Research Accomplishments 2004

Rocky Mountain Research Station

Front Cover Photo: Station scientists at the Southwest Forest Science Complex in Flagstaff, Arizona, conduct fish samplings on a number of streams in National Forests of the Southwest. These studies have produced a comprehensive record of the status of native and non-native fish populations. This information is used to help reestablish fish habitat and rehabilitate watersheds and riparian areas following wildfire.

Rocky Mountain Research Station

2004 Research Accomplishments

From the Director

As a world-class leader in natural resources management, the Forest Service has a responsibility to protect its most valuable resource – its employees. The success of our mission depends on how effectively we incorporate safety and health into our culture and our daily behavior. Including safety in the planning and execution of our daily business ensures our employees are provided with environments that enhance their ability to accomplish their work. We take a proactive, inclusive approach in designing projects and activities, and in developing supporting policies and procedures to help keep our employees out of "harms way."

A large part of our research involves fieldwork that can have various degrees of hazards and risks. In fact, much of the work we do is recognized by industry as being susceptible to the highest accident rates of all professions. Whether hiking through steep terrain searching for information on the elusive Canada lynx; traveling by snow cat to remote weather stations; fording streams and rivers to inventory rare and endangered fish species; scaling towering trees to investigate nesting sites of the northern goshawk; or working near roaring wildfires to better understand their behavior, our researchers share a common goal of managing their work to minimize or eliminate hazards and manage risks.

Despite the best-laid plans, the unforeseen does occur. On September 20, 2004, we lost two members of our Forest Service family in a plane crash in Montana's Bob Marshall Wilderness - Davita Bryant, an Ecologist at our Ogden, Utah laboratory (see "In Memory" on page iv), along with Ken Good, an employee of the Flathead National Forest in Montana. Contract Pilot Jim Long also perished in the crash. Two other passengers, Jodee Hogg and Matt Ramige, who are also Station employees in Ogden, managed to walk out of the backcountry and were rescued after they were initially thought lost in the crash. It was a bittersweet miracle.

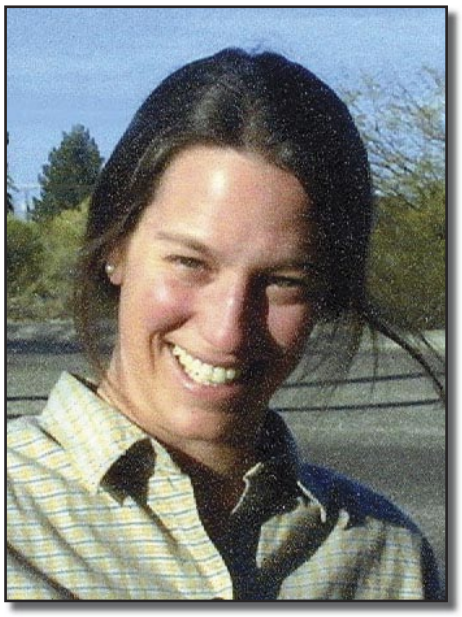
As of this message, the exact cause of the crash is under investigation. One thing is certain – the group was on one of those assignments that carry a degree of risk – flying into a remote backcountry location to conduct important vegetation inventory studies and maintain electronic equipment. This work is critical to the Forest Inventory and Analysis program in Ogden, where Davita, Jodee, and Matt worked. Scientists there measure, assess, and report on the extent, condition and health of forest lands throughout the Interior West.

Davita Bryant, Ken Good, and Jim Long will be greatly missed and their memory continues, as does our ongoing, relentless effort to incorporate safety into our work projects and activities. Our number one priority remains the safety and health of all employees, volunteers, cooperators, and others working for the Agency or on Forest Service lands.

Marcia Patton-Mallory
Station Director

In Memory

On September 20, 2004, Davita Bryant, a Station employee and member of our Forest Service family, was killed in a plane crash while in route to conduct vegetation inventory studies in the Bob Marshall Wilderness, Montana. Also killed were Electronics Technician Ken Good, an employee of the Flathead National Forest in Montana, and pilot Jim Long. Two other Station employees, Matt Ramige and Jodee Hogg, survived the crash.



Davita, age 32, was born in Pittsburgh, Pennsylvania. She graduated from Taylor Allderdice High School in 1989 and earned a Bachelor of Science degree in natural resources from Ohio State University in 1994. She began her forestry career as an intern with the Ohio Department of Natural Resources and advanced to Natural Resource Specialist. In 1995, she started her Forest Service career as a Forestry Technician for the Long Creek Ranger District in John Day, Oregon. She then worked for the Flathead National Forest in Montana before coming to the Rocky Mountain Research Station's Forest Inventory and Analysis Program in Ogden, Utah in 1999.

She married Brian Bryant, a Forester with the Station's Ogden unit, in 2001. She was promoted to Ecologist that same year and served in that position until her death. Davita was recognized throughout her Federal career for her outstanding efforts in inventory work. Most recently, she earned Certificates of Merit, a safety award, and extra effort awards. Davita embodied the young, energetic outdoorswoman. She loved skiing and being a part of the backcountry, whether working or playing in it. Her lasting legacy is a positive outlook on life and people. She had a knack for making everyone around her feel comfortable and at home. Friends are quoted as saying, "There wasn't a nicer person in the world."

"The mountains are calling and I must go." (John Muir)

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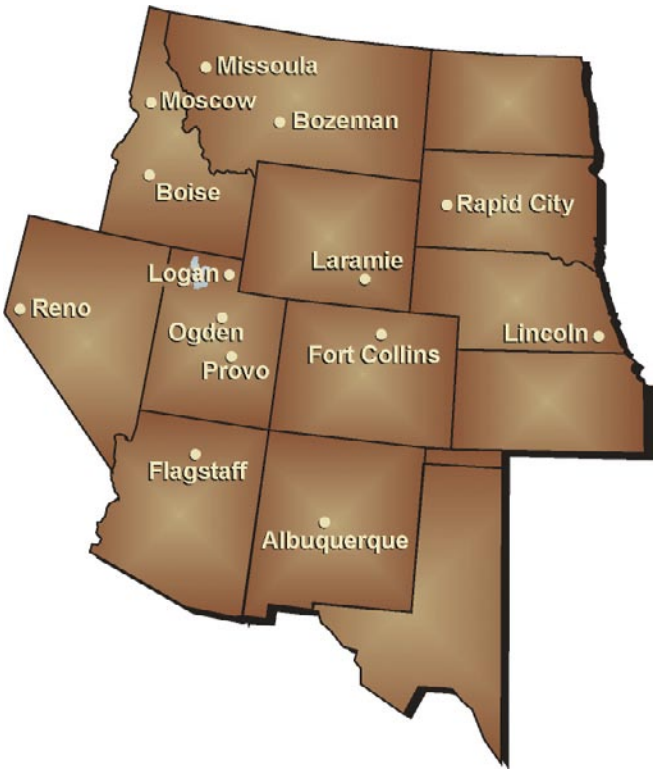
A Look at RMRS



The Rocky Mountain Research Station is one of six 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 14-state territory encompassing the Great Basin, Southwest, Rocky Mountains, and parts of the Great Plains. The Station employs nearly 500 permanent full-time employees, of which over 100 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 five ecosystem management and research partnership projects in Arizona, Colorado, Montana, New Mexico, and Nevada (see Ecosystem Management feature story on page 3).

Our research program serves the Forest Service as well as other Federal agencies, State agencies, international organizations, private groups, and individuals. Research results are made available through a variety of technical reports, journals, 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.

Our work is guided by the following:

- Quality science that is objective, unbiased, credible, and independent.
- Quality service that is responsive, timely, relevant, and customer-based.
- Quality relationships with partners and among employees.

Our scientists are working to:

- Provide knowledge on the productivity, risks, and uncertainties associated with ecosystem disturbances.
- Assist planners and managers to better assess social values and how to manage among conflicting values.
- Develop computer models and other tools that help managers understand fire behavior, wildland smoke, and their effects on ecosystems and communities.
- Evaluate the dynamics of a healthy environment and provide guidelines for resource specialists to ensure the sufficient availability of clean water and air.
- Develop guidelines for land managers and policymakers that help restore and maintain wildlife and fish habitats.

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 understand it and use it effectively. As we disseminate information, we solicit feedback as to its relevance and usefulness, monitor the success of our communication efforts, and adapt strategies as needed.

Administration and Support Services Staffs

Station scientists rely on a contingent of administrative and technical personnel who support the Station's research program. 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 and Technology Applications; Acquisition Management; Information Resources Management; Facilities Management; Financial Management; Human Resources; Library; Publishing Services; Safety, Health and Environment; Senior, Youth and Volunteer Program; and Statistics.

Director's Office Staff

Station Director: Marcia Patton-Mallory
Deputy Station Director: John Toliver
Assistant Station Directors for Research:
Alison Hill
Janine Powell
Jim Saveland
Jack Waide (transferred to U.S. Geological Survey in Fall, 2004)
Assistant Station Director for Operations:
Galen Hall

"We wanted to let you know what a great help Louise Kingsbury's Publication's Shop has been to Region 4 Fire Management. Recent examples include the distribution of A Study in Repeat Photography *from your Fort Collins center, and Nancy Chadwick's excellent design and layout of* The Cascade II Prescribed Fire Review Report. *If we go back a few more years, the list would be longer. We truly appreciate this teamwork and extra effort." (Regional Fuels Specialist, Intermountain Region, USDA Forest Service, Ogden, Utah)*

Ecosystem Management: A Sound Approach to Multiple-Disciplinary Research

In 1993, the Forest Service initiated a series of Ecosystem Management Projects across the United States. These projects were designed to integrate science with the needs of land managers, landowners, and users, providing an ecological approach to natural resource management that assures productive, healthy ecosystems by blending social, economic, physical, and biological needs and values.

An ecosystem approach is based on whole ecosystem function, rather than on single elements or species in isolation. Management objectives blend long-term needs of people and environmental values so the land will support diverse, productive ecosystems and sustainable ecosystem processes. Rather than mimic nature, the ecosystem approach uses nature's examples to make intelligent decisions. It fosters an expanded attempt to consider whole, natural systems, how they function and how human activities affect and are affected by them.

During 2004, the Rocky Mountain Research Station maintained five Ecosystem Management projects:

- Ecology, Diversity, and Sustainability of Soil, Plant, Animal, and Human Resources of the Rio Grande Basin (Albuquerque, New Mexico)
- Achieving Ecosystem Management in the Borderlands of the Southwestern United States through Research and Management Partnerships (Flagstaff, Arizona)
- Restoring and Maintaining Sustainable Riparian Ecosystems (Reno, Nevada)
- Bitterroot Ecosystem Management Research Project (Missoula, Montana)
- Research on Sustaining Social, Biological, and Physical Components of Colorado Front Range Ecosystems (Fort Collins, Colorado)

The Rio Grande Basin

Rio Grande Basin (New Mexico) ecosystems have evolved under human influence for at least 12,000 years. Since 1540, the Middle Basin has experienced increasing environmental and socioeconomic changes, including urban population growth, invasion of aggressive exotic plants, water development, changes in rural economic patterns, shifts in public values, and endangerment of riparian species. The Rio Grande Basin program, based in Albuquerque, New Mexico, generates and shares knowledge and

Equipment to monitor ground water level response to salt cedar removal is installed along the Rio Grande Basin.

methods to maintain the ecological health and diverse cultural and economic values of native grasslands, shrublands, and woodlands of this region. Working with over 30 stakeholders, the program coordinates and implements research designed to solve environmental and sociocultural problems in the Basin, with emphasis on sustaining rangeland health, riparian productivity, fish and wildlife populations, archaeological sites, and human values and needs.

Scientists determine short-term and long-term responses of upland soils, water, nutrients, mycorrhizae (a beneficial root fungus), and vegetation to historic and current changes caused by such factors as climate, grazing, fire, fuelwood cutting, recreation, and farming, and clarifying how such responses influence the dynamics, stability, and productivity of upland ecosystems.

Work is underway to determine the processes within stream and river ecosystems that form major linkages between upland watersheds, the Rio Grande River, and its floodplains. How plant and animal species respond to barriers in dispersal, migration, and reproduction along the Rio Grande and its tributaries is also being investigated.

Scientists are also gaining a better understanding of the environmental history of the Rio Grande Basin, the historic and contemporary human role in Basin ecosystems, the nature and extent of early human disturbances to the Basin, and the sustainability of cultural diversity in the Basin.

Results of fuel studies help land managers prevent the spread of wildfire in riparian woodlands. Research is testing three methods for reducing riparian fire fuels and restoring sites along the Basin. Studies also determine if removal of salt cedar and Russian olive reduces fire risk, preserves native trees, and improves habitats for wildlife, including reptiles, bats, and birds. Managers have used these data on fuels to leverage funds and justify salt cedar removal projects based on fuel loads.

In addition, new research is under way on past human-environmental interactions and landscape changes on the Sevilleta National Wildlife Refuge and the Cibola National Forest in New Mexico. Also, data from stratified alluvium (deposited sediment) along the Rio del Oso River in New Mexico are being used to reconstruct the long-term environmental and human land use history of the valley. Such information will be critical for future land use planning and other needs. Additional information is available at http://www.fs.fed.us/rm/albuq/rwu4652.htm.

Achieving Ecosystem Management in the Borderlands

The Borderlands project area is located in the Madrean Archipelago, a region of exceptional biological diversity and great biological and geographic interest. The Madrean Archipelago is that portion of the Basin and Range Physiographic Province south of the Rocky Mountains and north of the Sierra Madre Occidental in southeastern Arizona, southwestern New Mexico, northeastern Sonora, and northwestern Chihuahua, Mexico. The vegetation of this region is a diverse mixture of endemic Rocky Mountain and Madrean desert, savanna grassland, montane, and subalpine species. The area is one of the most floristically diverse areas in North America. Individual mountain ranges may support up to 1,000 native species. Animal diversity in the area is also exceptional. There is considerable concern for threatened, endangered, and sensitive species and the potential effects of natural disturbances and management strategies on these populations and associated habitats.

The program's geographical area is under multiple ownership and administration, with 53 percent in private ownership, 23 percent in State ownership, 16 percent in the Coronado National Forest, 7 percent by the Bureau of Land Management, and 1 percent by the U.S. Fish and Wildlife Service. This complex ownership pattern results in a unique partnership effort in adaptive ecosystem management among private landowners, and State and Federal land management agencies.

Scientists based in Flagstaff, Arizona, are working on three major objectives: 1) develop and understand the effects of rangeland health restoration

techniques, including mechanical treatments and prescribed fire, and interactions with grazing management strategies on the components of Borderlands grassland, savanna, and woodland ecosystems; 2) understand the effects of fire at landscape levels on Borderlands ecosystem components; and 3) develop and evaluate integrated and cost-effective methods to monitor Borderlands ecosystems.

In 2003, the project, in collaboration with the University of Arizona, was the key sponsor of the conference honoring the Santa Rita Experimental Range's 100-year history of accomplishments and contributions to rangeland ecology and management in the Southwestern United States. The conference and proceedings represent a starting point for planning and implementing a research program that provides knowledge for future improved, ecosystem-based, multiple use rangeland management. Santa Rita, located in southern Arizona, is the longest continuously operating research area dedicated to the sustainable management of North American rangelands.

The Borderlands project was a key sponsor of the international conference "Connecting Mountain Islands and Desert Seas: Biodiversity and Management of the Madrean Archipelago II and 5th Conference on Research and Resource Management in the Southwestern Deserts." The event focused on the future health of the Madrean Archipelago of the Southwestern United States and Northern Mexico as we enter the 21st century. The project also helped sponsor the "Toward Integrated Research, Land Management, and Ecosystem Protection in the Malpai Borderlands" conference. This Douglas, Arizona, meeting was held to inform the scientific, land management, and local communities of research progress. The proceedings were published as Rocky Mountain Research Station Proceedings 10.

Scientists and collaborators at the University of Arizona and Israeli Agricultura Research

Scientists study the use of high intensity fire to thin juniper woodlands in the Madrean Archipelago.

Organization have completed studies on the transpiration of dryland oaks. Transpiration is a critical and often unknown factor in the hydrologic cycle of arid and semi arid woodlands and savannas. Research results help plan and understand watershed treatments.

The project conducts a long-term program of research and monitoring to understand the role of fire as an important management tool used to restore natural vegetation composition, structure, and processes in semi arid grasslands and woodlands. This information was used by the Coronado National Forest to ignite and manage the 46,500-acre Baker II burn. The ability to use fire as a restoration tool on public and private lands at this scale is unprecedented.

A major study of fire and grazing interactions is ongoing on a private ranch in New Mexico. The study, in collaboration with several partners, is developing an understanding of the role of fire and interactions with grazing in restoring and maintaining semi arid grasslands, and determining the interactive effects of fire and grazing both separately and in

combination on the structure, composition, and productivity of these grasslands. Learn more at http://www.rmrs.nau.edu/lab/4651/.

Great Basin Project

The Great Basin of the Interior Western United States is big and diverse. It occupies most of the State of Nevada, the western third of Utah, as well as portions of California, Idaho, Oregon, and Wyoming. The landscape is dotted with more than seventy basins that receive the input of rivers and streams from the surrounding mountains. Interspersed in the landscape are ribbons of riparian vegetation that, while occupying only 1 percent of the land surface, are inordinately important for sustaining the biodiversity of plants and animals, as well as for humans because water is such a scarce commodity across this region. An estimated 50 percent or more of these riparian areas are in poor ecological condition. The ongoing deterioration concerns land managers and other stakeholders because, not only are riparian areas important components of all landscapes, but in the semiarid Great Basin, they constitute an especially vital resource, supplying water for both domestic and agricultural uses, forage and browse for wildlife and livestock, and recreational opportunities. In addition, they serve as the foundation for much of the region's biodiversity. Today, various municipalities throughout the Great Basin are among the fastest growing in the United States, the little available farmland is being subdivided for housing, and the constant call for more water continues. The past and present uses of riparian areas have left marks that signal a degree of degradation that suggests that the land cannot continue to support sustainably the inevitable increase of human activities into the future.

Riparian areas of the Great Basin support an abundance of plant and animal life.

The Restoring and Maintaining Sustainable Riparian Ecosystems project, based in Reno, Nevada, and working in collaboration with the Humboldt-Toiyabe National Forest, was initiated to address the problem of stream and riparian ecosystem degradation within the central Great Basin. The project uses an integrated, interdisciplinary approach to increase understanding of the effects of climate change and early human disturbance on riparian areas, and to clarify the connections among watershed and channel processes, and riparian ecosystem dynamics. Scientists work to: 1) determine the effects of long-term climate change processes and short-term natural and early human disturbance on central Nevada watersheds, riparian corridors, and riparian ecosystems; 2) determine the succession and recovery potentials of key riparian ecosystems exhibiting disturbances and varying levels of degradation; 3) develop criteria for evaluating the effects of changes in management or restoration activities on watersheds and riparian ecosystems; 4) evaluate the use of high resolution, low-altitude video imagery for rapidly assessing riparian ecosystem functions; and 5) evaluate specific management techniques for restoring or maintaining watershed and riparian ecosystem integrity.

Research sheds light on the effects of climate change and early human disturbances. This work provides valuable insights into the succession and recovery potentials of our key riparian ecosystems, and into the development of criteria for evaluating the effects of management or restoration treatments on watersheds.

Working models have been developed based on vegetation soils and hydrologic data from permanent study sites. This information has been used by the Humboldt-Toiyabe National Forest to classify central

Nevada riparian ecosystem types, used by managers to clarify questions regarding successional and ecological status in these ecosystem types, used to evaluate recovery potential and restoration scenarios, and has served as the basis for additional research needs.

Major progress has been made in evaluating the usefulness of low-altitude, high-resolution video imagery for assessing riparian ecosystems. A GIS tool was developed that addresses the effects of land patterns and disturbance on stream and vegetation dynamics. An additional study provides managers with an evaluation of the various remote sensing tools available, their resolution, and the tradeoffs among them in terms of precision and cost.

Project scientists develop restoration methods for key riparian meadows. Research results are used to prescribe restoration methods for these ecosystem types.

The project has developed a demonstration area on ecosystem response to watershed-scale burns in pinyon-juniper ecosystems. Results guide fuels and fire management efforts in Great Basin woodlands.

Finally, research results have been published in a Society for Ecological Restoration book, issued by Island Press, titled *Great Basin Riparian Ecosystems: Ecology, Management and Restoration*.

Fire crews conduct prescribed burns to reduce fire hazard in a ponderosa pine stand.

The publication outlines a model for conducting interdisciplinary watershed research, and the linked studies on climate history, geology, hydrology and ecology have broad-scale implications for riparian ecosystem management. Find out more about the Great Basin Project at http://www.ag.unr.edu/gbem/.

