste contaminants and their effects on the environment.

Fire, Fuel, and Smoke

Operating under a national charter, scientists with this program conduct fundamental research relating to wildland fire, fire behavior, the effects of fire on ecosystems and the atmosphere, and how ecosystems adapt to fire. Their mission is to improve the safety and effectiveness of fire management by creating and disseminating basic fire science knowledge, tools, and applications for scientists and managers. Find out more about this program at http://www.fs.fed.us/rmrs/research/programs/fire-fuels-smoke.

The Station also oversees the LANDFIRE (Landscape Fire and Resource Management Planning Tools) project, a five-year, multi-partner effort that produces comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States; and the Wildland Fire Management and Planning Research, Development and Applications project. These two projects are administered by the Science Applications and Integration program.

Understanding Past Climate Drivers of Fire

Widespread wildfires, like those in 1910, 2000 and 2003, can quickly overwhelm our ability to control them. Such regional-fire years can reset forest succession over large areas and result in more extensive fires in the future. The cumulative effect of these extensive fires can also alter regional forest carbon budgets, water and nutrient cycles, and habitats of species of conservation concern.

The history of fire on old stumps yielded information useful for planning fire management in the face of climatic change.

Fire scars on trees were used to identify climate conditions during wildfires over the past several centuries.

Scientists at the Fire Sciences Laboratory in Missoula, Montana, in collaboration with the University of Idaho, identified the climate conditions under which regional-fire years have occurred over the past 350 years in the Northern Rockies. Using both tree rings and written records, they found that regional-fire years occurred when warm springs were followed by warm, dry summers. Furthermore, 20th-century regional-fire years were also influenced by the Pacific Decadal Oscillation (El Niño-like pattern of Pacific climate variability), when spring snowpack was low and hence fire seasons longer. Climate continues to be a major driver of regional-fire years in this region despite intensive fire suppression, logging, and domestic livestock grazing.

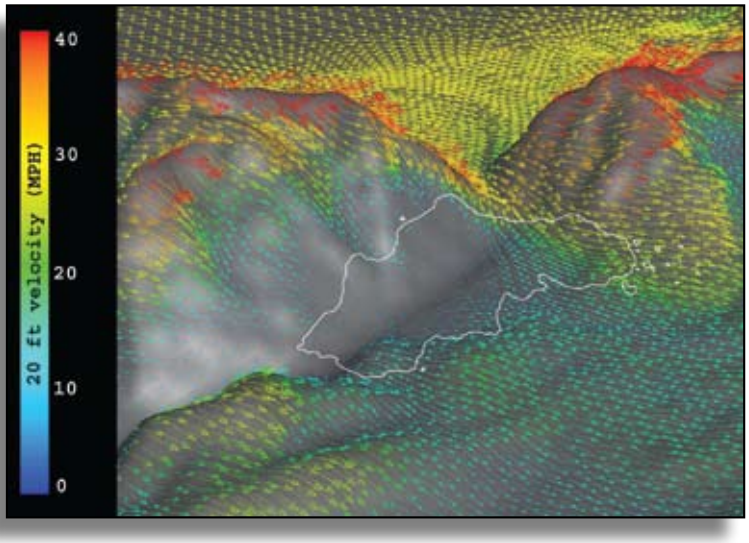
Understanding the climate conditions under which regional-fire years occurred in the past is critical to predicting the effects of climatic variability and climatic change on future fire extent and severity.

More information on this research can be found in Multi-season Climate Synchronized Historical Fires in Dry Forests (1650-1900), Northern Rockies, USA. *Ecology*. 89:705-716; and Multi-season Climate Synchronized Forest Fires Throughout the 20th Century, Northern Rockies, USA. *Ecology*. 89:717-728.

High-Resolution Surface Wind Simulations

Wind is often the dominant variable influencing the behavior of a wildland fire. Individual mountains, valleys, ridges, and other terrain features can influence both the speed and direction of wind flows. A major source of uncertainty in fire behavior predictions is the lack of fine-scale information about the variation in wind speed and direction in the vicinity of a fire. Researchers at the Fire Sciences Laboratory in Missoula, Montana, have developed two wind models that are being tested by fire behavior analysts for predicting wind speed and direction at spatial resolutions down to 100 meters. The first, called WindWizard, uses computer flow modeling technology originally developed for the aerospace industry. The second model, called WindNinja, uses a similar modeling approach but incorporates less physics. Each model has unique

Wind vectors can be plotted in Google Earth, allowing a 3-dimensional view of wind flow displayed over high resolution aerial photography.



A close-up image of a fire in northwest Montana. Note the highly variable wind direction and speed in this area. These variations play a primary role in the fire spread and intensity. Vector color represents wind speed in miles per hour.

strengths. For example, WindWizard is more accurate on the lee side of ridges because of the additional physics included, but takes much longer to compute a solution than WindNinja. WindNinja is very fast computationally but lacks sufficient physics to accurately simulate flows in highly variegated terrain.

The wind models produce outputs in various formats for use by fire personnel. Visual displays of wind flow over terrain can be used to make tactical decisions and for safety analysis on fires. The wind model outputs can be incorporated into fire behavior models to increase predictive accuracy. Several case studies showed a significant increase in fire behavior predictive accuracy when the modeled winds were used.

Find out more about these and other interesting studies at the Fire Sciences Laboratory at http://www.firelab.org

Assessing Post-fire Douglas-fir Mortality and Douglas-fir Beetle Attacks in the Northern Rocky Mountains

Understanding the effects of fire injury on tree survival following wild and prescribed fires is imperative for prescribed fire planning and post-fire management. A large body of research describing the complex interactions among fire injuries and tree survival exists and has been used to develop predictive models for a variety of tree species. However, no models predict the probability of delayed Douglas-fir tree mortality that include the interaction of fire injury and Douglas-fir beetle attack. This information is important because trees that are only moderately injured by fire and capable of recovery can be subsequently attacked by bark beetles and killed, confounding predictive models that do not include this second-order fire effect. In particular, Douglas-fir beetle has been consistently associated with fire-injured trees, often attacking larger trees with moderate to high levels of basal bole injury and light to moderate levels of crown scorch. Additionally, standardized methods are needed to collect fire injury data most useful in predictive models.

Researchers collect beetles from traps installed on Douglas-fir to help understand how beetles might kill trees injured by fire.

Using data from mixed-severity wildfires in Montana and Wyoming, Station researchers developed models for predicting the probability of Douglas-fir mortality and Douglas-fir bark beetle attack based on fire injury and stand characteristics to quantify the role of Douglas-fir beetle in delayed Douglas-fir mortality following wildfire. They then created a guide for use in developing post-fire management and prescribed burn plans that include descriptions of both models and variables that significantly influence post-fire Douglas-fir mortality and bark beetle attack. The guide also discusses how to interpret Douglas-fir mortality and bark beetle attack models for use in management decision-making regarding wild and prescribed fires in the Northern Rocky Mountains. A supplemental field guide provides photographs of a range of levels for each fire-related injury and descriptions for measuring each characteristic in the field.

This guide, including the supplement, is available in Assessing Post-fire Douglas-fir Mortality and Douglas-fir Beetle Attacks in the Northern Rocky Mountains, General Technical Report RMRS-GTR-199, available from the Rocky Mountain Research Station or online at http://www.fs.fed.us/rm/pubs/rmrs_gtr199.html.

Further details can be found in Predicting Post-fire Douglas-fir Beetle Attacks and Tree Mortality in the Northern Rocky Mountains, *Canadian Journal of Forest Research*, 37: 1058-1069.

Air, Water, and Aquatic Environments

Air quality, water availability, water quality, and aquatic habitats are critical issues within the rapidly changing western United States. Scientists with this program develop knowledge and science applications related to air and water quality, as well as habitat quality, distribution, diversity, and persistence of fish and other aquatic species. Research results help understand natural processes, and how human management and other interventions impact these critical resources. Additional information can be found at http://www.fs.fed.us/rmrs/research/programs/air-water-aquatics.

Monitoring Ozone in Mountain Ecosystems

Ozone is a pollutant that is highly toxic to vegetation, however, the amount of ozone in mountain ecosystems is largely unknown. Monitoring of ozone in remote ecosystems is problematic, since continuous ozone monitors need electric power to operate.

Station scientists in Fort Collins, Colorado, are exploring two solutions to this problem: 1) they use passive samplers that rely on a chemical reaction to estimate ozone loading over a two week period; and 2) they have designed a solar-powered monitoring system, using a battery-operated portable monitor to continuously record ozone concentration.

Results indicate that: 1) ozone at Colorado high elevation ecosystems is at concentrations that can exceed the National Ambient Air Quality Standard; 2) ozone concentrations in remote ecosystems in Colorado increase with elevation; 3) passive ozone samplers can be used to indicate loading of ozone at remote locations; and 4) battery-powered portable active ozone monitors can be used for determining actual ozone values at remote locations.

Remote battery powered ozone monitoring station near Silt, Colorado.

Find out more about ozone effects on plants in: The Challenge of Making Ozone Risk Assessment for Forest Trees more Mechanistic. *Environmental Pollution*: 2008 June 19.

Conservation of Western Trout

In the western United States, both bull trout and western cutthroat trout are threatened by climate change, invasive species and changing fire regimes, and population declines have prompted listing under the Endangered Species Act. Understanding these threats will help provide essential information to help prioritize limited management resources.

Climate plays an important role in determining population boundaries. Recent trends in stream temperatures driven by increasing air temperatures, decreasing flows, and increasing wildfires indicate losses and fragmentation of habitat may already be occurring. Science findings provide critical data that measure and model the threats posed by a warming climate to bull trout distributions associated with numerous warming scenarios. The results are being adopted by managers within the Forest Service, U.S. Fish and Wildlife Service, and state natural resource agencies across the Pacific Northwest.

The extensive lands managed by the Forest Service require monitoring that can be applied rapidly and inexpensively, yet provide powerful and accurate determination of the status and trends and help develop recovery plans for threatened trout species. Station scientists have developed monitoring methods that focus on patterns of occurrence within suitable bull trout habitats. This approach requires less intensive sampling at individual sites, which makes it possible to sample larger and more representative areas relevant to land management.

Investigations also focus on invasive species—one of the most important threats to the integrity of stream ecosystems. Nonnative brook trout, brown trout, and rainbow trout are among the most pervasive nonnative fishes in the West. They have invaded and replaced native cutthroat and bull trout in many Rocky Mountain streams. Managers often use intentional fish migration barriers to preempt invasions, but those barriers also isolate the native species, which can lead to loss of a population through the effects of habitat fragmentation. Understanding tradeoffs between intentional isolation and invasion is a central problem for managers of native salmonids throughout the Interior West. Station scientists developed a decision support model for the use of barriers as a management tool. Workshops on the framework and decision tool have been conducted with biologists in several western states, including the interagency management teams for Westslope cutthroat trout in Montana, and the recovery team for Colorado cutthroat in Wyoming and Colorado.

Invasive brook trout (top) have invaded and replaced native western cutthroat trout in many parts of the West.

Find out more about the Station's trout research in: A Watershed-scale Bull Trout Monitoring Protocol, to be published as a Rocky Mountain Research Station General Technical Report.

Strategies for Conserving Native Salmonid Populations at Risk from Nonnative Invasions: Tradeoffs in Using Barriers to Upstream Movement, General Technical Report RMRS-GTR-174 (http://www.fs.fed.us/rm/pubs/rmrs_gtr174.html).