Bitterroot Ecosystem Management

The Bitterroot Ecosystem Management Research Project, based in Missoula, Montana, addresses questions regarding the social, biophysical, and management challenges of applying ecosystem management principles on National Forest System lands. The project focuses on the Bitterroot National Forest, a complex of grassland, forest, and alpine ecosystems in western Montana and northeastern Idaho. The past century has seen major changes in animal populations and a decline in seral (stages of plant succession and growth) tree species on the Forest, as well as an increase in the potential for severe wildfire at lower elevations. The Forest curves like a horseshoe around a valley that is transitioning from agricultural to urban – an area that is currently one of the fastest growing in the United States. Forest managers are entrusted to protect species and diversity on this landscape, and provide commodities and other benefits to the public. This project addresses these issues through a science-management partnership. Participants include scientists from the Rocky Mountain Research Station and the University of Montana, along with managers from the Bitterroot National Forest and the USDA Forest Service's Northern Region.

Importance is placed on integrating and synthesizing knowledge about the land, its waters, wildlife, and people at landscape scales. The role of public participation and collaboration in determining long-term strategies for managing these ecosystems

is emphasized. The project identifies options, assesses feasibility, and develops information to help understand the consequences of management strategies.

Scientists work on five research objectives: 1) understand and manage changes within the landscape by developing and integrating vegetation, fauna, and aquatic information; 2) increase the efficiency of landscape analyses and assessments, adaptive management, and monitoring by developing integrative models; 3) propose and test potential solutions to social, administrative, and environmental barriers to implementing ecosystem management; 4) explore collaborative management across landscapes of diverse ownerships and land-use classification; and 5) develop and assess techniques for technical communication among researchers, managers, and the public.

Researchers have developed models that help resource specialists analyze alternative restoration, forest health, and fuel treatment strategies, along with ecosystem management learning sites that help managers understand forest change with various fuel and restoration treatments. Studies show that thinning and underburning can improve the health and vigor in old growth ponderosa pine and larch stands when undergrowth competition is severe. Research results also point out the effects of weeds and biological control agents on native plants, small mammals, the food chain, and hantavirus. For additional information, visit http://www.fs.fed.us/rm/ecopartner/.

Colorado Front Range Ecosystem Management

The Colorado Front Range of the Rocky Mountains comprises diverse ecological systems including alpine, subalpine, montane, woodland, and grassland, with associated riparian (near water) corridors and aquatic systems. A human population of 3 million lives in or adjacent to the area in diverse settings, ranging from isolated mountain homes, ranches, mountain subdivisions, and small communities, to major urban centers. The area offers a wide range of goods and services generated both by human infrastructure and wildland ecosystems. There is an increasing demand for these goods and services, not only from the local populace, but also from the rest of the United States and other countries. Human impacts have been significant and are projected to increase as both demand and populations grow. All of these factors conspire to create serious problems for those charged with managing these ecosystems, as evidenced by both increasing decline in the health of Front Range ecosystems, and by increasing public awareness of this decline.

The research program, titled the Colorado Front Range Ecosystem Management project, which was based in Fort Collins, Colorado, was merged into another Rocky Mountain Research Station project in 2004. Research continues to provide information that will help develop strategies for managing these ecosystems in a mix of ownerships. Strategies are designed to produce desired goods, services, and environmental values at levels that sustain ecological systems while providing special emphasis on humans and their interactions with the environment.

The project evolved through a series of intra-agency meetings involving the USDA Forest Service's Rocky Mountain Region, the Rocky Mountain Research Station, and the Arapaho and Roosevelt and Pike and San Isabel National Forests. This effort also involves a coalition of local, County, State and other Federal agencies.

Research results help guide restoration treatments in ponderosa and Douglas-fir forests throughout the Front Range. Using prescriptions developed by scientists, over 17,000 acres have been treated or are scheduled for treatment on the Pike National Forest alone.

Scientists with the project also helped initiate the Forest Service's Rocky Mountain Center (RMC) (http://www.fs.fed.us/rmc) that provides comprehensive, real-time, high-resolution fire weather intelligence and smoke forecasts for the Interior West, including three western fire

Geographical Coordination Center regions. RMC is funded by the National Fire Plan, the Rocky Mountain Research Station, and the NOAA Forecast Systems Laboratory in Boulder, Colorado, and is part of a national consortium (http://www.fs.fed.us/fcamms). Located in Fort Collins, Colorado, RMC provides critical information to fire managers, incident commanders, and air resource specialists during times of intense firefighting and prescribed burning.

Strategies are being developed to help manage ecosystems along Colorado's Front Range.

National Fire Plan Research Update

Years of fuels buildup, coupled with drought conditions, insect infestation, disease, and fire suppression, have left forests and grasslands in many areas vulnerable to intense and uncharacteristically destructive fires.

The Forest Service is one of several Federal, State and local agencies responding to this challenge through the National Fire Plan by addressing four strategic goals: firefighting capacity, rehabilitation and restoration, hazardous fuels reduction, and community assistance.

The Rocky Mountain Research Station, a world leader in wildland fire science, is supporting the National Fire Plan on several fronts:

Firefighting

National Fire Plan research in the area of firefighting capacity is producing new tools to improve firefighting preparedness through better risk assessment methodology, better tools for resource allocation, and improved fire weather and smoke dispersion modeling. Researchers are working in partnership with fire managers to apply these tools and make them widely available to firefighters.

- Scientists at the Fire Sciences Laboratory in Missoula, Montana, work on a nationwide fire monitoring system that uses satellite data to monitor factors such as active fires, fire severity, and smoke concentrations and dispersions, and allows reporting of data with only a 2-4 hour delay. This real-time fire information helps fire managers develop fire attack strategies and make resource allocation decisions. Active fire locations and fire perimeter information was provided to the Northern Rockies Multi-Agency Coordination Group during recent severe fire seasons in Montana and Idaho. The daily nationwide fire maps also were sent to the National Incident Information Center, as part of the Forest Service's briefing materials to the White House, Congress, and other Federal agencies.
- Particulates emitted by wildfires and prescribed fires can severely affect visibility and air quality resulting in car accidents, airport and road closures, and public health problems. Scientists in Missoula develop mobile instruments that can take real-time measurements of particulate concentrations over a large area. This information

Science findings help fire managers develop fire attack strategies and make resource allocation decisions.

enables managers and public officials to assess and predict effects on visibility and air quality, allowing for better preparation for these events. This is one of several projects working to better understand and predict smoke movement under different environmental conditions.

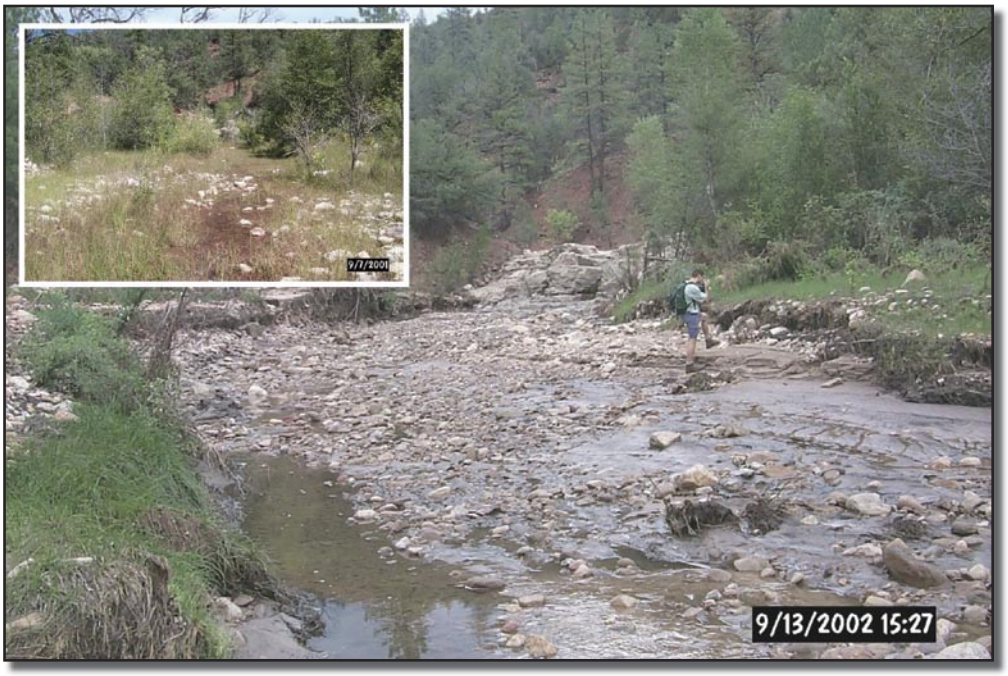
- Researchers used computer models to help managers on the Bitterroot National Forest schedule fuel treatments to meet management objectives and identify tradeoffs associated with choosing one type of fuel treatment over another.
- Wildfire resource deployments and prescribed burn "go/no-go" decisions depend on detailed weather intelligence. In response, the Station created and supports the new Rocky Mountain Center – a team of specialist who operate a computer modeling system that provides real-time, high-resolution weather intelligence over the Interior West. Based in Fort Collins, CO, RMC assists in fire and smoke management through regional simulations of specific fire-weather phenomena, including fire danger, fire behavior, and smoke dispersion. RMC products are specifically tailored to meet operational needs of fire managers, incident commanders, and air-resource smoke specialists during periods of intense firefighting and prescribed burning. Information, tutorial, and products are available at www.fs.fed.us/rmc.
- Fire Sciences Laboratory personnel developed and implemented the Fire Effects Planning Framework (FEPF) program that identifies where and under what conditions fire may create benefits or pose threats to ecological conditions or management targets, addressing the need to integrate fire management with land management planning. FEPF enables users to identify and prioritize areas needing fuel treatment, and then evaluate the effectiveness of fuel reduction strategies for meeting long-range management objectives. FEPF provided planning and tactical assistance to managers on the Bitterroot National Forest in Montana to help update their fire management plan.
- Scientists examine the relationship between fire, exotic plants, and bio-control agents. Research results show that the roots of exotic knapweed plants treated with a bio-control agent produced increased amounts of a natural herbicide, thus potentially inhibiting the growth of native grasses. Such findings could dramatically change the way managers practice post fire weed control and rehabilitation.
- Researchers developed methods for collecting data on the importance that residents place on areas being considered for fuel treatments, and then mapped this information so it can be used in landscape planning models. As a result, a GIS map of social values was produced and is being used to plan fuel treatments that simultaneously meet ecological and social objectives.

"We are excited about the visual weather analysis and forecasting products that your Rocky Mountain Center is putting out as a technology transfer product. Such applications are an invaluable resource that helps explain and demonstrate potential weather effects to fire managers. The latest product on your website, the Colorado Front Range wind analyses in real-time, is one of the best products and best examples we've seen of taking what's possible by stretching today's computer resources and delivering very useful information to field users. Congratulations specifically on that product! We want it for Montana and North Dakota." (Assistant Fire Weather Program Manager, Northern Rockies Coordination Center, Missoula, Montana)

Rehabilitation and Restoration

Minimizing postfire erosion and flooding damage, and helping native vegetation recover in burned areas, are critical National Fire Plan objectives.

- Following the recent Rodeo-Chediski wildfire, the largest in Arizona history, scientists at our Flagstaff, Arizona, laboratory teamed with the White Mountain Apache Tribe to better understand the effects of wildfire on riparian wetlands. To help rehabilitate and protect these areas, researchers placed rock formations within stream channels to encourage the retention of fine sediments and speed the growth of wetland plants. As a consequence of this and related work, the Tribe's wetland managers have successfully applied for grants to begin treatments at the most severely impacted sites. Scientists have also trained tribal staff in field techniques to monitor the outcomes of treatments, and are raising culturally and ecologically important wetland plants to speed the recovery of Tribal wetlands.
- Studies helped to evaluate the effects of the Three Forks Fire on fish in the White Mountains of Arizona. Streams are home to both native and non native fishes. Flagstaff laboratory scientists were part of a team that established a number of monitoring sites to evaluate post runoff impacts of the fire on aquatic life and channel conditions. Results are helping us understand how streams respond to wildfires throughout the Southwest.
- The Station published *Wildland Shrubs of the United States and Its Territories: Thamnic Descriptions: Volume I*, General Technical Report RMRS-GTR-26. This report provides general characteristics of 311 shrubs, including short monographs with general descriptions, ranges, ecology, reproductive habits, growth and management, and benefits to humans, animals and the environment. Many of these species are used to restore and rehabilitate ecosystems following wildfire.
- The Station's "Fire and Aquatic Ecosystems" Web site (www.fs.fed.us/rm/boise/teams/fisheries/fire/firehome.htm) has been updated with links and resources from multiple research projects. Information from this site is being used in regulatory consultation, forest planning, and burned area emergency rehabilitation planning.



Scientists in Flagstaff, Arizona study the effects of wildfire on riparian ecosystems. The inset photo shows a stream before the Rodeo-Chediski wildfire, supporting healthy populations of native fishes and wildland plants. Post fire floods scoured the severely burned canyon, which now needs rehabilitation.

- Scientists at our Boise, Idaho, laboratory developed the Fire Enhanced Runoff and Gully Initiation model that estimates probabilities of runoff and gully formation after fire and fire mitigation efforts. The model allows managers and specialists to estimate expected changes in runoff/erosion, given information on fire severity, selected treatments, and a range of possible climatic events. The model will help managers determine where significant benefits from proposed treatments can be realized and where efforts may be wasted. The Web version has been used in field applications with individual forests, saving literally millions of dollars in avoided costs. The final version has not yet been released.
- Researchers at our Flagstaff, Arizona, laboratory authored *Postfire Mortality of Ponderosa Pine and Douglas-fir: A Review of Methods to Predict Tree Death*, General Technical Report RMRS-GTR-132. This paper is a review of published literature designed to provide land managers with guidelines for measurements that are most useful in predicting whether or not ponderosa pine or Douglas-fir trees will survive following wildfires or prescribed burns.

Hazardous Fuels Reduction

New investigations are under way to facilitate fire risk assessment, anticipate treatment impacts, and develop new uses and systems for harvesting forest undergrowth and small diameter trees. Modeling and mapping efforts are helping determine where the most dangerous fuel buildups currently occur and predict where they will occur in the future.

- Studies based out of our Provo, Utah, Shrub Sciences Laboratory focus on rush skeletonweed population dynamics and invasion into burned and unburned sagebrush and cheatgrass ecosystems in Idaho and Oregon. Research results, which have been presented to land managers at various conferences and meetings, are providing insights into their ability to spread following wildfires and methods for controlling them.
- On the Tenderfoot Creek Experimental Forest in Montana, studies are providing managers with information on how thinning and prescribed burn treatments affect insect populations and behavior, and their effects on reproduction of understory vegetation. Additional studies at Tenderfoot Creek focus on post treatment surveys of noxious weeds along road corridors and within prescribed burn and non burn treatments. Findings provide

Researchers are developing guidelines for reducing fuels in overcrowded forests. Before (top photo) and after selective thinning and prescribed burning treatments in a ponderosa pine forest.

information for fuel treatment planners in regards to potential weed infestation.

- Research at our Moscow, Idaho, laboratory is defining the role of fungi in forest health and sustainability after fire suppression. Outcomes of this study provide baseline information that help determine the impacts of prescribed fire, thinning, and wildfire on belowground fungi and their roles in nutrient cycling, moisture retention, and protection from other pests.
- Scientists in Fort Collins, Colorado, helped develop the report *A Strategic Assessment of Forest Biomass and Fuel Reduction in Western States* that addresses the issues of forest biomass and fuel reduction needs in the West. Results of this effort help resource managers explore the impacts of alternative thinning strategies for forested areas.
- In the Black Hills of South Dakota, investigations center on the biology and ecology of woodboring insects. Scientists examine various insect traps and chemical attractants for monitoring woodborer populations, and compiling the first complete list of woodborer species in the Black Hills. Sampling is conducted following fires of various intensities and ages to examine habitat preferences and develop sampling approaches. Findings improve land managers' abilities to sample population dynamics, detect trends, and identify management options.
- At our Manitou Experimental Forest in central Colorado, studies show that soil microbes are highly sensitive to forest fires, altering both the composition and abundance of organisms for at least 2 years after fire. Studies provide tools to assist land managers in the use of prescribed fire to benefit ecosystems and reduce the potential for harm by examining how the soil's physical properties and different fuel amounts and loading densities influence soil recovery and forest regeneration after fires.

Community Assistance

Station researchers work to provide managers with information they can use to help communities increase their wildfire preparedness. Other research focuses on understanding individuals' beliefs, attitudes, and knowledge related to fire and fuels management treatments.

- Scientists in Fort Collins, Colorado, conducted workshops with homeowners who were affected by large wildfires in Oregon and Colorado. The workshops focused on the types of wildfire mitigation efforts that the homeowners used prior and subsequent to the fires. Results of the workshops were presented at conferences on wildfire risk.
- The Station helped organize a workshop in Santa Fe, New Mexico, that addressed Wildfire and Fuels Management: Risk and Human Reaction. Proceedings of the workshop will be published in 2005.
- At our Albuquerque, New Mexico, laboratory, researchers gather historic and contemporary information on public knowledge, beliefs, attitudes and practices related to fire use and fuels management in the Southwest, and provide this information to land managers in a user friendly format. Scientists also examine the factors contributing to successful public involvement approaches for fire and fuels management planning. Results will help managers design and implement successful, socially acceptable fire and fuels management policies and programs.

Studies help us understand people's beliefs, attitudes and knowledge related to fire and fuels management.

Joint Fire Sciences Program

In addition to supporting the National Fire Plan, Station scientists were awarded 14 projects in 2004 from the Forest Service/Bureau of Land Management co-funded Joint Fire Sciences Program.

The support for fire research enables the Forest Service R&D branch and its cooperators to accelerate research efforts and speed development and delivery of technology transfer products and tools to the field.

For more information on the Joint Fire Sciences Program, visit http://jfsp.nifc.gov.

Accomplishments

During 2004, the Rocky Mountain Research Station:

- Produced 1,013 technical publications and journal articles (a partial listing is available on the Station's Web site at www.fs.fed.us/rm/main/pubs.html).
- Provided 154 tours to educational and professional groups.
- Presented 209 short courses and training sessions to educational and professional groups.
- Offered 787 invited presentations before scientific organizations.
- Presented 167 audiovisual presentations on research findings.
- Gave 188 presentations to lay audiences.

Examples of International and Significant National Accomplishments Include:

- The Station was a co-sponsor of the Monitoring Science and Technology Symposium, held in Denver, Colorado. The event brought together hundreds of policymakers, natural resource managers, and scientists from more than 20 countries to address issues and opportunities surrounding environmental monitoring for sustainability.
- A Fort Collins scientist was invited to spend a week at the York office of the Stockholm Environmental Institute in the United Kingdom where he helped develop an ozone deposition model for use with the United Nations Economic Commission for Europe Convention on the Long-Range Transboundary Air Pollution program.
- A scientist with the Aldo Leopold Wilderness Research Institute in Missoula, Montana, spent 3 weeks in Durban, South Africa, as part of the Forest Service delegation to the 5th World Parks Congress. The event attracted more than 3,000 participants from 154 countries.
- The National Agroforestry Center in Lincoln, Nebraska, conducted a 3-day workshop for senior administrators from the Ministry of Water Resources of the People's Republic of China. The workshop was in response to a memorandum of understanding between USDA and China.
- A scientist based at our Albuquerque, New Mexico, laboratory was invited to attend the World System History and Global Environmental Change conference in Sweden where he presented a plenary address titled "Social and Ecological Systems in Convergent Evolution: Local Impacts of World Systems."
- The Southwest Forest Sciences Complex in Flagstaff, Arizona, hosted Dr. David Watson of Charles Sturt University in New South Wales, Australia. The visit was a catalyst for future collaborative research on dwarf mistletoes.
- A National Agroforestry Center scientist in Lincoln, Nebraska, served as the U.S. representative on a 25-member United Nations Ad Hoc Technical Expert Group on Biological Diversity and Climate Change. The group's effort resulted in a 154-page U.N. Convention on Biological Diversity report titled *Interlinkages Between Biological Diversity and Climate Change*, available at www.biodiv.org/doc/publications/cbd-ts-10.pdf.
- Fort Collins, Colorado, scientists hosted a group of senior researchers from the national Forestry and Forest Products Research Institute of Japan to discuss the Station's research and development in forest inventories and carbon estimation.
- A Station scientist with the Aldo Leopold Wilderness Research Institute in Missoula,

Montana, was invited to Parks Canada national headquarters in Ottawa, Ontario, to provide a summary of results from research conducted in the far Eastern Arctic of Canada. The Institute's research in social sciences is contributing to management plans in Canada's national parks.