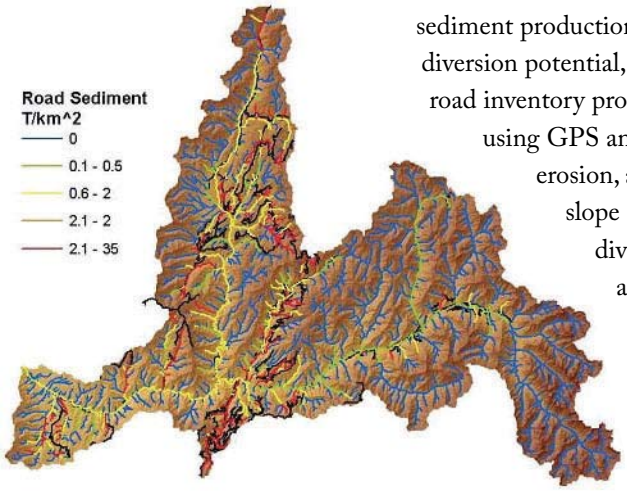
Analysis of Tradeoffs Between Threats of Invasion by Nonnative Brook Trout (*Salvelinus fontinalis*) and Intentional Isolation for Native Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*). *Canadian Journal of Fisheries and Aquatic Sciences* 65(4):557-573.

Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. *Transactions of the American Fisheries Society* 136:1552-1565.

Impacts of Roads on Forested Watersheds

Forest roads are the principle source of fine sediment entering streams on Forest Service lands. The Geomorphic Road Assessment and Inventory Package (GRAIP) is a process and a set of tools for analyzing the impacts of roads on forested watersheds. GRAIP combines a road inventory with a powerful GIS analysis tool set to predict sediment production and delivery, erosion from gullies and landslides, stream diversion potential, culvert maintenance, and fish passage at stream crossings. The road inventory protocol describes how to systematically inventory a road system using GPS and automated data forms. The program produces maps of surface erosion, accumulated road sediment in streams, as well as maps of slope stability and gullying risks. Other analyses relating to stream diversion potential, culvert maintenance needs, and fish passage are also provided with the program.

In addition to the National Forests, the Bureau of Land Management, tribes and state agencies have used GRAIP to complete inventories in areas of critical concern. Additional details can be found at http://www.fs.fed.us/GRAIP/index.shtml.



Map of accumulated road sediment in streams.

Wildlife and Terrestrial Ecosystems

This program focuses on four components: 1) sustaining species/ecosystems of concern, including multi-scale studies to identify factors that affect the persistence of species, communities, and ecosystems of concern; 2) informing federal, state, tribal, and local resource agencies on the interactions between people and fish/wildlife so they have a better understanding of public-use effects such that they can be mitigated by appropriate management actions; 3) answering questions about the amount, kind, distribution, and connectivity of habitat critical to the persistence and abundance of species; and 4) determining immediate, long-term, and cumulative effects of disturbances on species of concern and interest in the Intermountain West. Learn more at http://www.fs.fed.us/rmrs/research/programs/wildlife-terrestrial-habitats.

Wildlife CSI

A wild cougar shows up in downtown Chicago. Where did it come from? Does the Midwest need to start managing for these large cats? A wolverine appears in California for the first time in 80 years on Federal lands. How did it get there? Was it from a captive facility? Finally, a federally protected lynx is poached from the Superior National Forest. Can a confiscated mount from alleged wildlife trafficker's house be linked to the local population, or it is imported from Alaska? These are examples of forensic questions that the Station's Wildlife Genetics Laboratory in Missoula, Montana, answers using the same tools and techniques made popular by television shows.

Researchers didn't specifically set out to become forensic experts, but their wildlife genetic studies with researchers from around the world often leave them having the best genetic databases in existence for some sensitive species of interest. So, when legal cases appear involving wildlife, law enforcement is no stranger to collaborating with the Genetics Lab.

It started with several cases on lynx sent to the lab for assistance by the U.S. Fish and Wildlife Service Forensic Lab, and has grown from there. In 2007, scientists testified in federal court in Duluth, Minnesota, that a lynx confiscated during a 2004 raid of a suspected wildlife trafficker's house was not from Alaska, as the suspect claimed, but was an exact match to a lynx from a local population being studied by the Station, University of Minnesota, and the Superior National Forest. In fact, based on the DNA work conducted by the lab, researchers calculated that the probability that the confiscated animal matched the study animal who lived on the Superior National Forest by chance alone was greater that 1 in 2.5 million. When presented with this and other evidence, the poacher was found guilty and sentenced in August 2008.

Work at the Genetics Laboratory is assisting resource managers and aiding law enforcement in several states.

Another case that sparked the public's interest was the supposed sighting of a cougar in a rural Wisconsin barn. Wisconsin is nearly 1,000 miles from the nearest known cougar population. In this case, a farmer opened his barn one morning, only to have an animal spring out at him and run off to the nearby woods. Fortunately for the forensic scientists at the lab, the animal cut his paw on a board or nail. The spot of blood in the snow was carefully captured by the Wisconsin Department of Natural Resources, and sent to the lab for analysis, which found it to be from a male cougar. While additional tests were being conducted to compare its genetic fingerprint to a large database of cougars on the eastern edge of their distribution that the lab has been compiling for other research purposes, another cougar was spotted, this time 7 miles from downtown Chicago. Again a sample was collected and sent to the lab, this time by the Chicago police. And within 48 hours it was determined to be a match to the Wisconsin animal. In addition, statistical analysis was conducted that suggested that the cougar unbelievably came from the Black Hills of South Dakota and Wyoming—a population that was more than 800 miles away.

In the coming year, researchers at the Genetics Lab expect their forensic expertise to be called upon again in new cases. They hope that with the ever changing and improving DNA technology, they will once again be able to assist local managers and aid law enforcement.

Learn more about work at the Genetics Lab at http://www.rmrs.nau.edu/wildlife/.

Ponderosa Pine Mixed Fire Regimes in Southern Arizona

Restoring fire-adapted forests is a major priority of the U.S. Forest Service, particularly in the southwestern U.S., where frequent fires historically maintained low fuel loads and decreased the potential for large, severe, stand-replacing fires. Fire-adapted forests such as ponderosa pine occur across a wide range of landscapes, and historically experienced frequent low severity surface fires prior to 1900. In the sky islands (forested ranges separated by expanses of desert and grasslands) of southeastern Arizona, however, ponderosa pine forests are often found in diverse and complex landscapes such as isolated peaks surrounded by unburnable fuels and/or rock

outcrops. Experienced fire managers have noticed that few fires start in these diverse landscapes and even fewer are able to spread. This prompted the question: prior to 1900 did isolated ponderosa pine forests have the same fire regime as forests in more continuous landscapes?

To answer this question, Station researchers in Flagstaff, Arizona, collected evidence of past fires from 21 randomly selected locations near Tucson, Arizona. Using tree-rings, they were able to reconstruct the historical fire regimes back to 1495.

Results show that prior to 1900, fires were common and fire size depended on climate patterns. Prior to 1765, for example, fires occurred at each 2-hectare plot about every 7 to 15 years on average. Most large fire years occurred during very dry years typically preceded by several wet years. Between 1765 and 1867, however, climate patterns changed slightly causing longer fire intervals and more severe fires. Crown fires (<100 ha) converted ponderosa pine forests into oak shrub fields that persist today. Scientists believe that isolated ponderosa pine forests within diverse and complex landscapes had mixed fire regimes consisting of both frequent surface fires and infrequent stand-replacing fires, depending on climate conditions. Their findings suggest that managers should be more careful of associating surface fire regimes with certain cover types such as ponderosa pine. Instead, managers should consider the context within which that cover type exists, and evaluate each project from a landscape perspective.

These study results are being used by The Nature Conservancy and the Southwest Region of the U.S. Forest Service to develop models of current and historical conditions that will guide management decisions. This information is also being used in the Catalina-Rincon Firescape Project, which is a landscape restoration plan that involves multiple land management and research agencies including the State of Arizona, Coronado National Forest, Saguaro National Park, University of Arizona, Rocky Mountain Research Station and various local communities.

More information can be found at http://www.rmrs.nau.edu/lab/people/jiniguez/ or in "Spatially and Temporally Mixed Fire Regimes in Rincon Peak, Arizona," presented at the Association for Fire Ecology Conference in Tucson, Arizona in January 2008, and to be published in *Fire Ecology*.

Scientists developed models and collected historical fire data that is helping to restore landscapes near Rincon Peak in Arizona.

Hierarchical Den Selection of Canada Lynx

Fundamental to the stewardship of Canada lynx is determining the habitats and structures they require for denning. Habitat features associated with den sites are particularly important because they may directly affect lynx productivity. The U.S. Fish and Wildlife Service, in their listing of the lynx as a threatened species, identified that human alteration of forests is the most influential factor affecting lynx habitat. Thus, understanding how management activities of the Forest Service may affect den habitat is an important priority.

From 1999 to 2006, researchers used radio telemetry to locate 57 lynx dens in western Montana. They then evaluated den selection through field sampling and GIS analysis. They found that lynx mostly denned in pre-existing sheltered spaces created by downed logs, root-wads from wind-thrown trees, boulder fields, slash piles, and live trees. Lynx strongly selected den sites with high horizontal cover and abundant woody debris from piled logs. They mostly located their dens in spruce-fir forests, usually in stands that were mature or mid-seral in structure. Young regenerating or thinned stands with discontinuous canopies were seldom used.

This research provides information to land mangers that is defensible and relevant to lynx management, and is based on the largest sample of dens ever surveyed in the U.S. Land managers are now better able to manage habitat in ways that conserve the species, and results from this study are already being incorporated into management plans.

Learn more in: Hierarchical Den Selection of Canada Lynx in Western Montana. *Journal of Wildlife Management* 72:1497–1506.

Researchers use radio telemetry to study den selection of Canada lynx. Results are being incorporated into management plans.

Inventory, Monitoring, and Analysis

Scientists provide the data, analyses, and tools needed to identify and evaluate the current status and trends in the condition of forests and rangelands throughout the Interior West. Results help identify changes in use, management options and impacts, and threats and impacts of climate change, fire, insects, disease, and other natural processes. The Forest Inventory and Analysis Program is a central component of this Science Program. Details are available at http://www.fs.fed.us/rmrs/research/programs/inventory-monitoring-analysis.

The North American Forest Dynamics Project

The multi-faceted North American Forest Dynamics Project (NAFD), which uses inventory and satellite data to characterize the effects of forest disturbance across North America, includes collaborators from Forest Inventory and Analysis (Forest Service), NASA, University of Maryland, Pacific Northwest Research Station, Canadian Forest Service, Comisión Nacional Forestal (CONAFOR) in Mexico, and others.

Landsat imagery, dating back to 1972, is being used to create disturbance maps that provide estimates of the biomass or volume loss associated with forest disturbance and recovery. Models are being constructed to extend this information to maps of forest dynamics throughout the U.S. Collaborative work with Canada and Mexico has begun the process of applying these methods across North America to gather carbon-relevant historical information about forest dynamics.

Historical Landsat imagery is also being used to support a number of management-relevant applications. An important component of monitoring is gaining a clear understanding of what has happened in the past. Reconstructing historical trends in forest disturbance using FIA data alone can be challenging in areas where there are gaps in plot distributions and/or where little historical data exists. Disturbance maps generated from Landsat imagery, on the other hand, spell out disturbance trends in a straightforward manner, but lack the statistical rigor of a field-based inventory. Analysis of these maps, in conjunction with FIA inventory data, can provide a clearer understanding of forest dynamics over the last several decades.

Maps produced by the North American Forest Dynamics Project can show timing and intensities of fires.

The maps produced through NAFD methodologies offer the opportunity to communicate the timing, area, and intensity of fires, harvests, and other disturbances. Demonstration projects include harvest patterns on the Allegheny National Forest (PA), blowdown in the Boundary Waters Canoe Area (MN), woody encroachment in diverse ecozones, land use change in eastern Pennsylvania, as well as forest carbon tracking in Idaho and Montana. In addition, Station scientists and NAFD partners will pilot the first state-wide disturbance analysis in Utah. The goal of this project is to produce an historic disturbance product that is ready for state-level analysis by FIA staff and that can support other applications in the Interior West, such as habitat monitoring for fire effects.