- Three Station scientists were selected as members of the Forest Service's National Wildlife Monitoring Steering Committee. The group recommends nationally consistent approaches to monitoring terrestrial animal species and their habitats as part of the Agency's land and resource management plans.
- Scientists with our Boise, Idaho, laboratory traveled to Concepcion, Chile, to facilitate a workshop to help manage and conserve the Biobio River ecosystem. The event (www.eula.cl) highlighted key issues facing managers of developed river systems and presented key scientific principles that are useful for understanding the effects of river management.
- Our Boise, Idaho, laboratory hosted Russian Forestry Service and university officials as part of a State Department sponsored exchange supporting international cooperation and understanding in managing Russian forests.
- A scientist with our Flagstaff, Arizona, laboratory was an invited keynote speaker at the European Geosciences Union 1st General Assembly in Nice, France. His presentation was part of a special Soil Systems Sciences session on the effects of fire on soils.
- A scientist with the Aldo Leopold Wilderness Research Institute in Missoula, Montana, traveled on invitation to the Finnish Forest Research Institute and the Finnish Natural Heritage Services in northern Finland to speak at the Nordic and Baltic Workshop on Visitor Information Needs and Monitoring Methods. He was also an invited speaker at the Second International Conference on Monitoring and Management of Visitors in Recreational and Protected Areas.
- A Moscow, Idaho, scientist traveled to Switzerland to work with the Swiss Federal Research Institute on joint study plots that examine the impacts of cattle and sheep grazing on plants and carbon.
- The National Agroforestry Center in Lincoln, Nebraska, was a sponsor of the 1st World Congress on Agroforestry, held in Orlando, Florida. Station scientists served as presenters, coordinators, and instructors. More than 500 people from 82 countries attended.
- Our Flagstaff, Arizona, laboratory hosted visitors from the University of Alicante, Alicante, Spain, for a 2-month stay to learn about the Station's research on fire in the Southwestern United States.

Research Highlights

Understanding that "Special Place"

Concepts such as home and community imply an enduring and deeply emotional relationship to a place, and people often form similar bonds with specific sites on public forests and wildlands. These bonds may grow simply from frequent use of a particular place in a forest, or because some place has come to symbolize something important about a person's identity. With increasing public interest and involvement in natural resource decision making, land management agencies need to develop measures and assessments of these emotional and symbolic meanings and attachments, as well as develop an understanding of how these meanings and values shape, and are shaped by, social and ecological changes across the landscape. Such assessments are particularly relevant in situations where there is a wide divergence of values and perspectives among stakeholders regarding appropriate management. Research is advancing our understanding of how recreation activity contributes to psychological well-being; how attachments to places contribute to a sense of meaning, identity, and community; how attachments vary across culture and affect local management; and how place meanings and attachments affect natural resource conflicts.

Fort Collins scientists developed standardized questionnaires designed to measure place attachment among recreation site visitors and community residents. These questionnaires allow other investigators to describe and measure the nature and depth of meanings and attachments people have for places or landscapes at a range of geographic scales from campsite to community. They also help identify stakeholder groups with differing degrees and forms of attachment that may form the underlying basis of conflict between competing groups over natural resource management decisions. Versions of these questionnaires have been adopted and applied by numerous other investigators in studies of National Parks, Wilderness areas, National Forests, and resource-dependent communities, both nationally and internationally. This work on measuring symbolic meanings and emotional attachments to natural landscapes has been widely adopted by researchers in the United States, and is increasingly being incorporated into agency planning assessments and management practices such as the Forest Service's Recreation Heritage program, Wilderness Resources Plan Revision Technical Guide, and other agency planning assessment technical guides. Place assessment approaches are also being used by land mangers to enhance scenic quality assessments, develop a technical guide to assist recreation managers with the Federal Energy Regulatory Commission hydropower relicensing process, and to map public values in fuel treatment planning.

Recent publications and other information on the use of the place attachment measurement are available on the Web site: (http://www.fs.fed.us/rm/value/research-place.htm).

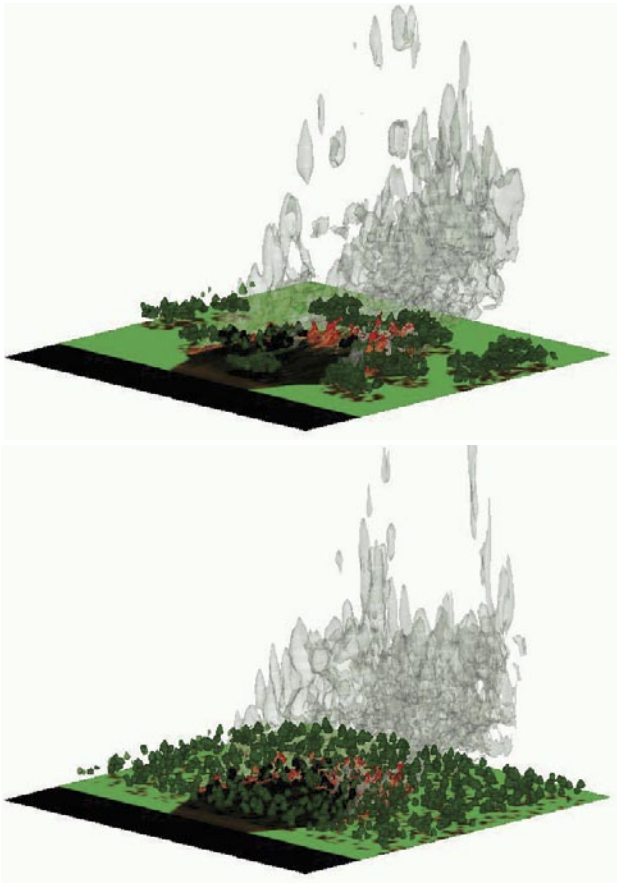
A New Wildfire Behavior Model for Use in the Southwest

Improved predictive models of fire behavior are needed to support forest fuels reduction activities and wildfire mitigation efforts, plan for prescribed burns, preventative training, and to assess postfire effects. Advancements in wildfire models can dramatically increase our ability to anticipate and respond to fires in situations composed of a variety of live and dead fuels with complex topography and fire-influenced winds. In addition, there is a pressing need to link fire behavior models to postfire effects and mitigation treatments that affect soil erosion, chemistry, productivity, and revegetation.

Station scientists in Flagstaff, Arizona are collaborating with the Los Alamos National Laboratory, Northern Arizona University, Pacific Southwest Research Station, and New Mexico State University to further develop, validate, and refine a new physical-process wildfire model called FIRETEC. Originally developed at Los Alamos National Laboratory, FIRETEC is the first physics-based, three-dimensional model designed to simulate the constantly changing, interactive relationship between fire and its environment. The model includes representation of the coupled interactions between fire, fuels, atmosphere, and topography on varying scales ranging from within forest stands to a landscape scale. Collaborators are working to provide real-time data from prescribed burns on fuels management research areas west of Flagstaff that are part of a national study of the consequences of fire and fire surrogate treatments, supported in part by the Joint Fire Science Program and implemented by the Coconino National Forest and the Southwest Fire Use Training Academy.

Unlike current empirically based models, FIRETEC simulates the dynamic processes that occur within a fire and the way those processes relate to and alter each other. The level of resolution embodied in the model allows research and development in wildfire mitigation strategies to be conducted at fine-scale levels of detail in time and space.

Physical-process models that intimately couple topography-influenced atmospheric flows with physics-based fire models have demonstrated sensitivity to these more complex conditions and provide more accurate results over short periods. Due to computational complexity and fine-scale resolution, these process models are not currently capable of being implemented in real time situations.



FIRETEC output: Top graphic shows simulation of wildfire burning in a ponderosa pine stand with irregular groups of residual trees with only patchy mortality; bottom graphic displays simulation of wildfire burning in a ponderosa pine stand where all trees less than 28 cm diameter were thinned, resulting in reduced tree mortality.

However, with further validation and development from ongoing field experiments, these models can be used as training, planning, and risk assessment tools. More important, these models provide a critically needed tool for further development of simpler, computationally efficient wildfire behavior models for operational purposes. This effort also facilitates regional and national collaboration with other discipline scientists and managers interested in using fire behavior models to assess expected effects on vegetation, habitat, soils, and watershed condition.

Additional information is available in: Utility of a Physics-based Wildfire Model Such as FIRETEC. In: *Forest Fire Research and Wildland Fire Safety: Proceedings of the IV International Conference on Forest Fire Research*; Luso Coimbra, Portugal; 2002 November 18-23. Millpress, Rotterdam, Netherlands.

Studying Wildfire Behavior Using FIRETEC. *International Journal of Wildland Fire* 11: 233-246.

(In recognition of support provided toward development of FIRETEC, the Station was a co-recipient of a technology transfer award from the Federal Laboratory Consortium.)

Forests, Fish, and Fire

Land managers have been concerned for decades about the cumulative impacts of drought, floods, sedimentation, cattle grazing, nonnative fish introductions, and the presence of other foreign aquatic species on native fish populations. Earlier research by Station scientists demonstrated declines in native fish species in some streams in the past decade from 80 percent of the total fish numbers to less than 20 percent. Researchers believe the single most important factor in this decline has been the introduction of nonnative predatory game fish and other aquatic species such as bait fish, bullfrogs, and crayfish. Drought and flow diversions also present ongoing threats to native fish because of their impacts on habitat. No evidence shows that cattle and elk grazing have had an adverse effect on native fishes.

On the other hand, wildfires have emerged as a major threat to native fish populations. Wildfires have increased in numbers, size, and frequency in the past decade. In 1990, the largest wildfire in Arizona recorded history was the Dude Fire that burned just over 24,000 acres. The Hochderfer Fire in 1996 was double that at over 50,000 acres, and then the Rodeo-Chediski Fire of 2002 took a 10-fold leap to over 500,000 acres. Fisheries biologists with the Station's Flagstaff, Arizona, laboratory, along with several National Forests and faculty and graduate students from Northern Arizona University and Western New Mexico University, initiated studies to evaluate the effects of post wildfire flood flows, ash-laden slurries, and sedimentation on native southwestern fishes. In 2004, they jointly resampled three previous fires and initiated sampling on two new (2004) fires.

The most detailed results have come from the 12,500-acre Picture Fire of 2003 on the Tonto National Forest. Seven monitoring sites on a complex of three streams were sampled in 2003 and 2004. Three native species - the headwater chub, desert sucker, and speckled dace - inhabit the stream along with several introduced species. As a result of ash and flood flows, fish numbers decreased 54 to 93 percent at five of six sites, and all fishes were lost at one site. Resampling in 2004 revealed survival of all native species and a total absence of nonnatives. Water quality sampling documented extremely high levels of ash that injured all fish. A laboratory study, designed to determine lethal concentrations of ash in stream water on a number of native and nonnative species, was initiated at the Station's aquatic research facility in Flagstaff this year. To date, a half dozen papers and presentations and one symposium have resulted from studies. Results from this work prompted the Arizona Game and Fish Department to remove threatened fish from streams below the Aspen Fire on Mount Lemmon, near Tucson, last year and the KP Fire in 2004. Efforts are in progress to determine the effects of the 2004 KP and Three Forks Fire, Apache-Sitgreaves National Forest, on native fish and fish habitat.

Permanent sampling points on streams document changes in stream geomorphology, sediment characteristics, fish populations, invertebrate health, and water quality.

Find out more about this work in: Forests, Fish, and Fire: Relationships and Management Implications for Fishes in the Southwestern USA; and Forests and Fishes: Effects of Flows and Foreigners on Southwestern Native Fishes. In: *Forest- Land-Fish Conference II - Ecosystem Stewardship Through Collaboration*. Proceedings of the Forest-Land-Fish Conference II, April 26-28, 2004. Edmonton, Alberta, Canada.

Native and Introduced Fishes: Their Status, Threat, and Conservation; and Fish Habitats: Conservation and Management Implications. In: *Ecology and Management of Riparian Areas in the Southwestern United States*. Lewis Publishers, Boca Raton, FL.

Plantings Can Make Dollars and Sense

Nearly 70 percent of the United States, exclusive of Alaska, is held in private ownership by millions of individuals, making these lands a dominant player in determining the health of our nation's lands.

The incorporation of "buffer zones" (tree and shrub plantings) is a key strategy for mitigating water quality problems, sequestering carbon, providing valuable habitat for wildlife, and serving as critical niches for flora and fauna on private lands. Buffer zones also help individual landowners meet personal objectives, creating a win-win option for private lands natural resource management. Unlike on public lands, use of these buffers on private lands is determined on an individual landowner basis - a decision making process compassing a variety of factors ranging from environmental impacts to aesthetics. Economics are key determinants in the decision making process, making economic tools highly influential in the acceptance and adoption of these practices on private lands.

Does it make economic sense for landowners to install buffers with conservation cost-share programs? Can landowners earn income on buffers after these programs expire? Does removing an existing buffer make economic sense? Answering these questions is now easy with a new conservation buffer planning tool called Buffer$, a simple, spreadsheet-based application to assist landowners and planners in analyzing the cost-benefits of conservation buffers.

Developed by the National Agroforestry Center in Lincoln, Nebraska, as part of a Comprehensive Conservation Planning Methodology for natural resource management on private lands, Buffer$ can calculate potential income from a buffer using cost-share programs, growing agroforestry products, and incorporating other opportunities, such as hunting fees. To aid in decision making, the tool can compare the potential income generated between a buffer alternative and a cropping alternative. Using this tool, landowners and natural resource planners can also evaluate the economic impact of removing an existing buffer.

"When people can estimate the costs of changing their minds before they install a practice, we are more likely to see conservation on-the-ground ten years after installation." (Economist, Natural Resources Conservation Service)

Rain simulation studies help scientists and managers understand how buffer composition and width can impact water quality in buffers over time.

"Buffer$ allows me to quickly calculate an economic return on buffers, saving me valuable time with landowners." (Conservation Professional, Natural Resources Conservation Service)

Buffer$ is gaining popularity with conservation professions because it has an easy-to-use interface. It uses state average Natural Resources Conservation Service (NRCS) costs for installation and maintenance budgets, and county rental rates for calculating program payments. Default values from Nebraska are used to demonstrate the tool. However, the tool is easy to customize for other areas.

The tool is available at: http://www.unl.edu/nac/conservation/ or by calling the National Agroforestry Center at (402) 437-5178.

Nonnative Invasions Threaten Aquatic Ecosystems

Invasive species are labeled as one of the Forest Service's Four Threats to our National Forests. Some of the most serious invasions involve nonnative trout which have been widely introduced in the western United States to support recreational fisheries. However, these fisheries also have adverse impacts on many native species and ecosystems.

Efforts to manage public lands and native fishes may directly influence invasions of nonnative trout. Invasions begin with introductions, but the ultimate success and spread of nonnative trout can depend on local habitat and landscape conditions. In-stream barriers and removal projects may control or limit invasions, but these and other management alternatives for dealing with nonnative trout are controversial, variably effective, and often expensive. Furthermore, there is little understanding of invasions that could be used to support a strategic approach to managing nonnative trout and help managers prioritize limited resources.

To address these issues, the Station's Aquatic Sciences Laboratory in Boise, Idaho, has undertaken a broad program of research on the invasion and interaction between native and nonnative species. Past work revealed that nonnative trout are now among the most widely distributed fishes in the region. Current research focuses on brook trout, a species widely implicated in threats to native species and ecosystems in the Western United States. Studies show that brook trout will invade steeper streams than previously anticipated, but invasions are often slowed or even halted by natural physiological processes linked to the nature of the habitat they encounter. Researchers also found that influence of brook trout on native species is highly variable. In some habitats they appear to have little influence, whereas in others, they appear to be a major threat.

Study results are allowing managers to prioritize conservation and restoration activities to sites and streams that are most vulnerable to invasion and native populations that are most vulnerable to displacement if nonnative species become established. The bottom line is that threats posed by nonnative trout could be very much dependent on the nature of the landscape and habitat. By using the knowledge emerging from new research, managers can better identify areas and native populations that are at risk and focus habitat and fisheries management efforts where they will be most effective.

Station biologists sample stream fishes as part of their research on brook trout invasions in Panther Creek, Idaho.

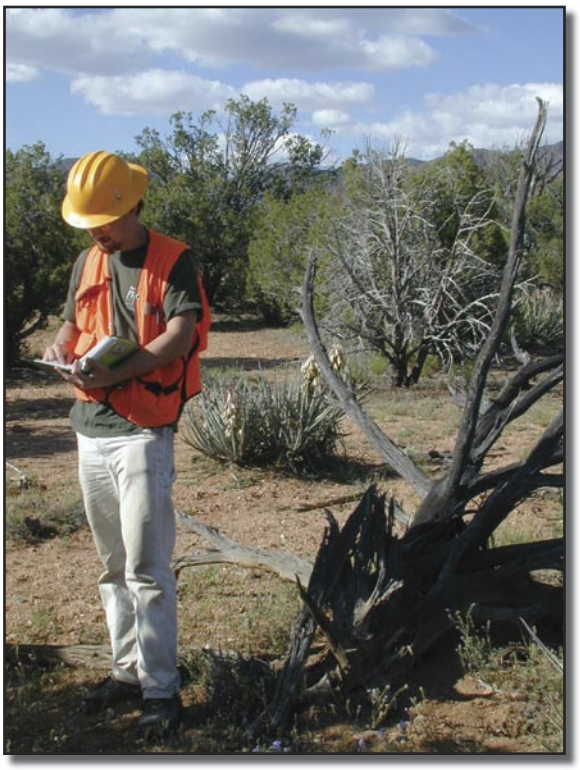
For more information and publications on this work, visit http://www.fs.fed.us/rm/boise.

Measuring Drought-Related Tree Mortality in the Southwest

Several years of drought in the Southwest have led to widespread tree mortality caused by a complex of drought, insects, and disease in several forest types. The Station's Interior West Forest Inventory and Analysis (IW-FIA) Program, located in Ogden, Utah, conducts and maintains comprehensive inventories on all forest land, using an annual inventory system designed to capture change in a timely fashion. The extent of coverage makes the FIA data well suited to detect trends in forest mortality on a regional scale. However, the number of plots measured each year is only 10 percent of the total plots measured in a 10-year cycle. FIA data and cooperative studies are being used to evaluate how sensitive this sampling intensity is for detecting and measuring the patchy, rapid onset of drought-related mortality currently occurring in Southwestern forests.

Annual inventories have been initiated in most Interior Western States. Of particular interest are inventory data from pinyon species in Arizona and Utah, where 3 and 4 years of annual data, respectively, have been collected. Preliminary results for all pinyon species show about 10 percent mortality in Arizona and 3 percent mortality in Utah. Maps of mortality detected on plots over time show an increase in severity and extent on Statewide and regional scales with an "epicenter" located in the Four Corners area. Upon completion of the 2004 field season, 3 years of annual data will be available for Colorado, 1-year of annual data for Nevada, and additional panels of data for Arizona and Utah. Using all available data, models of expected pinyon mortality will be developed and applied to New Mexico, where annual inventory has not yet been initiated. These results will be tested following the initiation of annual inventory in New Mexico in the near future.

Results will provide managers with timely estimates of the status and trends of drought-related mortality, and improve their understanding of stand conditions that are prone to high rates of mortality



As part of a pinyon-juniper mortality study, an FIA field technician assesses tree status on a woodland plot.

under long-term drought conditions. In addition, comprehensive analysis using FIA data from all affected States will provide the only large-scale, unbiased estimate of the impact of drought-related mortality on the forest resources of the Southwest.

Preliminary results have been presented in a poster at the Fourth National Congress of the Italian Society of Silviculture and Forest Ecology, October 7-10, 2003, Potenza, Italy, and in a panel discussion and poster at the 5th Joint Meeting of the Western Forest Insect Work Conference and the Western International Forest Disease Work Conference, April 26-30, 2004, San Diego, California. Proceedings that include poster abstracts and the panel summary are in press. Preliminary results have also been reported on the Web through Forest Health Monitoring as Forest Health Highlights (http://www.na.fs.fed.us/spfo/fhm/fhh/fhmusamap.htm). An update on analysis techniques and study results was presented at the Monitoring Science and Technology Symposium, September 20-24, 2004, Denver, Colorado (abstract available at http://www.monitoringsymposium.com).

Restoring Great Basin Riparian Areas

Streams and riparian (near water) areas in the Interior West's Great Basin provide critical ecosystem components such as water, habitat for aquatic and terrestrial organisms, forage and browse for native herbivores and livestock, and recreational opportunities. However, many of these stream systems are incised (eroded) and the riparian areas are often severely degraded.

In 1993, an ecosystem management project was initiated at the Station's Reno, Nevada, laboratory to study the structure and function of Great Basin watersheds and riparian areas, and to develop methods for maintaining or restoring their sustainability. The emphasis is on integrated studies of the abiotic and biotic components of the systems, including the watershed, riparian corridor, valley segment, and stream reach. The project is unique in that time scales include the mid-late Holocene (last 8,000 years), postsettlement period (1860 to present), and present (up to 10 years ago).

Results of the first 10 years of work were published in 2004 by Island Press as a Society for Ecological Restoration publication titled, *Great Basin Riparian Ecosystems: Ecology, Management and Restoration*. The book synthesizes the current knowledge of these important ecosystems; the interdisciplinary research and management approach that is being used by the project; and the results and management implications of the multiyear research project. The book also provides information on the underlying processes structuring these ecosystems to provide process-based approaches for their management and restoration.

The project approach serves as a model for conducting similar research and management programs. The information is being used to prioritize stream and riparian area restoration efforts, and to test methods for both stream stabilization and riparian ecosystem restoration.

More information on this research and the publications that have resulted from it can be found in: *Great Basin Riparian Ecosystems: Ecology, Management, and Restoration*, Island Press, Covelo, California.

Classifying riparian meadow soils in the central Great Basin.

How Effective is Erosion Mitigation After Wildfire?