More information about this project can be found in: Use of Landsat-based Monitoring of Forest Change to Sample and Assess the Role of Disturbance and Regrowth in the Carbon Cycle at Continental Scales, Proceedings of the ForestSat 2007, Montpellier, France, 5-7 November; Forest Disturbance and North American Carbon Flux. EOS Transactions 89(11), 11 March, 2008; and Applications of Satellite-derived Disturbance Information in Support of Sustainable Forest Management, Proceedings of the ForestSat 2007, Montpellier, France, 5-7 November.

Forest Inventory and Analysis Supports Land Management Planning

The Forest Inventory and Analysis (FIA) Program provides essential baseline data on forest attributes and conditions for land management planning purposes. Federal and State land management agencies, such as the U.S. Forest Service, rely on nationally standardized FIA information as a foundation for planning and monitoring the effects and sustainability of land management practices.

The Station's Interior West FIA Program has recently published three new reports for the Shoshone and Bighorn (Wyoming), and Gila (New Mexico) National Forests. The reports highlight forest conditions such as forest type, tree and stand size, biomass, age, volume, growth, and mortality. They also describe other forest vegetation, inventory methods, and references. These concise and easy to use documents provide land managers and users an important tool to assist in the complicated job of managing our Nation's national forests. The reports are available online at www.fs.fed.us/rm/ogden/publications/index.shtml.

Field crews collect information on coarse woody debris, which is used to estimate the biomass of fuels and fire risk.

Human Dimensions

This program provides social and economic science-based innovation to human societies as they develop a sustainable relationship with their environment. Major issues confronting societies across the globe, such as global climate change, energy, fire, and water, all have important social and economic dimensions that are explored and addressed by this Program. Scientists also work to improve firefighter and public safety, reduce large fire costs, and expand the treatment of hazardous fuels for watershed restoration that is strategic, cost-effective, and socially acceptable. Additional information is at http://www.fs.fed.us/rmrs/research/programs/social-economics-decision.

Adaptation Options for National Forests

The U.S. Climate Change Science Program (CCSP, http://www.climatescience.gov/) integrates federal research on global and climate change. A primary objective of the CCSP is to provide the best possible scientific information to support public discussion, as well as government and private sector decision-making, on key climate-related issues. To help meet this objective and define and set future program priorities, the CCSP has identified an initial set of 21 synthesis and assessment products that address its highest priority research, observation, and decision-support needs. These are listed at: http://www.climatescience.gov/Library/sap/sap-summary.htm. These products also help meet the requirements of the Global Change Research Act of 1990, which directs agencies to "produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change" and to undertake periodic scientific assessments.

A Station scientists is the lead author on a new climate change report that will help managers address the impacts of climate change on sensitive ecosystems.

The Climate Change Science Program (CCSP) released the Synthesis and Assessment Report 4.4 "Preliminary Review of Adaptation Options for Climate Sensitive Resources and Ecosystems." A Station scientist in Fort Collins, Colorado, was on the lead author team for the report. She was also the lead author for the National Forest chapter that will help resource managers address the impacts of climate change on sensitive ecosystems and natural resources and identify what options are available for adaptation. The process of developing the information has allowed the authors to engage national forest managers in ways that are unprecedented in research-management partnerships. Additionally, this report has been the incentive for numerous research-management workshops in the western U.S. where state-of-the-art scientific information is provided in a setting to engage in dialogue with managers. The influence of this report, and what the authors learned in research-management interactions in developing the report, will continue to ripple through the Forest Service for years to come.

For more information, see: Preliminary Review of Adaptation Options for Climate-sensitive Ecosystems and Resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, DC, USA.

Valuing Ecosystem Public and Private Goods

Some of the ecosystem goods and services produced on national forests and other public lands are private goods, in that consumption of a unit of the good by one person precludes consumption by another person. Examples include timber stumpage, livestock grazing, and a night's stay at a campsite. However, many ecosystem services are public goods, such as protection of water quality, species habitat, or scenic vistas, which may be enjoyed by many people without diminishing the supply. People are familiar with paying for private goods, but they have little experience paying for public goods. Studies investigated the public's ability to consistently value both public and private goods, and found that the reliability of individual choices involving public goods was only slightly lower than for choices involving private goods.

Scientists used the method of paired comparisons, wherein respondents are presented with many binary choices between goods or between a good and a monetary amount. To assess the consistency of these choices, the authors developed a new metric of choice consistency. This new metric is available in a software program (PAIRCOMP) at http://www.fs.fed.us/rm/value/paircomp.html.

These findings support efforts to measure public preferences regarding ecosystem services, and help to improve the management of public lands.

Learn more in: Defining, Valuing, and Providing Ecosystem Services. *Natural Resources Journal* 47(2):331-376; Reliability of Individual Valuations of Public and Private Goods: Response Time, Preference Lerning, and Choice Consistency. *Journal of Public Economics* 92(7):1595-1606; and An Inquiry into the Method of Paired Comparison: Reliability, Scaling, and Thurstone's Law of Comparative Judgment, a forthcoming Rocky Mountain Research Station research paper (see http://www.fs.fed.us/rm/publications/titles/rmrs_research_papers.html).

Station scientists investigated the public's ability to value both private and public goods, such as this scenic vista at Bearplat Lake in Montana.

Aldo Leopold Wilderness Research Institute

Scientists and other specialists with this program work on wilderness law, policy and management to help assure that the science necessary for the understanding and stewardship of wild ecosystems is developed, delivered and applied to those responsible for managing such lands. The Institute focuses on five problem areas: 1) recreation impacts and management; 2) relationships between people and public lands; 3) wilderness fire stewardship and management; 4) wilderness in the context of large ecological and social systems; and 5) science delivery and application. Find out more at http://www.fs.fed.us/rmrs/research/programs/aldo-leopold.