Following a wildfire, a Burned Area Emergency Rehabilation (BAER) team is often formed to evaluate the environmental risks of a given wildfire, and to recommend mitigation treatments to reduce the risk of flooding and soil erosion. The costs of such treatments can exceed several million dollars on large fires. Recent studies and a government report showed that information about the effectiveness in reducing runoff and erosion of these treatments was not known. To fill this knowledge gap, Station scientists in Moscow, Idaho, along with cooperators from the National Fire Plan, Forest Service Washington Office staff, and numerous Forests and Regions, planned a series of studies to evaluate the effectiveness of BAER treatments.

The study consists of a number of paired watersheds, where one small watershed (about 20 acres) is treated and a nearby one is not. In some cases, three watersheds were monitored, with two treated and the third not. Eight studies were installed in Washington, Montana, California, and Colorado between 1999 and early 2004. Additional sites will be identified for several more years.

Analyses of results are ongoing, but several themes are apparent. For example, the effectiveness of any treatment depends on the intensity of the storms that occur following the fire. For high intensity storms that occur about once every 5 years or less, mitigation methods are often overwhelmed and become ineffective. For small storms and snowmelt that may occur several times a year, there is no runoff and erosion from either the treated or untreated sites. For moderate storms that may occur only once or twice every year or two, some treatments appear to effectively reduce soil erosion.

Following wildfire on some sites, needles that have been killed soon fall from the trees and can cover the soil surface. This is known as needlecast. In many cases, ground coverage from needlecast exceeds 70 percent. In such conditions, no further mitigation is necessary as the cover from the needles is sufficient to significantly reduce soil erosion.

Researchers clean out sediment deposited by a single storm runoff event from a high severity burned area on the Hayman Fire, Colorado, September 2003.

One of the main mitigation treatments used is the log erosion barrier (LEB). LEBs are constructed by felling trees that have been killed by the fire, orienting them along the contour, and filling in any gaps between the tree and the ground surface. In some cases, earth is banked up on either end of the LEB to reduce the movement of surface runoff around the log. Based on studies of this method, LEBs reduced soil erosion an average of 35 percent the year following the fire, and even more in later years.

Research is ongoing on the benefits of numerous methods for using organic material to cover the soil surface after the natural cover has been burned. These covers, known as mulches, include straw mulch, hydromulch, and wood fiber. Mulching treatments show considerable promise for reducing erosion, but further evaluation of their effectiveness is needed.

Results of this work will help BAER teams to more effectively evaluate the need for, and benefits of postfire erosion mitigation treatments. The results have also been used to develop a new soil erosion interface specifically designed to predict soil erosion after fire, called the Erosion Risk Management Tool (ERMiT). ERMiT can be run on the Internet using any Web browser. Over 80 specialists were trained on the use of ERMiT this past year.

Additional information can be found in: A Probabilistic Approach to Modeling Erosion for Spatially-varied Conditions. ASAE paper number 01-8006, presented at the American Society of Agricultural Engineers Annual International Meeting, Sacramento, California, USA, July 30 - August 1, 2001. St. Joseph, MI.

Effectiveness of Needle Cast at Reducing Erosion after Forest Fires. *Water Resources Research*. 39(12).

Evaluating the Effectiveness of Postfire Rehabilitation Treatments. General Technical Report RMRS-GTR-63. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Erosion Risk Management Tool, (http://forest.moscowfsl.wsu.edu/fswepp/).

Wilderness Values and Threats in Arctic Alaska

More than half of our National Wilderness Preservation System (58 million of 106 million acres) is in Alaska. Since much of these wild lands and waters received wilderness protection through the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, there has been little research to guide management planning to meet the complexities entailed in coupling ANILCA with the Wilderness Act and other guiding legislation and policy. In response to requests by residents of the Alaskan native village of Kotzebue, the Aldo Leopold Wilderness Research Institute in Missoula, Montana, cofunded and participated in a project to develop understanding of traditional indigenous relationships with the wilderness lands of the Western Arctic Parklands, and how various forces of change threaten or enable the Qikiktagrugmiut (native Inupiaq people of Kotzebue) to maintain these traditional relationships.

The Leopold Institute worked with the native village of Kotzebue to obtain interviews with hunters and gatherers within the Tribe in 2003. From these interviews, several unique dimensions of the relationships they have with the Western Arctic Parklands were identified. Tribal members described their experiences in the Western Arctic Parklands in their own words, contrasting this place to other life situations. Study findings suggest that there are meanings assigned to these wilderness places that are not well defined in the Wilderness Act. Tribal members spoke of such values as identity, traditional ways of life, humility, and personal and community survival. While these values are not identified within the Wilderness Act as primary reasons for protection of these wilderness landscapes, some management actions or community programs could be modified to accomplish wilderness directives while being sensitive to these values.

This research also identified many forces that influence these values. Only some of them were related to Federal agency actions or policies. Others were more closely associated with societal and global changes. While Tribal members seemed to feel that agency protection of these lands mostly served to also protect local values, there was concern about loss of local control. Village residents also expressed concern that in the long-term, the agency intended to influence the residents' relationship with these lands so that they would become more like recreation visitors who do not remain.

The Alaska Tundra provides the ability for native residents to survive as well as recreation opportunities for visitors.

A second phase of this research has been proposed to fully understand the role the identified forces of change have on these traditional relationships. The native village of Kotzebue has expressed interest in this kind of research as an example of what other native villages could do to improve communication with Federal agency managers and increase the probability that the underlying purpose of ANILCA is met in the future.

The native people use research results during collaborative planning with Federal agencies, and park planning staff use the results to make decisions about future programs in a way that extends protection to the unique values attached to these wildlands, or, in some cases, at least acknowledge the justifiable loss of some local values for national interests. The long-term goals are greater appreciation of alternative views toward the wilderness resource among all parties (managers, local people, and distant populations), meeting the intent of ANILCA without negative impacts on the intent of the Wilderness Act, and protecting the relationship between evolving native cultures and changing wilderness landscapes.

Additional information can be found in: The Relationship Between Qikiktagrugmiut (Kotzebue Tribal members) and the Western Arctic Parklands, Alaska, U.S., *International Journal of Wilderness* 10(2).

FIREMON – A Fire Effects Monitoring and Inventory System

Monitoring the effects of wildland and prescribed fire is critical for documenting fire effects, assessing ecosystem damage and benefit, evaluating the success or failure of a burn, and appraising the potential for future treatments. However, monitoring is a task that many fire managers have been reluctant or remiss to complete. They often find themselves too busy with other essential duties, and the complexity of monitoring that will obtain useful data often overwhelms or intimidates fire managers. This is especially true when fires are large (more than 1,000 acres), on diverse landscapes, and of varying severity. It is difficult to design a cost-effective sampling strategy that will scientifically quantify stand-level fire effects across an entire landscape. Standardized and comprehensive sampling methods and tools would help fire managers plan and implement monitoring projects.

To fill the need for an independent fire monitoring system, scientists at the Fire Sciences Laboratory in Missoula, Montana, developed FIREMON: Fire Effects Monitoring and Inventory System, a sampling system that will satisfy the monitoring requirements of most fire managers. It is designed to characterize changes in ecosystem components over time, before and after treatment. The system consists of a sampling strategy manual, standardized sampling methods, field forms, database, and an analysis program so fire managers can: 1) design a fire effects monitoring project, 2) collect and store sample data, and 3) statistically analyze and summarize the data. Additionally, the FIREMON Landscape Assessment section describes how to sample and map postburn fire effects. Using project objectives and resource information (personnel, time, funds, expertise, and equipment), the manager uses a series of FIREMON keys to determine which methods and sampling strategy will provide the best assessment of treatments. FIREMON allows flexible but comprehensive sampling of fire effects so data can be evaluated for significant impacts, shared across agencies, and used to update and refine fire management plans and prescriptions.

FIREMON has been building a solid user base through training workshops and word of mouth. The first FIREMON User's Workshop was held in Missoula in May 2003 with representatives from the U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, USDA Forest Service, and university students. This training workshop provided participants the opportunity to learn all sampling methods, use the FIREMON database, and prepare summaries and reports. Recently, the Bureau of Indian Affairs (BIA) selected FIREMON as its fire monitoring and inventory package. Four workshops have been held for BIA personnel with three more planned. Also, two workshops have been held for Student Conservation Association interns working with the BIA and with the LANDFIRE project. Another FIREMON user's workshop was held in October 2004.

For more information, visit the FIREMON Web site: www.fire.org/firemon.

Density sampling station at the 2003 FIREMON User's Workshop.

The International Crown Fire Modeling Experiment

Over much of the last century forest fire research in North America has been directed toward developing methods for predicting wildland fire behavior so that fire management personnel can anticipate and manage wildland fires more effectively. Canadian and U.S. fire researchers approached the problem solution using two widely differing methods. Canadians followed a largely empirical approach involving extensive field experiments and wildfire observations, while U.S. research efforts emphasized theory and laboratory-based fire experiments. Both approaches resulted in the development of fire danger rating and fire behavior prediction systems that are used both nationally and internationally.

More recently, a multiyear, international collaborative effort has culminated in new understanding into the processes governing fire behavior—especially those processes associated with high intensity crown (tree top) fires. Researchers with the Fire Sciences Laboratory in Missoula, Montana, along with other Forest Service research units, worked with their Canadian counterparts to complete the International Crown Fire Modeling Experiment (ICFME) – the most thoroughly instrumented and documented experimental crown fires ever conducted. The primary objective was to provide new understanding into the physical processes occurring in naturally burning high intensity fires. The experiments occurred on 10 experiment plots between 1997 and 2000 in Canada's Northwest Territories (NWT), where the forest stands at the site were predominantly jack pine overstory and black spruce understory.

Fire behavior, fire danger, and fire weather conditions were recorded to evaluate the accuracy of fire behavior prediction systems and models. Rocky Mountain Research Station personnel designed, constructed, and deployed instrumentation to measure air temperatures, radiant and convective heating, and air flow velocities at five heights above the ground surface, and also to measure heating and ignition of various wood structures.

ICFME provided a unique opportunity for researchers to combine modern instrumentation with unprecedented international, multidisciplinary collaboration to advance current understanding of the mechanisms driving the ignition and spread of crowning fires. The knowledge gained has already proved critical to ongoing research programs. Results were published in a special issue of the *Canadian Journal of Forest Research*, providing a comprehensive picture of the physical and biological aspects governing crown fire spread and intensity. Three of the papers were authored by Station scientists: A Radiation-Driven Model for Crown Fire Spread; Measurements of Radiant Emissive Power and Temperatures in Crown Fires; and Relating Flame Radiation to Home Ignition Using Modeling and Experimental Crown Fires.

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

Researchers replicate a high intensity crown fire to help understand the physical processes occurring in naturally burning high intensity fires.

Restoring Damaged Wilderness Campsites

While wilderness areas are managed to maintain their natural conditions, heavy recreational use has caused many campsites to become compacted, erosion-prone places, stripped of vegetation and topsoil. Wilderness managers often close campsites that are excessively impacted or located in inappropriate places. Particularly at high elevations, restoration attempts are often unsuccessful. Researchers with the Aldo Leopold Wilderness Research Institute in Missoula, Montana, are evaluating the effectiveness of alternative means of accelerating campsite restoration.

Station scientists, assisted by the Eagle Cap Ranger District on the Wallowa-Whitman National Forest in Oregon, studied six highly impacted campsites around subalpine lakes that were restored using treatments to accelerate rates of restoration. Each campsite was divided into 12 subplots, each of which received some combination of the following treatments: (1) seeding and transplanting with local, native species, (2) soil amendment with organic matter, compost, and native soil inoculum (microorganisms), and (3) application of a surface mulch. The soil was loosened on all plots. Establishment and growth of vegetation, as well as soil chemical and biological characteristics, were monitored for 7 years following the restoration treatments.

Results show that transplanting and seeding were both effective in establishing vegetation cover. Most transplants survived, regardless of treatment. However, the growth rates were greater on sites treated with organic matter, soil inoculum, and compost. The surface mulch had no clear effect on growth of transplants. The density of seedlings on plots varied greatly, exceeding several hundred seedlings per square meter on some subplots. Scarification, seeding, and the organic and compost soil amendment were all effective in increasing seedling density. Scarification and seeding had more effect on seedling establishment, while the soil amendment had more effect on seedling survival during the hot, dry summers. The mulch treatment had no clear effect on seedling density. Soil analysis showed that the soil amendments were important to plant establishment and growth because they increased the water holding capacity of the soil and restored available nitrogen for plants. These results indicate that it is possible to restore damaged campsites in the subalpine zone, but transplanting, seeding, scarification, and soil amendments are all critical to rapid restoration.

Eagle Cap Wilderness managers are using the treatments identified as most effective to restore campsites and trails. The result is faster and more cost-effective restoration. Wilderness managers elsewhere have received training and are applying these results to other restoration treatments.

Additional information is available in: Campsite Restoration in High Subalpine Forests, Eagle Cap Wilderness, Oregon. In: *Proceedings, High Altitude Revegetion Workshop No. 13*. Information Series No. 89, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO.

Some subplots were only scarified, while others received soil amendments of organic matter or organic matter and compost.

Soil Amendments and Planting Techniques: Campsite Restoration in the Eagle Cap Wilderness, Oregon. In: *Wilderness Science in a Time of Change Conference--Volume 5: Wilderness Ecosystems, Threats, and Management*. USDA Forest Service General Technical Report RMRS-P-15-VOL-5.

Restoration of Subalpine Campsites in the Eagle Cap Wilderness. In: *Handbook of Ecological Restoration: Restoration in Practice*. Cambridge University Press: Cambridge, UK.

Understanding the Causes of Productivity Decline as Forests Age

In forests around the world, aboveground wood production declines after tree canopies (tree tops) grow together in even-aged stands, but forest biologists do not understand why. This pattern of decline affects commercial forestry, slows carbon storage in older forests, and might be related to the increased susceptibility of older trees to insects and disease. Understanding this decline in wood growth may lead to ways to reduce or eliminate it, and better predict forest growth.

Tackling the question presents several challenges. Most forests grow slowly, making it difficult to observe changes over time and explore how nutrition and competition might change the pattern of decline. Another challenge is that wood production uses only about 20 percent of the tree's photosynthesis, so looking for a mechanism that causes the decline means developing methods to measure the photosynthesis used for roots, leaves, and respiration.

Fort Collins, Colorado, scientists and cooperators designed an experiment using fast-growing tropical plantations to compress the time needed to study the pattern. Growth in these plantations peaks and declines at about the same biomass as that in temperate forests, but happens in 6 to 8 years. Researchers tested several ideas to try to determine what is responsible for the decline in wood production: 1) respiration—it should increase as woody biomass increases (the textbook explanation), 2) nutrition—nutrients may become bound in the growing vegetation and limit growth, and 3) photosynthesis—it may decline as trees grow taller.

After 8 years, the group found that these fast-growing plantations did grow and decline with a pattern similar to that in temperate forests. A decline in photosynthesis caused the decline in wood production, and this decline occurred despite abundant nutrients or low competition from other plants. Abundant nutrition did slow the rate of decline relative to controls, suggesting that good nutrition can overcome some of the growth decline. Respiration did not slow growth, contradicting many reports in the literature and textbooks. These results provide a better understanding of wood growth decline in forests worldwide.

Read more about this research in: An Experimental Test of the Causes of Forest Growth Decline with Stand Age. *Ecological Monographs*, 8/04.

Belowground Carbon Cycling in a Humid Tropical Forest Decreases with Fertilization. *Oecologia* 139.

Primary Production and Carbon Allocation in Relation to Nutrient Supply in an Experimental Tropical Forest. *Global Change Biology* 9.

Experimental forests of fast growing Eucalyptus at age 1.5 years (top photo) and 7.5 years.

A Better Understanding of Forest Carbon Balances

Vegetation, such as trees, takes up and releases carbon dioxide during growth, stores carbon, and releases carbon dioxide in the process of dying. How much carbon ecosystems absorb is of interest in addressing the role of natural resource management in mitigating the increasing amounts of atmospheric carbon dioxide with carbon sequesteration in forests. These increasing levels of atmospheric carbon dioxide and other trace gases result largely from human activities involving the combustion of fossil fuels, the spreading of fertilizer, and the alteration of the vegetation cover on the landscape. As a result, atmospheric carbon dioxide has increased by more than 30 percent in the past century. Of concern is the potential that changes in the chemical composition of the atmosphere will dramatically affect global temperature and rainfall patterns. Increasing the amount of carbon stored in ecosystems is seen as a possible mitigation measure to reduce the amount of carbon dioxide in the atmosphere. However, gaps in understanding the ecosystem cycling of carbon dioxide cause significant uncertainty in predicting future concentrations of atmospheric carbon dioxide. This uncertainty represents a major impediment to formulating energy policies and mitigating the growth of atmospheric levels of carbon dioxide.

The amount of carbon dioxide exchanged between the atmosphere and different forests varies with the environment of the forest as well as the type of forest. Continuous observations of exchanges of carbon dioxide, water, and energy in different ecosystems over years have been the focus of AmeriFlux, a group made up of Federal agency and university representatives studying carbon dioxide, water, and energy exchange from a variety of ecosystems. The Glacier Lakes Ecosystem Experiments Site, located in Wyoming, is one of approximately 70 AmeriFlux sites. Globally, these sites number more than 250. The growing body of experimental data from these sites has demonstrated that a uniform theoretical framework is necessary to clearly interpret the data. Understanding the results and implications of these data should help define the current amount of global carbon dioxide, improve predictions of future concentrations of atmospheric carbon dioxide, and enhance knowledge of carbon fluxes and carbon sequestration. It is important to develop protocols to minimize the impact of differences in equipment and data processing procedure, and to have appropriate data quality assurance and control procedures.

Ameriflux initiated efforts to develop standardization of methods. Through a series of workshops, participants examined the fundamental

Forest carbon balance studies are taking place at the Glacier Lakes Ecosystem Experiments Site in southern Wyoming.

concepts, as well as the analytical and numerical techniques underlying the use of fine scale data on carbon dioxide exchange to derive estimates of carbon absorbed by the ecosystem over a specific time period. Initiated in part by the Rocky Mountain Research Station, these workshops included leading scientists from around the world and active members of AmeriFlux.

A significant workshop result is *The Handbook on Micrometeorology: A Guide for Surface Flux Measurements and Analysis*, which contains contributions by a Station scientist. This book provides the first analytical review of methods for analyzing flux data collected in the national and international carbon flux networks. The intended audience includes micrometeorolgists, ecosystems scientists, and boundary-layer meteorologists. The Handbook provides guidance on estimating mass and energy exchange as part of the role of the terrestrial biosphere in global environmental change. Finally, it provides many of the analytical tools needed to determine the capabilities of forests to sequester carbon.

To find out more about this and related work, visit www.fs.fed.us/rm/landscapes/.

Our Research Programs

Our research and development programs are regional, national and international in scope and application. This section covers our programs based on the State in which they are located.

Total FY2004 Station Appropriations: $42,070,000

Total Outside Funding: $12,246,987

Total National Fire Plan Funding: $7,762,157

Total Number of Scientist Years: 108

(In addition to the outside funding shown above for our research work units, the Station's library and publications units were supported by $297,884 in outside funding.)

Forest Service Research and Development in Arizona

The Rocky Mountain Research Station maintains five research work units in Arizona. They are located at the Southwest Forest Sciences Complex, a Federal/State partnership between the Rocky Mountain Research Station and Northern Arizona University's College of Ecosystem Science and Management.

Scientists conduct research on vegetation, watershed, wildlife and fisheries resources, and their associated Southwestern ecosystems. The Station's Fort Valley Experimental Forest is near Flagstaff on the Coconino National Forest. The Santa Rita Experimental Range near Tucson, formerly maintained by the Station, remains a site for important rangeland studies.

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(928) 556-2001
Fax: (928) 556-2130
(www.fs.fed.us/rm/main/labs/flagstaff.html)
(www.rmrs.nau.edu/lab)

Total FY2004 Appropriations: $5,424,000
Total Outside Funding: $1,841,831
Total National Fire Plan Funding: $1,288,404
Total Number of Scientist Years: 13

"The faculty in the School of Forestry at Northern Arizona University use results from Forest Service Research in our undergraduate and graduate classes. Many of your publications are coauthored by our graduate students doing research in cooperation with Rocky Mountain Research Station scientists. Your publications are a very important source of literature for our faculty and students." (Dean of the Consortium of Professional Schools and Colleges, Northern Arizona University, Flagstaff, Arizona)

Southwestern Forest Health Restoration and Wildland-Urban Interface Fuels Management

(RMRS-4156) Flagstaff, Arizona (http://www.rmrs.nau.edu/lab/4156/)

Mission: Contribute to the scientific basis for natural resource management activities in Southwestern forests and urban interface areas to restore forest health and manage forest fuels in a publicly supported manner.

FY2004 Appropriations: $2,390,000
Outside Funding: $1,164,799
National Fire Plan Funding: $741,930
Scientist Years: 4
Number of Products: 141

Key Accomplishments, Products, and Publications

- Scientists and collaborators are investigating the effects of forest management techniques that restore stand structure and provide fuels management in Southwestern ponderosa pine forests. Studies provide demonstration areas of forest vegetation management strategies for managers and community partnerships developing community wildfire protection plans under the Healthy Forests Restoration Act.
- In collaboration with Los Alamos National Laboratory in New Mexico, researchers are developing and validating models of fire behavior needed to support forest fuels reduction activities, wildfire mitigation efforts, planning for prescribed burns, and assessment of postfire environmental effects.
- Research is under way on the western spruce budworm, the most important defoliator of Douglas-fir in Western North America. Results show that susceptible trees become a preferred food source for budworm caterpillars with consecutive years of defoliation, but resistant trees do not. Forest managers use this information to select naturally genetically resistant trees to provide the next generation of seedlings for healthy forests.
- Scientists reviewed and synthesized published literature to provide managers with guidelines useful in predicting whether or not trees will survive following wildfire and prescribed burning.

Scientists are developing models of fire behavior in southwestern forests.

Ecology and Conservation of Terrestrial Wildlife and Habitats in the Interior West

(RMRS-4251) Flagstaff, Arizona (www.rmrs.nau.edu/wildlife)

Mission: Acquire, develop, and provide reliable information on wildlife populations and habitats in terrestrial ecosystems to support science-based decisions for natural resource management.

FY2004 Appropriations: $1,786,000
Outside Funding: $665,000
National Fire Plan Funding: $198,718
Scientist Years: 5
Number of Products: 148

Key Accomplishments, Products, and Publications

- Project scientists led development and completion of the Mexican Spotted Owl Recovery Plan, which provides management guidance for this species throughout the Southwestern United States. In addition, habitat and monitoring protocols developed by this unit have averted numerous lawsuits and appeals.
- Long-term studies are under way on the effects of forest management on the northern goshawk on Arizona's Kaibab Plateau. Research results helped develop management recommendations for the goshawk in the Southwest and much of the Western United States.
- Researchers completed a synthesis document on ponderosa pine that contributed to settling a lawsuit (Silver vs. Thomas) that prohibited timber harvest in the Southwest for 18 months.
- Studies are evaluating the effects of various fuels reduction treatments on wildlife, both within and outside the urban-wildland interface.

Habitat of the northern goshawk is being studied on the Kaibab Plateau in Arizona.

- Scientists are conducting a comprehensive study in the Sacramento Mountains of New Mexico to better understand the effects of forest health restoration treatments within the urban-wildland interface on the Mexican spotted owl.

Watersheds and Riparian Ecosystems of Forests and Woodlands in the Semiarid West

(RMRS-4302) Flagstaff, Arizona (www.rms.nau.edu/lab/4302)

Mission: Create, develop, and apply knowledge on stream, geology, water, soil, biologic and ecologic functions, processes, and dynamics. This information helps sustain watershed integrity and diverse, healthy and productive biotic populations within watersheds and riparian ecosystems of forests and woodlands in the semiarid interior Western United States and Mexico.

FY2004 Appropriations: $841,000

Outside Funding: $12,032

National Fire Plan Funding: $347,756

Scientist Years: 3

Number of Products: 149

Key Accomplishments, Products, and Publications

- Scientists provide comprehensive data and watershed management information from five decades of research in the Southwest through a cooperative Web site interface (http://ag.arizona.edu/OALS/watershed/index.html).
- In cooperation with the Apache-Sitgreaves National Forest, Arizona Game and Fish Department, and Western New Mexico University, researchers continue to evaluate the effects of the 2004 Three Forks and KP Fires on stream environments. Streams affected by these fires in the White Mountains of Arizona harbor native and nonnative fishes and are popular recreational fishing sites.
- Studies help advance the restoration of degraded stream channels and riparian wetlands that are culturally and ecologically significant.
- Project scientists also hosted the 2004 Annual Workshop of the International Energy Agency, Bioenergy Task 31: "Biomass Production for Energy from Sustainable Forestry." Scientists and managers from 12 countries attended.

Project scientists sampling streams after the 2004 Three Forks Fire in Arizona.

Achieving Ecosystem Management in the Borderlands of the Southwestern United States through Research and Management Partnerships

(RMRS-4651) Flagstaff, Arizona (www.rmrs.nau.edu/lab/4651/)

Mission: Contribute to the scientific basis for developing and implementing a comprehensive ecosystem management plan to restore natural processes, improve the productivity and biological diversity of grasslands and woodlands, and sustain an open landscape with a viable rural economy and social structure in the Southwestern Borderlands area.

FY2004 Appropriations: $407,000

Scientist Years: 1

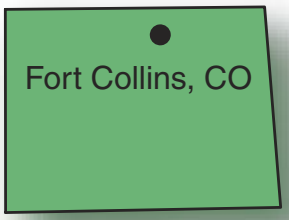
Number of Products: 32

Key Accomplishments, Products, and Publications

- Scientists helped sponsor a conference honoring the Santa Rita Experimental Range's (http://ag.arizona.edu/SRER/) 100-year history of accomplishments and contributions to rangeland ecology and management in the Southwest. Santa Rita is the longest continuously operating area dedicated to the sustainable management of North American rangelands. The conference and proceedings represent a starting point for planning and implementing a research program to provide knowledge for future improved, ecosystem-based, multiple-use rangeland management.
- Scientists and collaborators completed two studies on the transpiration of dryland oaks. Transpiration is a critical, and often unknown, factor in the hydrologic cycle of arid and semiarid woodlands and savannas. Results will help plan and understand watershed treatments.
- The project conducted and sponsored a collaborative long-term program to understand the role of fire as an important tool to restore natural vegetation in semiarid grasslands and woodlands. Studies demonstrate the benefits of average fire frequencies in sustaining nutrients and restoring plant cover.

Research results help develop plans for managing and restoring grasslands and woodlands in the Southwest.

Forest Service Research and Development in Colorado



The Rocky Mountain Research Station maintains five research work units and the Stream Systems Technology Center at Station headquarters in Fort Collins, Colorado. Two of the units have national charters. They support the Forest Service and other Federal land management agencies on technology related to natural resource assessment, ecology, and management, and social and economic values in land management planning. Other units focus on regional issues related to fisheries and watersheds, climate change and air resources, recreation benefits, biological diversity, and ecological processes and ecosystem health.

Station headquarters is in the Natural Resources Research Center in Fort Collins. This state-of-the-art facility is a Station-led partnership among eight Federal agencies and is near the Colorado State University campus.

The Station's Fraser Experimental Forest is on the Arapaho National Forest in central Colorado, and the Manitou Experimental Forest is on the Pike-San Isabel National Forest, northwest of Colorado Springs.

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Total FY2004 Appropriations: $7,692,000

Total Outside Funding: $1,847,829

Total National Fire Plan Funding: $966,349

Total Number of Scientist Years: 25

"Over the past 12 months, meteorologists at the Rocky Mountain Area Coordination Center (RMACC) Predictive Services Group have recognized the benefit and practicality of the fire-weather and smoke information product provided by the Station's Rocky Mountain Center (RMC). This is the second year in a row that the RMACC has used RMC products as part of our daily operations, which include fire weather analysis, weather briefings and fire weather highlights. Not only is the RMC website a valuable tool in our daily wildfire operations, but it also offers significant promise toward managing prescribed burns and smoke impacts." (Fire Weather Program Manager, Rocky Mountain Area Coordination Center, Lakewood, Colorado)

Consequences of Land Management and Natural Disturbance to Water Quality and Quantity Across the Aquatic, Riparian, and Upland Continuum

(RMRS-4352) Fort Collins, Colorado, and Laramie, Wyoming (www.fs.fed.us/rm/rwu4352)

Mission: Quantify watershed processes and the impacts on watershed resources of management activities, disturbance and associated uncertainties across upland forests, riparian areas, and streams in the Central Rocky Mountains.

FY2004 Appropriations: $1,708,000

Outside Funding: $53,047

Scientist Years: 6

Number of Products: 109

Greenback cutthroat trout.

Key Accomplishments, Products, and Publications

- In collaboration with the Arapaho-Roosevelt and Medicine Bow-Routt National Forests in Colorado, scientists are devising new protocols for monitoring the recovery of greenback cutthroat trout, listed as threatened under the Endangered Species Act, and Colorado River cutthroat trout, considered a sensitive species in the Agency's Rocky Mountain Region. Scientists have created and validated the first empirically based model to predict population size based on stream length. These results will help efforts to conserve and restore trout populations.
- Scientists are working with the National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and the Department of Defense to design, test, and launch a satellite that will improve abilities to measure hydrological information on local, regional, and global scales, and improve forecast models for runoff and water supply.
- Studies show that the decline in productivity with forest age is caused by a decline in canopy photosynthesis, and that proper nutrition can slow the decline.
- Scientists have characterized postfire recovery rates for key shrubs, and studied the influence of management practices on regrowth following wildland fire. Results will assist in prescribing effective rehabilitation projects following fire, particularly in priority watersheds or along streams that provide critical habitat for rare fish species.

Sustaining Alpine and Forest Ecosystems Under Atmospheric and Terrestrial Disturbances

(RMRS-4451) Fort Collins, Colorado (www.fs.fed.us/rm/landscapes)

Mission: Develop and refine the knowledge and technology needed to understand, model, and thus manage vegetation dynamics and ecosystem processes for the long-term sustainability of alpine, forest, and woodland ecosystems of the Rocky Mountains.

FY2004 Appropriations: $1,882,000

Outside Funding: $358,614

National Fire Plan Funding: $532,432

Scientist Years: 7

Number of Products: 192

Scientists helped establish research priorities for white pine ecosystems affected by blister rust.

Key Accomplishments, Products, and Publications

- To help assess forest biomass and fuel reduction needs in the Western United States, scientists developed a method in which silvicultural prescriptions can be used with forest inventory data to provide a realistic estimate of fuel reduction.
- Scientists helped improve detection strategies for a new exotic insect, the banded elm bark beetle. An attractant was used in surveys to help detect infested areas and populations of the beetle.
- Researchers coedited and contributed to the *Handbook on Micrometeorology*, the first analytical review of methods for analyzing data collected within the national and international carbon flux networks. The publication helps resource specialists understand forest carbon balances.
- Researchers have helped establish research priorities for high-elevation white pine ecosystems under blister rust attack as part of the White Pine Implementation Team. The Station spearheads education awareness on white pine blister rust impacts on high elevation pines in cooperation with the Forest Service's Rocky Mountain Region, National Park Service, and universities.
- Studies shed light on why research results sometimes go unused by resource managers. Scientists found that barriers arise from differences in organizational culture within the Forest Service, and from uncoordinated communication. Suggestions on how these breakdowns can be avoided are being offered.

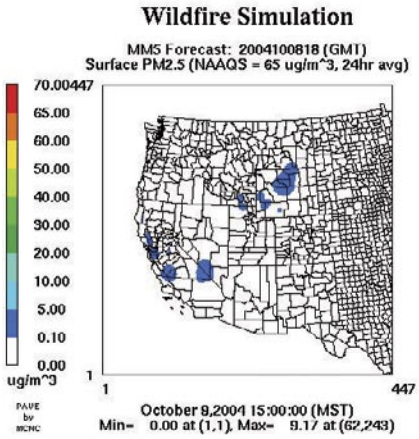
Research on Sustaining Social, Biological, and Physical Components of Colorado Front Range Ecosystems

(RMRS-4653) Fort Collins, Colorado
(This unit was merged with RMRS-4852 in 2004)

Mission: Improve approaches to integrate social, organizational, and ecological values and issues, improve conflict management strategies, establish the state of knowledge, and improve our understanding of key biological and physical aspects of the functioning of ecological systems and interactions of humans on system structure, diversity, and productivity.

Key Accomplishments, Products, and Publications

- Historical fire and landscape ecology research contributes to restoration of ponderosa pine/ Douglas-fir forests through the Front Range Fuels Treatment Partnership in Colorado. More than 17,000 acres have been treated or are scheduled for treatment using prescriptions developed through these studies.
- Project scientists helped develop the Forest Service Rocky Mountain Center (RMC) that provides comprehensive, real-time, high-resolution fire weather intelligence and smoke forecasts for the Interior West, including three Western fire Geographical Coordination Center regions. Products are specifically tailored to meet operational needs of fire managers, incident commanders, and air-resource smoke specialists during periods of intense firefighting and prescribed burning.



Example of a smoke dispersion forecast available from the Rocky Mountain Center.

"Please convey my appreciation to Merrill Kaufmann for his participation at a recent public meeting in Estes Park, CO. The meeting served to introduce residents of the Estes Valley to planned fuel reduction treatments on National Forest land. His presentation on ponderosa pine ecology, and comparing current conditions with those of 100 years ago, provided a very effective introduction for the need to reduce hazardous fuels in the project area. Opportunities like this allow us to provide sound information, creating a more informed public and leading to increased community involvement and understanding." (District Ranger, Canyon Lakes Ranger District, Fort Collins, Colorado)

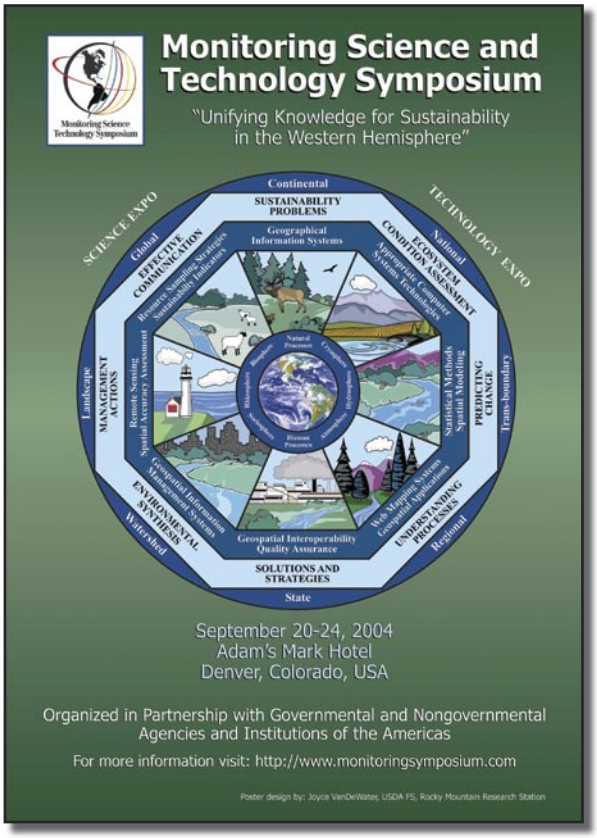
Forest Inventory and Monitoring Environmetrics

(RMRS-4804) Fort Collins, Colorado (http://www.fs.fed.us/rm/ftcol/index.shtm)
(This unit was merged with RMRS-4852 in 2004)

Mission: Develop, validate, and transfer scientifically credible methods of mathematical statistics for the Forest Inventory and Analysis programs and related efforts to achieve more timely and useful inventory and monitoring of forest lands.

Key Accomplishments, Products, and Publications

- Scientists collaborated with the Finnish Forest Research Institute in Helsinki to improve mapping processes for forest resources in the United States.
- Researchers published a technical reference titled *Statistical Techniques for Sampling and Monitoring Natural Resources* (www.treesearch.fs.fed.us/pubs/viewpub/jsp?index=6287).
- This unit organized the Monitoring Science and Technology Symposium, held in Denver, Colorado, that brought together policymakers, natural resource managers, and scientists from throughout the Americas to address issues and opportunities surrounding environmental monitoring for sustainability.
- Scientists supported a large pilot study for the Mexican States of Jalisco and Colima that produces consistent, compatible, comparable, and integrated inventory and monitoring strategies for the assessment and management of ecosystem sustainability.
- Work concluded the national Annualized Integrated Inventory and Monitoring Initiative, which sought methods to build interoperability among major United States Departments of Agriculture and Interior programs that monitor natural resources.



This project and the Station helped sponsor the Monitoring Science and Technology Symposium, held in Denver, Colorado.

Social and Economic Values in Natural Resource Planning and Management

(RMRS-4851) Fort Collins, Colorado (www.fs.fed.us/rm/value)

Mission: Promote full consideration of social and economic values in natural resource decision making by conducting theoretical and empirical research on value measurement, changing and conflicting values, and process by which values are incorporated into planning and decision making.

FY2004 Appropriations: $1,023,000

Outside Funding: $78,500

Scientist Years: 4

Number of Products: 60

Key Accomplishments, Products, and Publications

- As a companion to the book *A Primer on Nonmarket Valuation*, coauthored by a Station scientist, a Web site now hosts nonmarket valuation data sets, survey materials, and links to publications, offering students the opportunity to estimate models using the data and view the survey instruments used to collect the data.
- The Sustainable Rangelands Roundtable - a collaborative open partnership of Station scientists, rangeland managers, ecologists, social scientists, policy and legal experts, environmental advocates, and industry representatives – developed an integrated conceptual model of rangeland sustainability that defines the linkages between ecological factors and social and economic factors related to sustainability.
- Place attachment is increasingly being recognized as an important consideration in the management of public lands. Studies on place attachment help land managers understand the public's concerns about and values for public natural resources.

Scientists assisted recreation management planning at the Valles Caldera National Preserve in New Mexico to gain a better understanding of revenue generation, public access, and program design.

- National Forests are the source of much of the West's water. The value of that water highly depends on local demand and supply conditions. Research on water value helps us understand what influences water value and how that value changes over time.
- Scientists study how Federal and related State and local government fuels management programs affect homeowners living adjacent to forest lands. Results help managers design more effective fuels management strategies.

Natural Resource Assessment, Ecology, and Management Science Research

(RMRS-4852) Fort Collins, Colorado (www.fs.fed.us/rm/analytics)

Mission: Provide improved technology and methods for quantitative resource management planning and analysis. Researchers incorporate the dimensions of human-caused and natural disturbances into analysis tools to support forest planning.

FY2004 Appropriations: $1,974,000

Outside Funding: $1,351,668

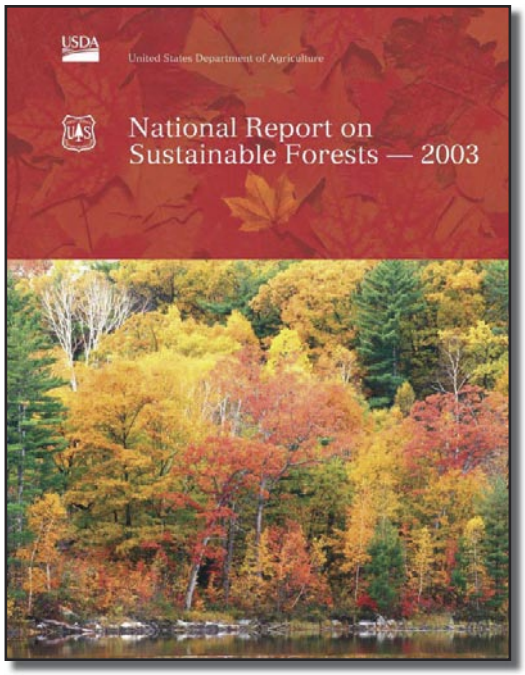
National Fire Plan Funding: $433,917

Scientist Years: 8

Number of Products: 129

Key Accomplishments, Products, and Publications

- Recent work on bird population trends in relation to open space shows that the ability of a species to withstand habitat conversion depends upon its reproductive potential. Study results suggest that maintaining a full complement of forest breeding birds can be accomplished by focusing management on those species found to be most sensitive to the loss of open space.
- Scientists provided a comprehensive analysis of trends in key biodiversity indicators in support of an international effort (Montreal Process) to advance forest sustainability as a resource management approach. This led to a national publication on the status of forest resources in the United States that will be used to improve national and international dialog and decision making.
- Historical fire and landscape ecology research is guiding restoration of ponderosa pine/Douglas-fir forests through the Front Range Fuels Treatment Partnership in Colorado. More than 17,000 acres have been treated or are scheduled for treatment using prescriptions developed by this research.



Scientists contributed to a national publication on the status of forest resources in the United States.

- The Station is a partner in the Sustainable Rangelands Roundtable (SRR) – a collaborative process involving more than 50 agencies and organizations. This roundtable has developed a suite of five criteria and 64 indicators of sustainable rangeland management that are being validated by connecting them to a conceptual model of how the environment, natural resources, the economy, and society affect rangelands.

Stream Systems Technology Center

(STREAM) Fort Collins, Colorado (www.stream.fs.fed.us)

Mission: The Stream Systems Technology Center is a national technical center chartered to improve knowledge of stream systems, develop operational tools and technology, provide training and technical support, and identify research needs for the purpose of coordinating development of needed technology to secure favorable conditions of water flows.

FY2004 Appropriations: $1,105,000

Outside Funding: $6,000

Key Accomplishments, Products, and Publications

- Scientists identified methods of estimating essential water flow regimes needed for the self-maintenance of gravel-bed stream channels in the western United States.
- Researchers continue to develop technologies that provide simple and quick measurement techniques to support channel maintenance.
- Scientists assess relationships between flow regimes and streamside and floodplain vegetation to help develop protocols for quantifying instream flows.
- In collaboration with the North Central Research Station, researchers produced a multimedia training program in CD and DVD formats explaining stream classification and demonstrating how to identify bankfull stage in stream types found in forested areas of the Northeastern United States.

Researchers empty a portable bedload trap at the Fraser Experimental Forest in Colorado.