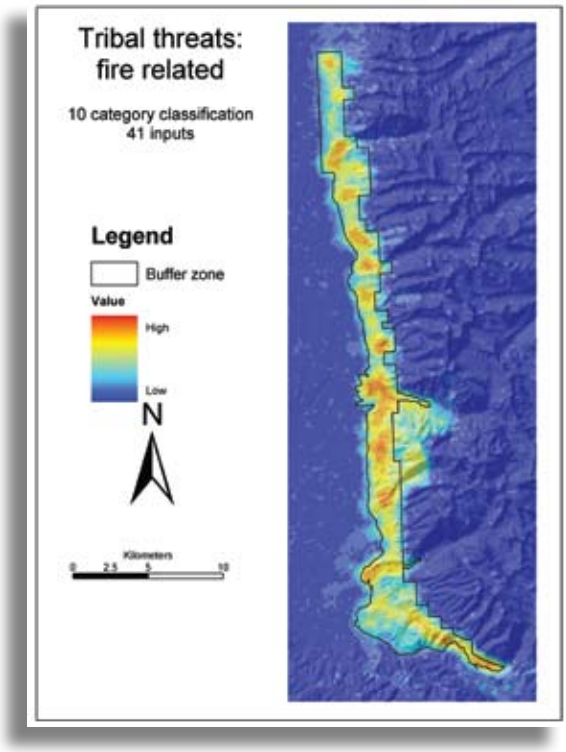
Flat Tops Wilderness, Colorado (photo by Lisa Parresol).

Ecosystem Health in the Mission Mountains Tribal Wilderness: A Social Challenge

One of the primary barriers to fire restoration and forest health in the Mission Mountains Tribal Wilderness on the Flathead Indian Reservation in western Montana, is the health of adjacent lands. Fire suppression has had substantial influence on the structure and general health of the forest within the adjacent "buffer zone." Heavy accumulations of dead wood and down timber on the forest floor, a dense understory of brush and young trees, and closely spaced trees and closed forest canopy make the forest "unhealthy" and highly susceptible to destructive wildifes, as well as diseases such as pine bark beetles.

This 22,000-acre area, established in 1987, was designated as a buffer zone, seemingly protecting the wilderness from nearby non-wilderness activities and development. Initially, the zone timber was designated as "unavailable" for harvest and removal. A proposal to change from "unavailable" to "available" for timber extraction created a great deal of controversy and conflict within the tribal population.

Scientists at the Aldo Leopold Wilderness Research Institute in Missoula, Montana, worked closely with the Confederated Salish & Kootenai Tribes Forestry Department and the University of Montana to understand and map both the meanings tribal members ascribed to this buffer zone landscape and the threats of fire and logging to these meanings. Through an initial round of interviews, followed up by a web-based mapping activity which further probed not only the meanings and threats attached to the landscape, but also the location and intensity of those meanings, greater understanding of how tribal members are likely to respond to fuel treatment proposals at specific places was created.



Comparing the extent and intensity of perceived threats related to wildland fire and logging activities in the Tribal Buffer Zone on the Flathead Indian Reservation, Montana.

Central to these discussions are how both logging and fire activities of various scales, methods and intensities influence: 1) wildlife and water quality, 2) access and functional attachments, 3) protection of the wilderness, 4) personal and cultural meanings, and 5) recreation and scenic values associated with the buffer zone. In these discussions, emphasis is on fully understanding the basis for public response to the threat of fire and logging practices in hopes that the public can contribute to defining the tradeoffs between these threats and eventually support solutions that acknowledge and consider these tradeoffs.

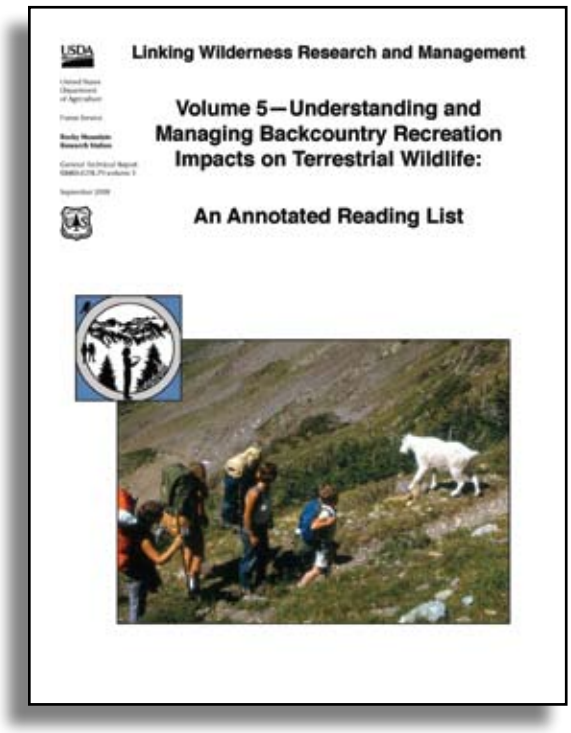
The maps generated offer a foundation for interaction between the Tribal Forestry Department and the public not previously available. In seeking solutions to the tradeoffs between wildland fire threats and disapproval of logging activities in the Buffer Zone, a continual dialogue is necessary. This research provides the foundation to facilitiate this dialogue.

Learn more about this research in: "Developing Computer-based Participatory Approaches to Mapping Landscape Values for Landscape and Resource Management." In: Planning Support Systems: Best Practices and New Methods, 431 DOI 10.1007/978-1-4020-8951-0, Chapter 21.

Mapping Tradeoffs in Values at Risk at the Interface Between Wilderness and Non-wilderness Lands, General Technical Report PSW-GTR-19 (also in Spanish), is available from the Rocky Mountain Research Station.

Understanding and Managing Backcountry Recreation Impacts on Wildlife

The increase in outdoor recreation activity over the last 50 years is recognized as a potentially serious threat to North American wildlife populations. Threats to wildlife in wilderness are of concern to both backcountry recreationists and, more broadly, the American public. According to the Southern Research Station's 1990's telephone survey of approximately 1,900 people in the United States, the protection of wildlife habitat and endangered species was one of the most highly valued benefits of wilderness. In addition, many backcountry recreation users cite the opportunity to view wildlife as an important part of their wilderness experience.