"I want to inform you of the tremendous job David Merritt and Larry Schmidt did on behalf of the United States in the recent Hage trial. The report they coauthored on streamflows and alleged willow loss was extremely thorough in its research and convincing in its presentation – a credit to both of them. If it were military service, it would qualify as combat pay. Theirs was very distinguished service making a valuable contribution to this important case." (Trial Attorney, U.S. Department of Justice, Seattle, Washington)

Forest Service Research and Development in Idaho

The Rocky Mountain Research Station maintains four research work units at two Forestry Sciences Laboratories in Idaho, one in Boise and one in Moscow.

Scientists at Boise conduct integrated research that relates land use activities to the quality of riparian and aquatic environments. Areas of focus include: the evaluation and management of sensitive aquatic species; watershed processes that constrain and influence the quality of the habitats for those species; and the interrelationships of riparian-stream ecosystems.

Research at our Moscow facility centers on biology and ecological genetics of Interior West forests, including biometric methods to quantify changes in forest composition and structure over time and across landscapes; root disease management practices and soil management techniques to sustain productivity of the cedar, hemlock, grand fir, and Douglas-fir ecosystems of the Inland Northwest; and cost-effective methods of predicting and avoiding or minimizing impacts of forest roads on soil and water resources on steep unstable lands.

The Station maintains three experimental sites in Idaho: the Boise Basin Experimental Forest on the Boise National Forest, and the Deception Creek and Priest River Experimental Forests on the Idaho Panhandle National Forests.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
316 East Myrtle St.
Boise, ID 83702
(208) 373-4342
Fax: (208) 373-4391
(www.fs.fed.us/rm/boise)
(In Spring of 2005, the Boise lab will relocate to a new facility at 322 East Front St., Boise, ID 83702)

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
1221 South Main St.
Moscow, ID 83843
(208) 882-3557
Fax: (208) 883-2318
(http://forest.moscowfsl.wsu.edu)

Total FY2004 Appropriations: $5,389,000

Total Outside Funding: $969,756

Total National Fire Plan Funding: $1,338,084

Total Number of Scientist Years: 15

"Enclosed is an award for your outstanding work as a member of the Woody Biomass Assessment Team for producing the report 'A Strategic Assessment of Forest Biomass and Fuel Reduction Treatments in Western States.' Your contributions were critical to this important synthesis report, which is cited and used often." (National Program Leader for Forest Operations Research, USDA Forest Service, Washington, D.C.)

Integrated Research on Watershed Processes and Aquatic Ecology to Guide Management of Aquatic Ecosystems and Water and Soil Resources

(RMRS-4353) Boise, Idaho (www.fs.fed.us/rm/boise)

Mission: Develop knowledge of the biophysical conditions and processes that influence water quality and quantity, aquatic habitat quality, and the distribution, diversity, and persistence of fish and other aquatic species. Apply this knowledge to develop guidance for water resource management and the conservation and restoration of fish populations and other aquatic species at scales that define functional aquatic ecosystems.

FY2004 Appropriations: $1,898,000

Outside Funding: $346,003

National Fire Plan Funding: $278,205

Scientist Years: 5

Number of Products: 150

Key Accomplishments, Products, and Publications

- Project staff developed an Aquatic Multi-scale Assessment and Planning Framework to help revise and implement forest plans.
- Researchers developed models to predict the distribution of spawning habitat for Chinook salmon to help identify critical habitats without extensive on-the-ground inventory. These models will help scientists and managers predict the influence of natural and human related disturbances.
- New remote sensing techniques will allow scientists and managers to map large landslides over extensive areas, evaluate responses to land use and climate change, and develop appropriate management plans.
- Researchers devised new methods for large-scale snowmelt modeling that can help analysis and prediction of runoff for whole river basins.
- New models of bedload transport will improve predictions of channel maintenance flows and total maximum daily loads for sediment that must be considered under formal planning guidance and the Clean Water Act.
- Researchers developed standardized methods to evaluate Endangered Species Act listed fishes.

Biologists compare the efficiency of fish sampling methods to develop more consistent monitoring tools for managers and biologists responsible for species listed under the Endangered Species Act. .

Effects of Environmental Variability and Forest Management on Ecosystem Processes that Regulate Forest Dynamics in the Interior West

(RMRS-4155) Moscow, Idaho (http://forest.moscowfsl.wsu.edu/gems/)

Mission: Develop new knowledge on selected ecological processes and forest dynamics at the plant, stand, ecosystem, and landscape levels. This mission specifically includes research that expands our understanding of Interior West forest biology and ecological genetics, and provides biometric methods to support forest science and management.

FY2004 Appropriations: $1,411,000

Outside Funding: $322,840

National Fire Plan Funding: $394,174

Scientist Years: 3

Number of Products: 419

Key Accomplishments, Products, and Publications

- Science provides information on the genetic structure of conifer species in the Interior West that is useful in planning for reforestation, gene conservation, and climate change.
- Silvicultural studies on how forest structure modifies wildfire behavior show that crown fires can be limited by managing the amounts of surface, ladder, and crown fuels.
- Researchers used satellite and airborne imagery to evaluate wildfire soil burn severity, which helps prioritize postfire rehabilitation efforts.
- Scientists study how forests respond after thinning to reduce the risk of crown fires. Findings are used to decide how much thinning is needed to reduce wildfire risk and how long the thinning will be effective.

Measuring diameter of a tree killed in a Montana wildfire.

Microbial Processes that Affect Ecosystem Function

(RMRS-4552) Moscow, Idaho (http://forest.moscowfsl.wsu.edu/smp)

Mission: Conduct research and technology transfer on microbial processes that regulate forest ecosystem function in support of sustaining and enhancing productivity in the Western United States.

FY2004 Appropriations: $1,023,000

National Fire Plan Funding: $191,266

Scientist Years: 4

Number of Products: 58

Research on forest substrates helps develop tools for determining forest health and sustainability.

Key Accomplishments, Products, and Publications

- Scientists have discovered that beneficial fungi reside in wood roots and are important for maintaining forest health in many fire-dominated ecosystems.
- Studies on the difference between pathogenic and nonpathogenic Armillaria species are helping resource managers sustain forest ecosystems.
- Newly-developed methods enable long-term storage of root rot, decay, and mycorrhizal fungi (a beneficial root fungus) for future research on fungal interactions.
- Fire exclusion promotes large amounts of surface organic matter in many areas. Fire and silvicultural methods research guide restoration of ponderosa pine forests through alternative burning regimes.
- In cooperation with National Forest Systems, the North American Long-Term Soil Productivity study sites continue to provide valuable information on the effects of stand management on above- and below-ground processes important for sustainability.

Soil and Water Engineering Research

(RMRS-4702) Moscow, Idaho (http://forest.moscowfsl.wsu.edu/engr/)

Mission: Gain an increased understanding of forest soil erosion processes in order to develop management tools and practices to reduce onsite soil erosion and offsite sedimentation resulting from forest disturbances, including roads, forest operations, and fires.

FY2004 Appropriations: $1,057,000

Outside Funding: $300,913

National Fire Plan Funding: $474,439

Scientist Years: 3

Number of Products: 94

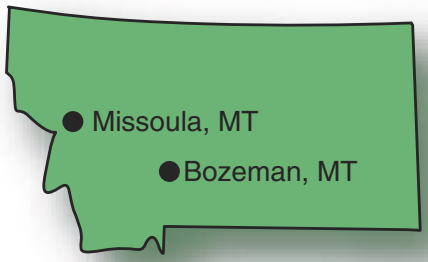
Key Accomplishments, Products, and Publications

- Scientists initialized a field study to measure the soil impacts from offroad vehicle traffic. Findings will help develop effective land management plans.
- Researchers continue to monitor the impacts of road removal and associated mitigation practices. Results will help minimize adverse watershed impacts.
- Studies measure the effectiveness of rehabilitation treatments and the impacts of salvage logging following wildfire.
- Scientists evaluate the impacts of fuel reduction operations, including cable logging, skidding, and other operations and prescribed fire on soil erosion.
- Researchers installed 20 watershed studies in the Priest River and Boise Basin Experimental Forests in Idaho to measure the impacts of fuel management activities on runoff and erosion.
- Scientists also held workshops on the applications of Station-developed erosion prediction tools, including the new Erosion Risk Management Tool (ERMiT) and the Geospatial Erosion Prediction Wizard, GeoWEPP.

A Station researcher measures the snow water equivalent as part of a fuel management study in the Priest River Experimental Forest, Idaho.

"This letter is in appreciation of Bill Elliot who made presentations at the Water/Road Interaction Workshop, held in Golden, CO. Many attendees commented that his presentations will help them do their jobs better. Bill always brings much valuable experience, insight and enthusiasm to the workshops." (Director of Engineering, Rocky Mountain Region, USDA Forest Service, Lakewood, Colorado)

Forest Service Research and Development in Montana



The Rocky Mountain Research Station maintains four research facilities in Montana: Forestry Sciences Laboratories in Missoula and Bozeman, and the Aldo Leopold Wilderness Research Institute and the Fire Sciences Laboratory in Missoula.

Scientists also conduct studies on the Coram Experimental Forest on the Flathead National Forest, and the Tenderfoot Creek Experimental Forest on the Lewis and Clark National Forest.

USDA Forest Service
Rocky Mountain Research Station
Aldo Leopold Wilderness Research Institute
790 East Beckwith
PO Box 8089
Missoula, MT 59807
(406) 542-4190
Fax: (406) 542-4196
(www.leopold.wilderness.net)

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
800 East Beckwith
PO Box 8089
Missoula, MT 59807
(406) 542-4150
Fax: (406) 543-2663
(www.fs.fed.us/rm/main/labs/missoula.html)

USDA Forest Service
Rocky Mountain Research Station
Fire Sciences Laboratory
PO Box 8089
West Highway 10
Missoula, MT 59802
(406) 329-4820
Fax: (406) 329-4825
(www.fs.fed.us/rm/main/labs/miss_fire.html)

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
1648 South 7th Ave.
MSU Campus, Bldg. 278
Bozeman, MT 59717
(406) 994-4852
Fax: (406) 994-5916
(www.fs.fed.us/rm/main/labs/bozeman.html)

Total FY2004 Appropriations: $ 7,769,000

Total Outside Funding: $4,345,680

Total National Fire Plan Funding: $2,889,577

Total Number of Scientist Years: 28

Ecology and Management of Northern Rocky Mountain Forests

(RMRS-4151) Missoula and Bozeman, Montana (www.fs.fed.us/rm/ecology)

Mission: Integrate knowledge about forest ecology and silvicultural practices into management guidelines needed to sustain ecosystem integrity, improve forest health, and enhance social values in landscapes of the Central and Northern Rocky Mountains.

FY2004 Appropriations: $1,257,000

Outside Funding: $84,195

National Fire Plan Funding: $662,201

Scientist Years: 3

Number of Products: 145

Key Accomplishments, Products, and Publications

- Scientists developed a landscape dynamic simulation system (www.fs.fed.us/rm/missoula/4151/SIMPPLLE) used by Forest Service planners and the Bureau of Land Management for management plan revision.
- Research results assist managers in hazardous fuel reduction planning with the Environmental Consequences Toolkit. The kit provides a synthesis of information about the environmental consequences of thinning and burning on water, air, soil, plants, and animals (www.fs.fed.us/fire/tech_transfer/synthesis/synthesis.index).
- Reevaluation of a 1967 study of wildfire and salvage logging provides valuable information about long-term effects of fuel treatments on soil, vegetation, succession, and tree growth.
- Scientists evaluate ecological and physiological methods that will improve testing of potential weed biocontrols.

Measuring the effectiveness of biocontrols to reduce the ability of Dalmation toadflax to reproduce.

Wildlife Ecology in Rocky Mountain Landscapes

(RMRS-4201) Missoula, Montana (http://www.fs.fed.us/rm/wildlife/genetics)

Mission: Develop wildlife habitat information at multiple spatial scales for use in managing and conserving wildlife in forest and rangeland ecosystems of the Rocky Mountains.

FY2004 Appropriations: $1,007,000

Outside Funding: $737,719

Scientist Years: 5

Number of Products: 129

The Canada lynx is one of the species scientists study at the Missoula, Montana laboratory.

Key Accomplishments, Products, and Publications

- Scientists address some of the most pressing issues surrounding lynx, wolverine, and fisher. Issues include responses to recreation and timber management, population viability, species distribution, and habitat connectivity relative to forest management and roads. Research results help develop guidelines for managing threatened and endangered species.
- Studies continue on the effects of management practices on native fauna. Researchers utilize novel methods to break through barriers and develop reliable, defensible, and cost-effective monitoring protocols. Findings help create new statistical methods to develop habitat relationships and noninvasive DNA techniques.
- Scientists develop new understandings of the ecological processes through which wildlife are impacted. Findings provide managers with tools to address problems such as invasive species without the need to manage or study each affected organism. Research has led to paradigm shifts regarding the application of biological controls and their effects on communities and ecosystems.
- Studies are highly integrated with forest managers' needs, such as delineating species range, determining historical conditions, assessing population abundance in threatened and endangered species, and identifying residual native populations where introductions have occurred. Scientists also work with States, Tribes, universities, foreign entities, and private groups on questions about wildlife genetics and other wildlife management needs.

Economic Aspects of Forest Management on Public Lands

(RMRS-4802) Missoula, Montana (www.fs.fed.us/rm/missoula/4802)

Mission: Develop information, methodology, and models needed to better integrate analyses of economic efficiency and economic effects into forest management decisions on public lands.

FY2004 Appropriations: $388,000

Outside Funding: $585,590

National Fire Plan Funding: $173,908

Scientist Years: 1

Number of Products: 85

Researchers develop tools to forecast wildland fire suppression expenditures and to help schedule fuel treatments that efficiently meet management objectives

Key Accomplishments, Products, and Publications

- Researchers apply GIS data, which show the spatial location of resource values, in a "break-even" approach to evaluate fire suppression options. Break-even analysis, the point where project benefits equal costs, identifies how much larger a fire would have to become without suppression before the value of the fire-threatened resources protected (benefits) equals fire suppression expenditures (costs).
- Scientists have developed statistical models for forecasting annual fire suppression expenditures for the Forest Service and Department of Interior. These models are run biweekly during the fire season to aid in meeting Federal regulations.
- Studies that analyze past large wildland fires and fire incident command teams help us to better understand the most important factors in influencing suppression expenditures.
- Scientists have developed a decision support system for scheduling fuel treatment options at landscape scales in the presence of multiple and sometimes competing resource objectives and operational constraints. This system, combined with vegetation disturbance models, helps optimize landscape treatments for reducing wildfire risk and improving ecosystem sustainability.

Bitterroot Ecosystem Management Research Project

(RMRS-4654) Missoula, Montana (www.fs.fed.us/rm/ecopartner)

Mission: Strengthen the scientific theory and practice of managing Rocky Mountain ecosystems at the landscape level in the context of social, economic, and ecological opportunities and constraints.

FY2004 Appropriations: $414,000

Number of Products: 112

Key Accomplishments, Products, and Publications

- Scientists measure the effects of weeds and biological control agents on native plants, small mammals, the food chain, and hantavirus.
- Studies show that thinning and underburning can improve the health and vigor of old growth ponderosa pine and larch stands when undergrowth competition is severe.
- Scientists evaluate the restoration of native bunchgrass using herbicides and prescribed burning.
- Ecosystem learning sites demonstrate forest change with various fuel and restoration treatments, contrasted with untreated areas.
- Researchers develop models for analyzing restoration, forest health, and fuel treatment strategies.
- Scientists have tested and demonstrated FireWorks, an educational program for increasing adult knowledge about wildland fire through hands-on learning.

Researchers host field trips to communicate science to resource managers and the public.

Aldo Leopold Wilderness Research Institute

(RMRS-4901) Missoula, Montana (http://leopold.wilderness.net)

Mission: Provide scientific leadership in developing and using the knowledge needed to sustain wilderness ecosystems and values.

FY2004 Appropriations: $892,000

Outside Funding: $372,692

National Fire Plan Funding: $347,756

Scientist Years: 4

Number of Products: 186

Key Accomplishments, Products, and Publications

- Scientists developed and demonstrated the Fire Effects Planning Framework that allows managers to display where and under what conditions fire may create benefits or pose threats to ecological conditions and management goals for wilderness.
- Researchers developed and tested BurnPro, a GIS model that identifies areas with opportunities for wildland fire use in wilderness.
- Research on visitor experiences in heavily used areas helps managers make decisions regarding objectives and appropriate strategies for managing heavy use in wilderness.
- Studies led to a better understanding of recreation visitor experiences and influences on those experiences for backcountry planning in National Parks and Forests in Alaska.
- The Institute cooperated with the native village of Kotzebue, Alaska, to identify values placed on wilderness lands by Tribal members, and the important forces of change on those values.

Scientists use global positioning systems to help gather data for managing wilderness.

- Studies on the effects of fire on stream communities provide managers with information on how aquatic species respond to different severities of fire in wilderness.

Fire Behavior Research

(RMRS-4401) Missoula, Montana (www.firelab.org/fbp/home.htm)

Mission: Conduct research on wildland fire behavior to help land managers involved in prefire planning and management, fire suppression, and prescribed burning to better manage and protect the environment, firefighters, and communities. This unit conducts fundamental laboratory and field research on wildland fire behavior, develops physically based models, and synthesizes knowledge into models and tools useful to managers.

FY2004 Appropriations: $1,642,000

Outside Funding: $409,207

National Fire Plan Funding: $357,692

Scientist Years: 5

Number of Products: 99

Researchers use controlled experiments at the Fire Sciences Laboratory in Missoula, Montana, to examine heat transfer mechanisms involved in extreme fire behavior.

Key Accomplishments, Products, and Publications

- Research on how homes ignite during extreme wildfires relates a home's ignition characteristics to burning objects immediately surrounding a home, and forms the basis for the National Firewise Communities USA Program, training courses, and educational materials. This work has been documented in a special August 2004 issue of the *Canadian Journal of Forestry Research* and has been internationally used in Canada and Europe.
- Newly developed instrumentation and field deployment protocols have helped integrate ground-based and airborne remote sensing measurements with in-situ instrumentation and measurements of wildfire properties and behavior.
- A "stem-heating" model for fire-induced tree mortality links models of heat transfer and tree cell death. The information is now available in a user-friendly format.
- New research uses mathematical procedures to identify major fire travel routes that optimize patterns of placement for fuels treatments for a particular weather condition. This method examines long-term impacts of optimal fuels treatment strategies on wildlfire impacts.

Fire Effects Research

(RMRS-4403) Missoula, Montana (http://www.firelab.org/fep/fehome.htm)

Mission: Determine the effects of fire on forests and rangelands through a program that involves site-, watershed-, and landscape-level field studies integrated with remote sensing and computer modeling.

FY2004 Appropriations: $1,241,000

Outside Funding: $1,817,291

National Fire Plan Funding: $382,532

Scientist Years: 7

Number of Products: 198

Scientists investigate the effects of fire on old-growth western larch forests near Seeley Lake, Montana.

Key Accomplishments, Products, and Publications

- Scientists developed methods and protocols for mapping fuels, fire hazard, and fire condition class for the national LANDFIRE (www.landfire.gov) effort, as well as map layers for central Utah and western Montana.
- FIREMON, a monitoring system that includes sampling protocols, databases and analysis tools, was developed for monitoring the effects of fire on vegetation and fuels.
- Researchers sample forest canopy fuels at fire and fire-surrogates study sites around the nation in replicated treatments that included mechanical thinning, prescribed fire, and untreated stands. Findings led to a method and software for estimating canopy density and height using forest stand data.
- Scientists also conducted restoration studies in ponderosa pine, lodgepole pine, and whitebark pine forests; monitored invasive species following prescribed fire and wildfire in Montana, Oregon and Idaho; examined the historical role of fire in ponderosa pine and mixed conifer forests in Utah and Idaho; and conducted landscape and stand level modeling work to examine the interactions of fuels, fire behavior, and stand and landscape structure. Results provide answers to how fire effects forests and rangelands.

Fire Chemistry Research

(RMRS-4404) Missoula, Montana (www.firelab.org/fcp/fchome.htm)

Mission: Develop knowledge of combustion processes, emissions of trace gases and aerosols by fires, spatial and temporal distribution of fires, and long-range transport of atmospheric pollutants produced by fires using a variety of advanced technologies. Produce critical fire and smoke information to aid land managers in reducing the effects of smoke.

FY2004 Appropriations: $928,000

Outside Funding: $338,986

National Fire Plan Funding: $965,488

Scientist Years: 3

Number of Products: 56

Researchers gather data during a wildfire in Alaska.

Key Accomplishments, Products, and Publications

- The project provides comprehensive daily, near real-time, high-resolution satellite images of fire locations and smoke dispersion nationwide on the Internet at www.firelab.org/rsl.
- Extensive field experiments during one of Alaska's worst fire seasons (2004) provided measurements of atmospheric pollutants and greenhouse gases, and the radiative energy released from fires in boreal black spruce ecosystems.
- Scientists carried out a prescribed burn experiment in Dillon, Montana, to monitor the dynamics of smoke plumes and the backscattering from aerosols emitted by a sagebrush fire. Results aid land managers in reducing the effects of smoke.
- In cooperation with the Desert Research Institute and Colorado State University, scientists conducted research on optical, physical, and chemical properties of aerosols in smoke. Results help analyze lidar data, and provide information for improved estimates of the effects of smoke particles on public health and global climate.

LANDFIRE

Missoula, Montana (www.landfire.gov)

Mission: The LANDFIRE project is a multiagency, interdisciplinary research and development project designed to develop maps and computer models needed by land and fire managers to prioritize, evaluate, plan, complete, and monitor fuel treatment and restoration projects essential to achieving the goals targeted in the National Fire Plan and the Healthy Forests Restoration Act of 2003.

Appropriations and Staffing Shown Under RMRS-4403

Key Accomplishments, Products and Publications

- Scientists and cooperators create maps that characterize vegetation, historical natural fire regimes, and departures of historical natural fire regimes, known as fire regime condition classes. These maps help prioritize areas for hazardous fuels reduction projects while evaluating rehabilitation and restoration objectives. They also aid in plans to reduce wildfire costs, losses, and damages by prioritizing communities within the vicinity of Federal lands that are at high risk from wildfires.
- LANDFIRE also creates maps that characterize fuel conditions based on fire behavior, fire effects, and fire danger research, and develops models that will be used to evaluate ecosystem status, fire hazard, and fire potential status.
- During a recent summer of severe wildfires in Montana and Idaho, LANDFIRE concepts and procedures provided fire specialists with technical support for locating fires and conducting a long-range assessment of potential fire behavior and effects. The fires demonstrated LANDFIRE concepts, and aided in refining procedures and building partnerships with fire managers.

Treating fuels to reduce the potential for crown fires and restore healthy forests.

- A recent Congressional General Accounting Office report describes LANDFIRE as “the only proposed research project so far that appears capable of producing consistent national inventory data for improving the prioritization of fuel projects and communities.”

Forest Service Research and Development in Nebraska

The USDA National Agroforestry Center, located in Lincoln, Nebraska, pioneers the development of agroforestry, a science and practice that integrates agriculture and forestry land uses. The partnership combines resources of the USDA Forest Service and Natural Resources Conservation Service to develop and apply agroforestry technologies in appropriate conservation and/or production systems for farms, ranches, and communities. The Center oversees a Technology Transfer and Applications Program that works with a national network of cooperators to develop and distribute technical agroforestry information.

USDA Forest Service
Rocky Mountain Research Station
National Agroforestry Center
University of Nebraska – East Campus
Lincoln, NE 68583
(402) 437-5178
Fax: (402) 437-5712
(http://www.unl.edu/nac/)

Total FY2004 Appropriations: $1,109,000

Total State and Private Funding: $467,000

Total Forest Service Research and Development Funding: $642,000

Total Natural Resource Conservation Service: $702,000

Total Number of Scientist Years: 2

"As the State Forester of South Dakota, we are interested in research that can be applied in real situations in the field. We have been very impressed with the applied research conducted by the National Agroforestry Center in Lincoln, Nebraska. The outreach and technical transfer of scientific information, showing the importance of trees in agricultural areas, has been outstanding. The information produced is readily adaptable to field implementation. The Center is a perfect example of how federal research should be conducted." (State Forester/Division Director, South Dakota Department of Agriculture, Pierre, South Dakota)

USDA National Agroforestry Center (NAC)

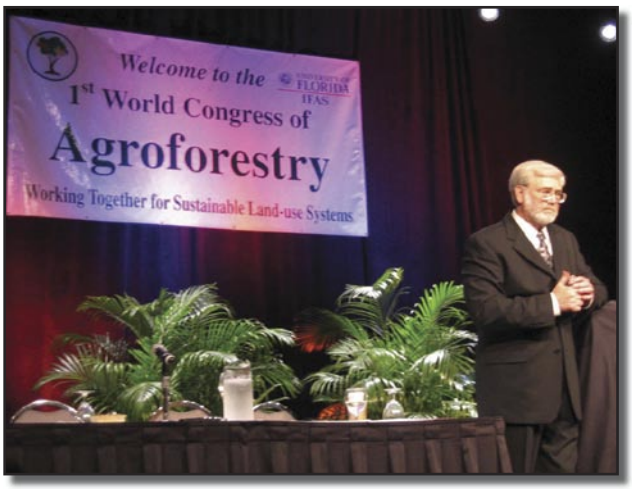
Lincoln, Nebraska (www.unl.edu/nac)

Mission: Catalyze and facilitate the development and application of agroforestry (agriculture/forestry) technologies to attain more economically, environmentally, and socially sustainable land use systems.

FY2004 Appropriations: $467,000

Key Accomplishments, Products, and Publications

- The Center helped sponsor the 1st World Congress of Agroforestry, held in Orlando, Florida, in 2004. The Congress, attended by more than 500 participants from 82 countries, provided a global forum for agroforestry professionals to share knowledge, experiences, and ideas. Two books that document the current state of knowledge and practice of agroforestry worldwide have been produced and another two are in production. These publications can be found at http://conference.ifas.ufl.edu/wca.
- Scientists partnered with the USDA Cooperative States Research, Education and Extension Service – Sustainable Agriculture Research and Education (SARE), to co-fund competitive grants for professional development workshops on agroforestry through its four regional centers. These workshops build upon the 75 on-farm demonstrations of agroforestry that the Center and Extension Service partnered on over the previous 5 years.
- The Center presented three invited papers at the 1st Sino-U.S. Seminar on Water and Soil Conservation, held in Beijing, China. The papers covered the use of agroforestry to reduce soil erosion and improve water quality in agricultural watersheds. This was in response to a recent USDA/China Ministry of Water Resources memorandum of understanding.
- In 2004, the Center distributed over 60,000 pieces of printed materials nationally to fill requests for agroforestry technology information.



USDA Deputy Secretary James Moseley delivers the keynote address at the 1st World Congress of Agroforestry, June 2004.

Tree-Based Buffer Technologies for Sustainable Land Use in the Central United States

(RMRS-4551) Lincoln, Nebraska (www.unl.edu/nac/research.html)

Mission: Understand the functions and processes of riparian and upland tree-based buffer technologies, and utilize this information to design plantings that integrate trees into land use systems to restore ecological functions and provide environmental services and economic opportunities.

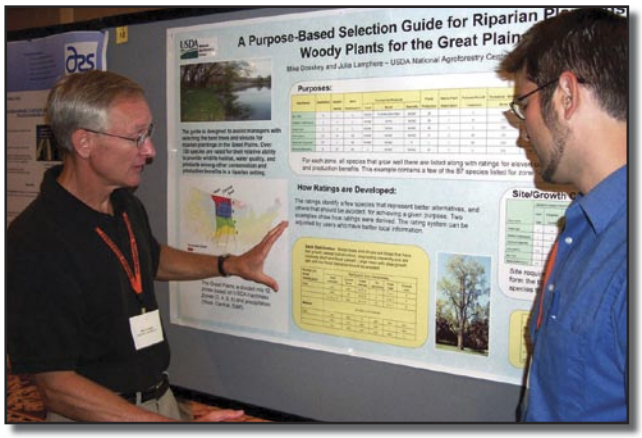
FY2004 Appropriations: $642,000

Scientist Years: 2

Number of Products: 98

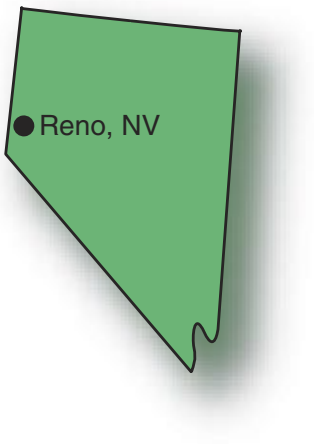
Key Accomplishments, Products and Publications

- Collaborative field research provides data and models that predict the impact of riparian and upland buffers (tree and shrub plantings) on water quality.
- Studies on the ability of riparian areas to trap sediment help managers understand how to design more efficient buffer systems to improve water quality.
- Scientists developed and tested a GIS-based method for identifying critical gaps in Midwestern riparian corridors. This tool aids in planning and designing riparian buffers that improve habitat for terrestrial wildlife.
- Scientists developed Buffer$, a computer-based, cost-benefit analysis tool that evaluates the economic impacts of buffer installation or removal in agricultural landscapes (www.unl.edu/nac/conservation).
- Buffer$, CanVis (easy to use software program for creating realistic visual simulations for resource planning), along with other NAC-developed buffer tools, were utilized in several USDA national training workshops as a means to both test and showcase these aids for conducting comprehensive conservation buffer planning on private lands.



The National Agroforestry Center is developing a variety of decision-support tools that assist in the planning and design of tree-based systems that better balance landowner production objectives with larger scale natural resource issues on private lands.

Forest Service Research and Development in Nevada



The Rocky Mountain Research Station maintains one research unit and the Great Basin Interdisciplinary Ecosystem Management Program in Reno, Nevada. Researchers examine the response of both upland communities, especially those associated with pinyon-juniper woodlands, and riparian ecosystems to past and present climate change and human disturbance in the Great Basin.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
University of Nevada
920 Valley Rd.
Reno, NV 89512
(775) 784-5329
Fax: (775) 784-4583
(www.fs.fed.us/rm/main/labs/reno.html)

Total FY2004 Appropriations: $604,000

Total Outside Funding: $178,002

Total National Fire Plan Funding: $114,263

Total Number of Scientist Years: 2

Ecology, Paleoecology and Restoration of Great Basin Watersheds

(RMRS-4252) Reno, Nevada (http://www.fs.fed.us/rm/main/labs/reno/rmrs4252.html)

Mission: Increase understanding of the effects of both long-term climate change processes and more recent natural and anthropogenic disturbances on Great Basin ecosystems and watersheds, and use this understanding to devise meaningful scenarios for their restoration and management.

FY2004 Appropriations: $366,000

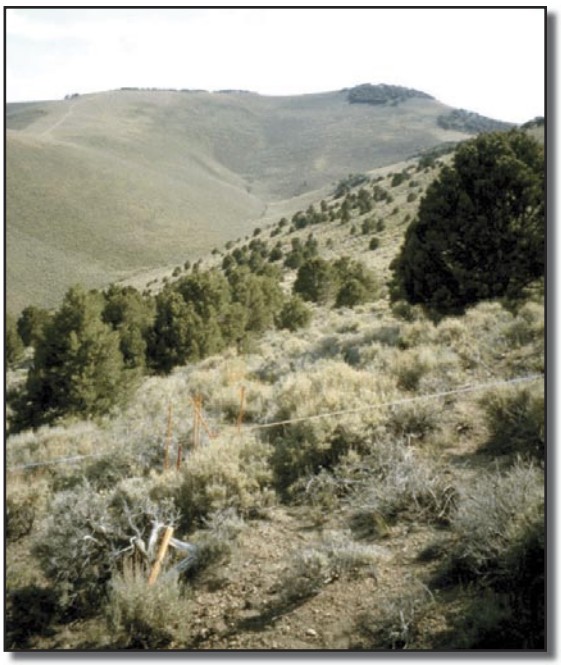
National Fire Plan Funding: $114,263

Scientist Years: 2

Number of Products: 35

Key Accomplishments, Products, and Publications

- Studies provide a better understanding of the causes, patterns, rates, and locations that have experienced expansion of pinyon/juniper woodlands. These changes have affected some of the Great Basin's most diverse and productive sagebrush ecosystems. Findings shed light on the changes in community composition, and help develop methods to measure increases in fuel loads and fire risk associated with the woodland expansion.
- Scientists examine the susceptibility of Great Basin vegetation communities that have been altered by woodland expansion and climate change to exotic annual plants. These studies focus on the expansion in range and dominance of cheatgrass. The most susceptible topographic, soils, and environmental and plant community conditions facilitating cheatgrass expansion following disturbances are being identified.
- Plant fossil data from woodrat middens (nests) help determine the effects of long-term trends in environmental changes on the patterns and rates of change now resulting from human impacts. Extreme climate events that occurred as long as 2,000 years ago still have significant influence on the patterns of current changes, and provide insight into potential future changes.



Ongoing upslope expansion of pinyon/juniper woodlands in the Shoshone Mountains study area in central Nevada.

Great Basin Ecosystem Management Project

(RMRS-4655) Reno, Nevada (www.ag.unr.edu/gbem)

Mission: Increase understanding of the structure and function of riparian ecosystems and watersheds within the central Great Basin, and develop management guidelines for maintaining or restoring their integrity.

FY2004 Appropriations: $238,000

Outside Funding: $178,002

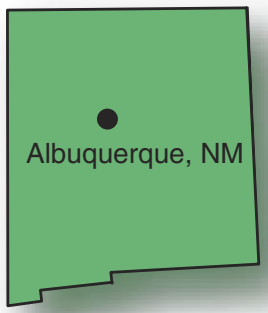
Number of Products: 34

Key Accomplishments, Products, and Publications

- Scientists provide process-based information for restoring and managing Great Basin riparian areas in a book published by Island Press titled *Great Basin Riparian Ecosystems: Ecology, Management and Restoration*. The approach provides a model for conducting interdisciplinary watershed research, and the linked studies on climate history, geology, hydrology, and ecology have broad-scale implications for riparian ecosystem management.
- Project researchers developed a demonstration area on ecosystem response to watershed-scale burns in pinyon-juniper ecosystems that is guiding fuels and fire management efforts in Great Basin woodlands.

Studies in pinyon-juniper ecosystems are helping to develop guidelines for fuels treatment.

Forest Service Research and Development in New Mexico



The Rocky Mountain Research Station maintains three research units at the Forestry Sciences Laboratory in Albuquerque, New Mexico. The lab is colocated with the Forest Service's Southwestern Region headquarters.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
333 Broadway S.E., #115
Albuquerque, NM 87102
(505) 724-3660
Fax: (505) 724-3688
(http://www.fs.fed.us/rm/albuq/)

Total FY2004 Appropriations: $1,633,000

Total Outside Funding: $130,220

Total National Fire Plan Funding: $693,525

Total Number of Scientist Years: 9

Ecology, Recovery, and Sustainability of Southwestern Grasslands and Associated Riparian Ecosystems and Wildlife

(RMRS-4351) Albuquerque, New Mexico (www.fs.fed.us/rm/albuq/rwud4351.htm)

Mission: Develop, synthesize and apply new methods and knowledge of processes, interactions, and human uses of grassland and riparian ecosystems to restore damaged lands, recover sensitive species, and sustain intact, productive, and diverse plant and wildlife communities and associated abiotic systems in the Southwest.

FY2004 Appropriations: $752,000

Outside Funding: $130,220

National Fire Plan Funding: $368,125

Scientist Years: 6

Number of Products: 66

Scientists study the use of prescribed fire to restore grasslands in the Southwest.

Key Accomplishments, Products, and Publications

- Results of National Fire Plan research on the role of wildfires in altering and restoring Southwestern riparian habitats is used by land managers to monitor and control the exotic woody plant salt cedar.
- Research results on the use of fire as a management tool guides restoration of National Grasslands in the Southwest. A project scientist received the 2004 National Grassland Council Research Award for this work
- National Fire Plan research on the use of prescribed fire to manage woody plants and exotic weeds on Southwestern grasslands were presented to several professional societies.
- Managers will benefit from a new Station report prepared in part by project scientists that comprehensively describes Southwestern grasslands, including their classification, biology, sustainability, cultural dimensions and management tools.
- Research results help in the design of management plans that reduce soil erosion and improve watersheds in New Mexico.
- Researchers identify the distribution of algae to highlight prime locations of refuge habitats for the endangered Rio Grande silvery minnow.

Ecology, Diversity and Sustainability of Soil, Plant, Animal and Human Resources of the Rio Grande Basin

(RMRS-4652) Albuquerque, New Mexico (www.fs.fed.us/rm/albuq/rwu4652.htm)

Mission: Develop, synthesize, and apply new knowledge on processes, interactions, and sociocultural uses of upland and riparian ecological systems for sustaining diverse, productive, and healthy plant, animal, and human populations and associated natural resources in the Rio Grande Basin.

FY2004 Appropriations: $407,000

Number of Products: 38

Key Accomplishments, Products and Publications

- Fuel reduction studies help managers prevent the spread of wildfire in riparian woodlands. Research tests include three methods for reducing fuels and restoring sites along the middle Rio Grande.
- Research focuses on whether removal of salt cedar and Russian olive reduces fire risk, preserves native trees, and improves habitats for wildlife, including reptiles, bats, and birds. Managers have used these data to leverage funds and justify salt cedar removal projects.
- Research is underway on past human-environmental interaction and landscape change on the Sevilleta National Wildlife Refuge and Cibola National Forest in New Mexico.
- Scientists measure water gain from removing salt cedar and Russian olive at cottonwood sites, and assess evaporative losses after removal.
- A large-scale survey examines the sociocultural and economic roles of livestock ranching in maintaining rural Hispanic culture and traditions among all grazing permittees on the Santa Fe and Carson National Forests in New Mexico.

Research is under way on past human-environmental interactions and landscape change.

Cultural Heritage Research

(RMRS-4853) Albuquerque, New Mexico (http://www.fs.fed.us/rm/albuq/)

Mission: Support efficient and effective land management by improving understanding of sustainable relationships between communities and their environments, diversity in communities of land users, and human communities modifying landscapes through time.

FY2004 Appropriations: $474,000

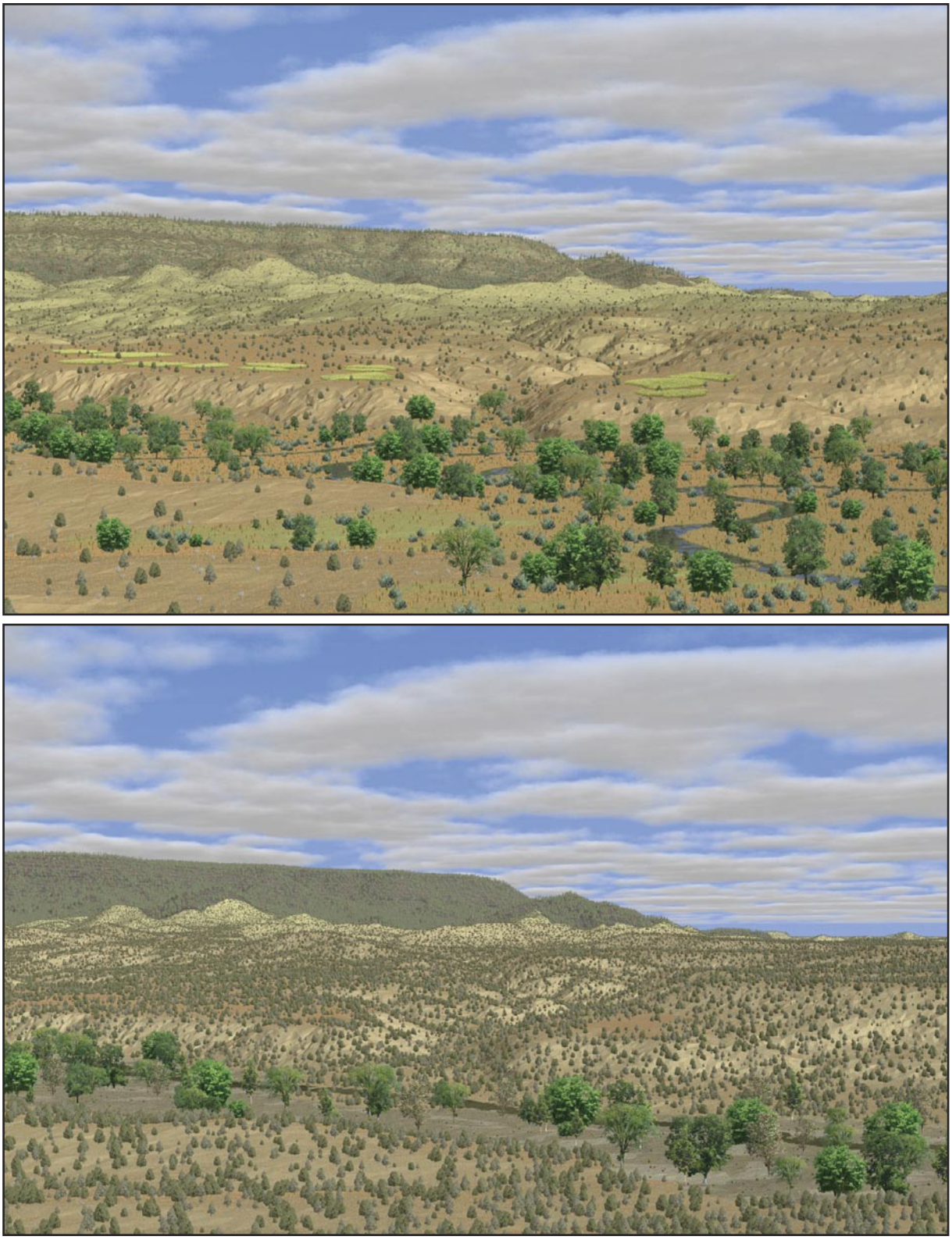
National Fire Plan Funding: $325,400

Scientist Years: 3

Number of Products: 68

Key Accomplishments, Products, and Publications

- Scientists published the pilot study, *Economic, Social and Cultural Aspects of Livestock Ranching on the Espanola and Canjilon Ranger Districts of the Santa Fe and Carson National Forests: A Pilot Study* (RMRS-GTR-113), which provides information on the importance of public land grazing in northern New Mexico.
- Project scientists published definitive papers in the multivolume Encyclopedia of Energy, a new, standard reference work on all aspects of energy.
- Work is under way to increase understanding of long-term fire history in riparian areas, and the factors that led to present vegetation conditions and fire vulnerability. This study provides models of environmental conditions that can exist under a range of climatic conditions and human land uses.
- Scientists conducted a large-scale survey among all grazing permittees on the Santa Fe and Carson National Forests in New Mexico to examine sociocultural and economic roles of livestock ranching in maintaining rural Hispanic culture and traditions.
- Research among communities and forest users throughout the Southwest includes gathering information on public knowledge and attitudes concerning prescribed fire as a vegetation management tool. Results will help land managers plan forest restoration and fuels reduction projects.
- Results from recently completed studies of New Mexico's Rio del Oso Valley help reconstruct the long-term environmental and human land use history of the Valley. This information will inform managers about past vegetation in the study area, which will clarify options for future conditions.