Impacts of recreation on wildlife include increased energetic demands during critical periods of the year, reduction of habitat through avoidance of areas of human activity, exposure to predators while avoiding humans, and loss of habitat through changes in vegetation resulting from recreation activities. If widespread, cumulative impacts on individuals of a species may ultimately affect local and regional populations, and changes in species' populations can alter wildlife communities.

Managing recreation impacts on wildlife in wilderness is especially complicated by the potentially conflicting mandates of The Wilderness Act of 1964 [Public Law 88-577]. The Act mandates the preservation of natural conditions in wilderness while requiring managers to provide opportunities for primitive recreation. To address the dual mandates, appropriate wilderness recreational activities must not only be provided, but must be managed to minimize their impacts to wildlife.

Station researchers have compiled an annotated list of references to help wildlife, recreation, and wilderness managers better understand backcountry recreation impacts to wildlife, and be informed of the variety of management tools available for minimizing impacts. This volume of the Linking Wilderness Research and Management series crosses disciplinary boundaries and includes literature from the wildlife discipline, such as papers needed to understand impacts to wildlife, as well as literature from the recreation discipline that is needed to understand recreation management techniques. Readings included in the recreation section are intended to provide a basic understanding of recreation management techniques, the reasoning behind them, and their assumptions.

This publication will help increase understanding of backcountry recreation impacts on wildlife and familiarize readers with various recreation management approaches.

Copies of Linking Wilderness Research and Management—Volume 5. Understanding and Managing Backcountry Recreation Impacts on Terrestrial Wildlife: an Annotated Reading List, General Technical Report RMRS-GTR-79-Vol 5, are available on the Internet at http://www.fs.fed.us/rm/pubs/rmrs_gtr079_5.html.

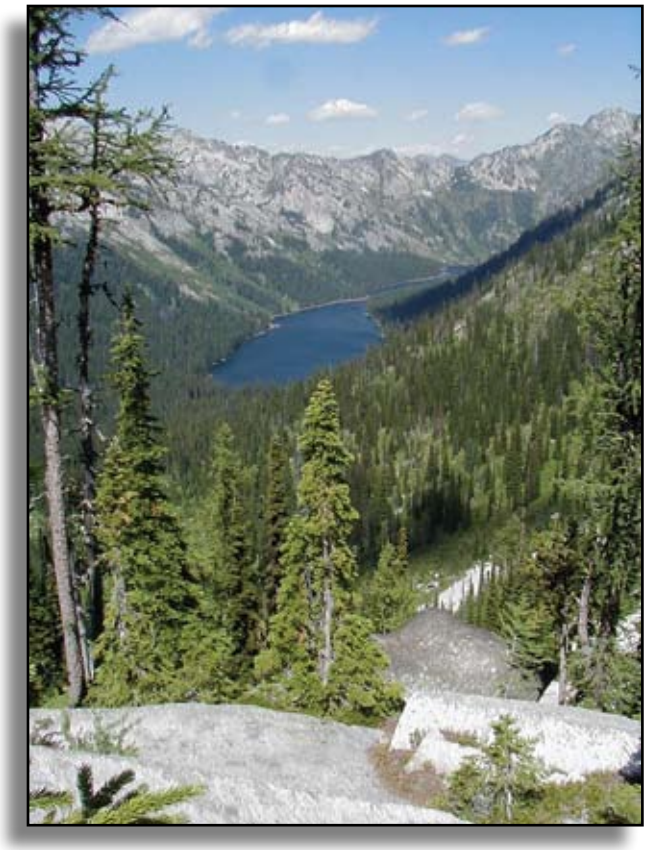
Monitoring Wilderness Character

The 1964 Wilderness Act, and all 115 subsequent federal laws that designate wilderness, state that the primary responsibility of the four federal agencies (Bureau of Land Management, Forest Service, Fish and Wildlife Service, National Park Service) with administrative responsibility for wilderness is to preserve the wilderness character of this land. Despite 44 years of experience, these federal agencies have yet to monitor trends in wilderness character, whether it is degrading, stable, or improving, across the 107.4 million acres of the National Wilderness Preservation System.

Building on previous efforts to develop protocols for monitoring trends in wilderness character in wildernesses administered only by the Forest Service, Station scientists in Missoula, Montana, recently led an interagency team that developed new and practical methods to monitor trends in wilderness character across all four federal agencies.

This new monitoring strategy ("Keeping it Wild: an Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System") defines a core set of four qualities and 13 indicators of wilderness character on which each wilderness and each agency would be responsible for reporting trends. The monitoring strategy further identifies a wide range of possible measures and data sources that the agencies could use to collect data for assessing and tracking trends in an indicator.

This strategy offers many tangible benefits to the agencies and the public: 1) improved accountability by linking performance measures and management outcomes directly to the mandates of wilderness legislation and agency policy; 2) improved decisionmaking and priority setting by being able to assess how specific projects will affect specific aspects of wilderness character; 3) creating legacy information on wilderness character; and 4) improving public trust and confidence in agency stewardship of wilderness.



Station scientists have helped develop new methods for monitoring trends in wilderness character. (Big Creek Lake, Selway-Bitterroot Wilderness, Montana)

More information on this new interagency monitoring strategy can be found in Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System, General Technical Report RMRS GTR-212 (http://www.fs.fed.us/rm/pubs/rmrs_gtr212.html.

Other publications on the Forest Service monitoring strategy include: Monitoring Selected Conditions Related to Wilderness Character: A National Framework, General Technical Report RMRS GTR-151 (http://www.fs.fed.us/rm/pubs/rmrs_gtr151.html); and Developing Indicators to Monitor the 'Outstanding Opportunities' Quality of Wilderness Character." *International Journal of Wilderness*, Volume 10, No. 3.

Research, Development, and Application (RD&A) Programs

The Human Factors & Risk Management RD&A is helping the Agency develop ultra-safe systems in high-risk environments. Organizationally, the challenge is to develop a highly reliable safety culture that practices proactive risk management and takes a systems approach. Work being done by the RD&A in partnership with universities, agencies, and the private sector will result in the following deliverables:

- Human Factors Handbook for Accident Investigations
- Implementation of Safety Management Systems (SMS)
- Mindfulness-Based Situational Awareness for firefighters
- Appropriate Management Response Balanced Scorecard and Key Decision Log

Contact: Jim Saveland, 970-218-4781, jsaveland@fs.fed.us, http://fsweb/science-application-integration/docs/human-factor-risk.pdf

The Wildland Fire Management RD&A helps develop and apply wildland fire science, decision support tools, and science integration service to the national interagency wildland fire community. The RD&A serves as a primary point of contact for communication between scientists and participating field managers, and as an advisor to program administrators at local, regional, and national levels, focusing on:

- Coordinating fire science application including interoperability and delivery of wildland fire decision support systems, and science liaison with the Wildland Fire Program Analysis Project;
- Developing and supporting the Wildland Fire Decision Support System (WFDSS);
- Projecting annual fire suppression costs;
- Coordinating scientific efforts associated with wildland fire costs; and
- Supporting development of hazardous fuels planning applications.

Contact: Tom Zimmerman, 208-387-5871, tomzimmerman@fs.fed.us

RMRS Headquarters, Science Programs, and Field Locations

Rocky Mountain Research Station (Headquarters)
240 West Prospect Road
Fort Collins, CO 80526
Phone: 970-498-1100
Website: http://www.fs.fed.us/rmrs

Science Programs

Grassland, Shrubland and Desert Ecosystems

Program Manager: Deborah Finch (Acting)
Address: 333 Broadway S.E., Albuquerque, NM 87102
Phone: 505-724-3660
E-mail: dfinch@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/grassland-shrubland-desert/

Forest and Woodland Ecosystems

Program Manager: Tom Crow
Address: Rocky Mountain Research Station, 240 West Prospect Rd., Fort Collins, CO 80526
Phone: 970-498-1378
E-mail: tcrow@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/forest-woodlands-ecosystem/

Human Dimensions

Program Manager: Cindy Swanson
Address: Forestry Sciences Laboratory, 800 East Beckwith Ave., Missoula, MT 59801
Phone: 406-542-4172
E-mail: cswanson@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/social-economics-decision/

Fire, Fuel and Smoke

Program Manager: Colin Hardy
Address: Fire Sciences Laboratory, 5775 Highway 10 West, Missoula, MT 59808
Phone: 406-329-4978
E-mail: chardy@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/fire-fuels-smoke/

Air, Water and Aquatic Environments

Program Manager: Frank McCormick
Address: 322 East Front Street, Suite 401, Boise, ID 83702
Phone: 208-373-4340
E-mail: fmccormick@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/air-water-aquatics/

Wildlife and Terrestrial Ecosystems

Program Manager: William Block
Address: Southwest Forest Science Complex, 2500 South Pine Knoll, Flagstaff, AZ 86001
Phone: 928-556-2161
E-mail: wblock@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/wildlife-terrestrial-habitats/

Inventory, Monitoring and Analysis

Program Manager: Michael Wilson
Address: Forestry Sciences Laboratory, 507 25th Street, Ogden, UT 84401
Phone: 801-625-5407
E-mail: mjwilson@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/inventory-monitoring-analysis/

Aldo Leopold Wilderness Research Institute

Program Manager: David Parsons
Address: 790 East Beckwith Ave., Missoula, MT 59801
Phone: 406-542-4193
E-mail: dparsons@fs.fed.us
Website: http://www.fs.fed.us/rmrs/research/programs/aldo-leopold/

Field Locations

Arizona

Southwest Forest Science Complex
2500 South Pine Knoll
Flagstaff, AZ 86001-6381
Phone: 928-556-2001

Colorado

Rocky Mountain Research Station (Headquarters)
240 West Prospect Road
Fort Collins, CO 80526
Phone: 970-498-1100

Natural Resources Research Center
2150A Centre Avenue
Fort Collins, CO 80526
Phone: 970-295-5020

Idaho

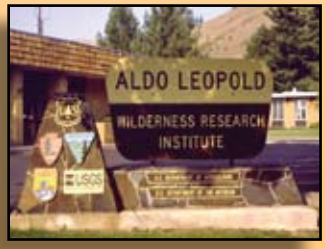
Forestry Sciences Laboratory
1221 South Main Street
Moscow, ID 83843
Phone: 208-882-3557

Aquatic Sciences Laboratory
322 East Front Street, Suite 401
Boise, ID 83702
Phone: 208-373-4340

Montana

Forestry Sciences Laboratory
800 East Beckwith Avenue
Missoula, MT 59801
Phone: 406-542-4150

Aldo Leopold Wilderness Research Institute
790 East Beckwith Avenue
Missoula, MT 59801
Phone: 406-542-4190



Fire Sciences Laboratory
5775 Highway 10 West
Missoula, MT 59808
Phone: 406-329-4820

Forestry Sciences Laboratory
1648 South 7th Avenue, MSU Campus
Bozeman, MT 59717-2780
Phone: 406-994-4852

New Mexico

Forestry Sciences Laboratory
333 Broadway, S.E., Suite 115
Albuquerque, NM 87102
Phone: 505-724-3660

Nevada

Forestry Sciences Laboratory
University of Nevada, Reno
920 Valley Road
Reno, NV 89512
Phone: 775-784-5329

South Dakota

Forest Service Center in Rapid City
8221 South Highway 16
Rapid City, SD 57702
Phone: 605-394-1960

Utah

Forestry Sciences Laboratory
860 North 1200 East
Logan, UT 84321
Phone: 435-755-3560

Forestry Sciences Laboratory
507 25th Street
Ogden, UT 84401
Phone: 801-625-5406

Shrub Sciences Laboratory
735 North 500 East
Provo, UT 84606
Phone: 801-356-5100

www.fs.fed.us/rmrs