Studies help reconstruct the long-term environmental and human land use history of New Mexico's Rio del Oso Valley. Top photo is a simulation from A.D. 1400; bottom photo is a simulation of the current landscape.

Forest Service Research and Development in North Dakota

Although there are no Station research units currently in North Dakota, the Station conducts research throughout the Great Plains that benefits the residents of North Dakota. For instance, the research unit located in Rapid City, South Dakota, works to protect and restore grassland ecosystems while providing benefits and maintaining commodity outputs. Scientists also investigate ways to maintain viable populations of such animal and plant species as the black-footed ferret, swift fox, ferruginous hawk, mountain plover, burrowing owl, prairie fringed orchid, milkvetch, and Dakota buckwheat. Other work focuses on the effects of fire, climate change, and grazing on the prairie landscapes of the northern and central Great Plains, as well as on the interactions of gamebirds and big game species with livestock. The Station maintains cooperative working relationships with researchers and other resource specialists throughout North Dakota.

Forest Service Research and Development in South Dakota

The Rocky Mountain Research Station maintains one research work unit in South Dakota - the Center for Great Plains Ecosystem Research, in Rapid City.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
1730 Samco Rd.
Rapid City, SD 57702
(605) 394-1960
Fax: (605) 394-6627
(http://www.fs.fed.us/rm/rapidcity/)

Total FY2004 Appropriations: $786,000

Total Outside Funding: $35,000

Total Number of Scientist Years: 3

Management for Sustainable Ecological Systems on the Northern and Central Great Plains

(RMRS-4254) Rapid City, South Dakota (www.fs.fed.us/rm/rapidcity)

Mission: Increase knowledge and develop technology to manage for sustainability in grassland and forested ecological systems of the Great Plains.

FY2004 Appropriations: $786,000

Outside Funding: 35,000

Scientist Years: 3

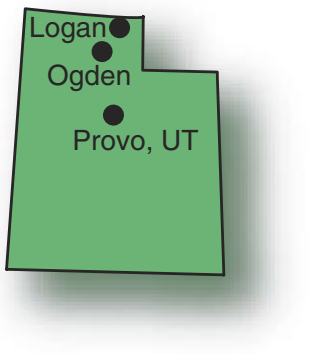
Number of Products: 26

Key Accomplishments, Products, and Publications

- Scientists develop simple, cost-effective techniques to accurately estimate forage production, utilization, and ecological trends in relation to management needs.
- Landscape level research on the fire enhanced spread of invasive plants via roads and riparian corridors will facilitate early detection and rapid responses to infestations.
- Long-term monitoring of chemical and biological control of leafy spurge (an invasive weed) provides managers with information on the efficacy of control methods, potential nontarget impacts, and recovery patterns following control.
- Scientists are testing, modifying, and retesting a habitat model for elk in the Black Hills. This research has resulted in a complete rewrite of the model code into a high performance, user-friendly format.
- Studies explore habitat relations of birds in prairie woodlands and grasslands to ecological land condition, Black-backed woodpeckers to mountain pine beetle infestations, and Merriam's turkeys to land-use patterns.

Studies look at the relationship between black-backed woodpeckers and mountain pine beetle infestations.

Forest Service Research and Development in Utah



The Rocky Mountain Research Station maintains four research units in Utah: two in Logan, one in Ogden, and one in Provo. An administrative service center is also in Ogden.

The Station also maintains the Desert Experimental Range in southeastern Utah, and the Great Basin Experimental Range on the Manti-La Sal National Forest.

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860 North 12th
Logan UT 84321
(435) 755-3560
Fax: (435) 755-3563
(www.fs.fed.us/rm/main/labs/logan.html)

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
507 25th Street
Ogden, UT 84401
(801) 625-5388
Fax: (801) 625-5723
(http://www.fs.fed.us/rm/ogden/)

USDA Forest Service
Rocky Mountain Research Station
Shrub Sciences Laboratory
735 North 500 East
Provo, UT 84606
(801) 356-5100
Fax: (801) 375-6968
(http://www.fs.fed.us/rm/provo/)

Total FY2004 Appropriations: $11,664,000

Total Outside Funding: $2,898,669

Total National Fire Plan Funding: $471,955

Total Number of Scientist Years: 11

"As Forest Entomologist for the State of Idaho, I have the responsibility to provide technical assistance relating to forest insect questions and problems to state and private woodland owners, including the forest industry. More than once I have called on Barbara Bentz, Project Leader at Logan, UT, and her staff. Their willing cooperation and excellent and timely information have been of great value to me as I have responded to questions and problems relating to the mountain pine beetle and other bark beetles. Their high level of technical knowledge and willingness to take the time to help has been greatly appreciated." (Forest Entomologist, State of Idaho, Boise, Idaho)

Biology, Ecology and Management of Western Bark Beetles

(RMRS-4501) Logan, Utah (http://www.usu.edu/beetle/)

Mission: Develop a scientifically credible knowledge base focused on insect population dynamics, in particular bark beetles, and their associated ecological effects in coniferous forests of Western North America. Using this knowledge, develop tools to facilitate effective management strategies designed to maintain or restore these forests into productive, sustainable ecosystems at stand, landscape, and regional levels.

FY2004 Appropriations: $679,000

Outside Funding: $81,862

Scientist Years: 2

Number of Products: 21

Key Accomplishments, Products, and Publications

- Results from a 3-year study suggest that mountain pine beetle-caused lodgepole pine mortality can be reduced using high doses of synthetically produced verbenone, a compound often found in bark beetle/conifer systems.
- The project's mountain pine beetle phenology model, being used in conjunction with a model developed by Canadian researchers, predicts impacts of climate change on mountain pine beetle expansion into previously unoccupied regions.
- A model system that combines gypsy moth phenology, host range distributions, and historic and projected weather is an important new aid to viable risk assessment for detecting gypsy moth introductions into Western forests.
- Recent research on bark beetle population dynamics in fire-injured trees is being incorporated into probability models of bark beetle-caused delayed tree mortality following wildfires. These models can be used in timber marking guidelines for salvage operations following wildfire.

Sampling a fire injured tree infested with Douglas-fir beetles following the Green Knoll wildfire in Wyoming.

- Recent research with the mountain pine beetle suggests that pheromone traps, a tool routinely used by managers, may be a biased sample of the timing and number of beetles occurring at the local and landscape scale.

Restoration of Disturbed Ecosystems

(RMRS-4301) Logan, Utah (www.fs.fed.us/rm/logan/4301)

Mission: Find ways to better understand and manage lands and streams disturbed by human activities and natural events such as mining and burning, and investigate aspen dynamics and ways to restore aspen stands at the landscape level.

FY2004 Appropriations: $354,000

Outside Funding: $494,532

Scientist Years: 2

Number of Products: 23

Key Accomplishments, Products, and Publications

- Scientists developed and transferred science findings and tools to reduce exposure to selenium-contaminated soils in southeastern Idaho. Such information is vital to mine spoils reclamation efforts.
- Research results documented water quality trends and conditions in central Nevada watershed studies. Such information is helping develop land management plans throughout the region.
- Researchers address concerns about the decline of aspen in the Western United States by advising land managers on how best to restore this species and evaluate their efforts.

Scientists consult with land managers on how best to restore and maintain aspen forests.

"I would like to personally thank your Station for allowing Dale Bartos to visit the Caribou-Targhee National Forest. He provided expertise on aspen ecology and management to 60 people and visited six ranger districts. The information he provided will help our managers make better decisions in their environmental documents and feel more confident about the success of implementing these decisions." (Forest Supervisor, Caribou-Targhee National Forest, Idaho Falls, Idaho)

Shrubland Biology and Restoration Research

(RMRS-4253) Provo, Utah, and Boise, Idaho (www.fs.fed.us/rm/provo)

Mission: Develop knowledge, plant materials, and technology for successful long-term restoration of diverse shrubland plant communities to meet resource needs and values.

FY2004 Appropriations: $1,144,000

Outside Funding: $1,234,075

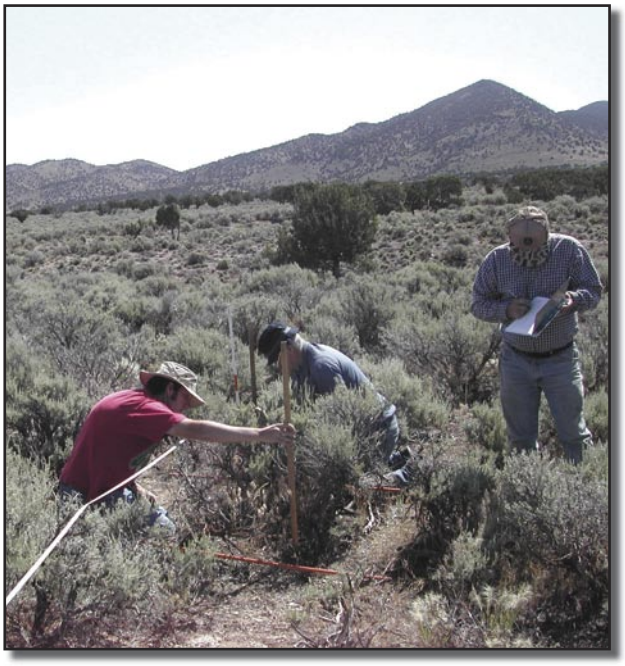
National Fire Plan Funding: $471,955

Scientist Years: 5

Number of Products: 397

Key Accomplishments, Products, and Publications

- Scientists published a series of studies on the biological control of cheatgrass by headsmut fungus. Results show that both cheatgrass and the headsmut fungus have multiple genotypes that interact with each other and the environment. The realization of a biological control for cheatgrass would be a huge boon to restoring Western wildlands to more natural, ecologically functioning conditions.
- Scientists produced a major publication with the International Institute of Tropical Forestry that provides monographs of more than 300 shrub species, including descriptions of ecology, distribution, reproductive characteristics, growth and management, and benefits to humans, animals, and the environment.
- Work continues on the collection, cultural care, genetics, and ecology of native wildland plant species indigenous to and useful for the rehabilitation of degraded big sagebrush and pinyon-juniper ecosystems. Results of this work include the formal release of germplasm of 'Anatone' bluebunch wheatgrass and 'Maple Grove' Lewis flax, and the publication of appropriate seed zones for fourwing saltbush, a species widely used for rehabilitation and restoration plantings.



Researchers collect data on the health and status of a big sagebrush community.

Interior West Forest Inventory and Analysis Program

(RMRS-4801) Ogden, Utah (www.fs.fed.us/rm/ogden)

Mission: Improve the understanding and management of our Nation's forests by measuring, assessing, and reporting on the extent, condition and health of the forest lands of the Interior West on an annual basis.

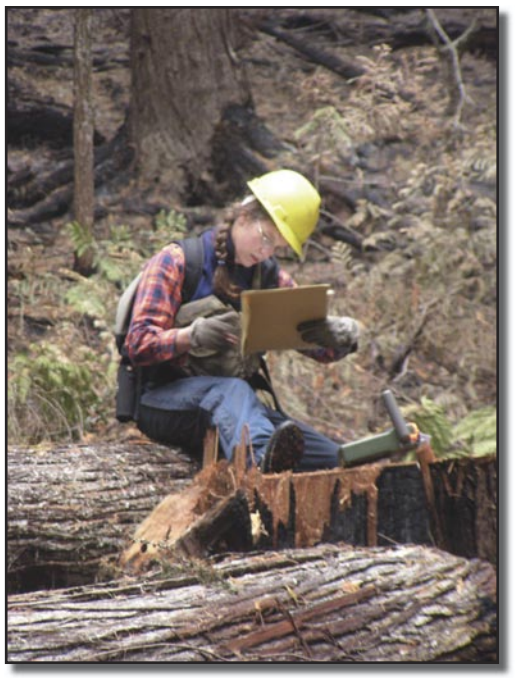
FY 2004 Appropriations: $9,487,000

Outside Funding: $1,088,200

Scientist Years: 2

Key Accomplishments, Products and Publications

- Crews collect, compile, and make available to the public forest resource data on six of the eight Interior West States: Arizona, Colorado, Idaho, Montana, Nevada and Utah. More than 80 percent of the forest lands in the Interior West are currently in the annual forest inventory system.
- Research staff developed mid-scale maps of forest attributes for the State of Wyoming using ground data, satellite imagery, and other ancillary data. This effort helps develop strategic level maps used by land managers to assess current resource conditions such as biomass or wildlife habitat, evaluate a variety of potential risks of fire and insects, and formulate forest plans.
- Analysis staff reported on data from the latest periodic forest inventory in New Mexico. This was the first comprehensive report on the State that included all National Forest System lands and reserved lands. The data and report provide land managers with a reliable baseline with which to assess forest condition, use, and potential.
- Program analysts recently published a report describing five indicators of forest and rangeland health and functionality, and demonstrated the use of FIA data for evaluating the indicators within several vegetation types on the Bridger-Teton National Forest in Wyoming.
- In a collaborative effort with the Forest Service's Remote Sensing Applications Center, staff conducted an application and cost analysis using digital, large-scale GPS-controlled aerial photo sampling for pinyon-juniper forest inventory.



Field professionals sample forest lands throughout the Interior West.

Forest Service Research and Development in Wyoming

The Rocky Mountain Research Station maintains one research unit at the Forestry Sciences Laboratory in Laramie. The project is co-located at Station headquarters in Fort Collins, Colorado. Scientists study watershed processes, wildlife and fisheries, and their associated habitats. Other Station projects, located in Fort Collins, conduct research at the Glacier Lakes Ecosystem Experiments Site on the Medicine Bow National Forest in southern Wyoming.

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(307) 742-6621
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(http://www.fs.fed.us/rm/rwu4352/)

(Appropriations and Scientist Years are Incorporated into RMRS-4352 in the "Forest Service Research and Development in Colorado" Section.)

Consequences of Land Management and Natural Disturbance to Water Quality and Quantity Across the Aquatic, Riparian and Upland Continuum

(RMRS-4352) Laramie, Wyoming (www.fs.fed.us/rm/main/labs/ftcollins/rmrs4352.html)
(this project is co-located with RMRS-4352 in Fort Collins, Colorado)

Mission: Quantify watershed processes and the impacts on watershed resources of management activities, disturbance, and associated uncertainties across upland forests, riparian areas, and streams in the Central Rocky Mountains.

Key Accomplishments, Products, and Publications

- In collaboration with the Arapaho-Roosevelt and Medicine Bow-Routt National Forests in Colorado, scientists devise new protocols for monitoring the recovery of greenback cutthroat trout, listed as threatened under the Endangered Species Act, and Colorado River cutthroat trout, considered a sensitive species in the Agency's Rocky Mountain Region. Scientists have created and validated the first empirically based model to predict population size based on stream length. These results will help efforts to conserve and restore trout populations.
- Scientists work with the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, and the Department of Defense to design, test, and launch a satellite that will improve abilities to measure hydrological information on local, regional, and global scales, and improve forecast models for runoff and water supply.
- Studies show that the decline in productivity with forest age is caused by a decline in canopy photosynthesis, and that proper nutrition can slow the decline.
- Scientists have characterized postfire recovery rates for key shrubs, and the influence of management practices on regrowth following wildland fire.

Greenback cutthroat trout.

Results will assist in prescribing effective rehabilitation projects following fire, particularly in priority watersheds or along streams that provide critical habitat for rare fish species.

Honors and Awards

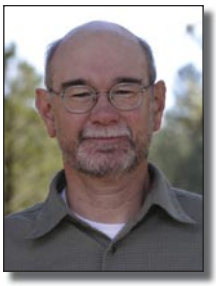
- Plant Physiologist *Bob Musselman*, Fort Collins, Colorado, was awarded an Honorary Diploma and medal from the Forest Research and Management Institute in Bucharest, Romania, for exceptional and outstanding cooperation in forestry research and development. He and a cooperating scientist have been conducting studies in Romania since 1998 on ozone effects on vegetation.

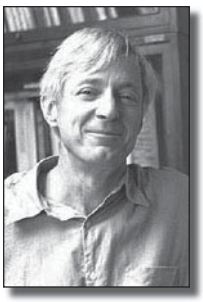
- *Michael Schwartz*, Wildlife Ecologist in Missoula, Montana, was honored with the 2003 Forest Service Chief's Early Career Scientist Award. The award recognizes his sustained research effort over the past years in the field of ecology and genetics. Schwartz leads the only wildlife genetics laboratory in the Forest Service, which he helped initiate and develop.

- Research Fisheries Biologist *John Rinne*, stationed at the Southwest Forest Sciences Complex in Flagstaff, Arizona, was recognized by the American Fisheries Association with the Rise to the Future Award. He was noted for his research that has resulted in major Forest Service successes and contributions toward the conservation of native fishes and their habitat in the Southwestern United States.

- Two researchers from our Flagstaff, Arizona, laboratory were honored at the Arizona/New Mexico meeting of the Wildlife Society and American Fisheries Society. *Kristin Covert* received the Roger Hungerford Student Award for "contributions to the management and conservation of Arizona's wildlife." *Nate Gwinn's* (not pictured) poster paper "Smallmouth Bass Predation on Crayfish in Fossil Creek, Arizona, Based on Stable Isotope Analysis," won awards as best student poster.

- The Station presented its 2003 Outstanding Science and Administration and Research Support Awards. Research Plant Pathologist *Brian Geils (top photo)*, Flagstaff, Arizona, received one of two "Technology Transfer Publication Awards" for the co-authored *Mistletoes of North American Conifers*, General Technical Report RMRS-98. The other award went to Economists *Patty Champ* and *Tom Brown*, Fort Collins, Colorado, for the book *A Primer on Nonmarket Valuation*, published by Kluwer Academic Publishers.





- The "Early Career Scientist Award" was presented to *Carol Miller*, Research Ecologist with the Aldo Leopold Wilderness Research Institute in Missoula, Montana. The award is based on her recent paper "Simulation of Effects of Climatic Change on Fire Regimes," published as a chapter in the 2003 Springer-Verlag book *Fire and Climatic Change in Temperate Ecosystems of the Western Americas*.

- *Sam Cushman*, Postdoc employee in Missoula, Montana, was honored with the "Best Scientific Publication Award" for his co-authored paper titled "Landscape-level Patterns of Avian Diversity in the Oregon Coast Range," published in the May 2003 issue of Ecological Monographs.

- Boise, Idaho, Fisheries Biologist *Gwynne Chandler* (not pictured) received the "Outstanding Science Support Award" for her skills as a data analyst and database manager, and for contributing to a more efficient and effective operation of the Boise Lab.
- The "Outstanding Lab/Project Support/Secretaries Award" was presented to Program Assistant *Karen Iverson*, Missoula, Montana. Karen was noted for outstanding leadership and management skills, managing the project's budget, and serving as the Director's Representative Assistant.

- The "Outstanding Customer Service Award" went to Grants and Agreements Specialist *Judy Perry*, Fort Collins, Colorado. She was recognized for her exemplary work in assisting scientists in establishing grants and agreements with a variety of state, Federal and university cooperators, and her professionalism and can-do attitude under extremely challenging circumstances.

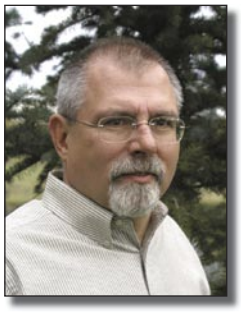
- The Station's Acquisition Management Staff (*Sue Evans, Mai Dailey, Deb Jensen, Carolyn Lumar, Sue Major,* and *Christina Schofield*) were honored with the "Outstanding Administrative Team Award." The group was noted for being extraordinarily capable and helpful in establishing agreements and providing other acquisition support with unparalleled knowledge, can-do attitudes and courtesy.

Left to right: Deb Jensen, Christina Schofield, Sue Major, Sue Evans, Carolyn Lumar, and Mai Dailey.

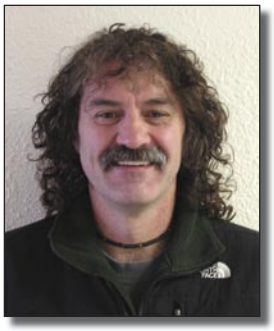
- *Diane Jacobs*, Supervisory Administrative Officer in Flagstaff, Arizona, was awarded the "Open Category Award" for outstanding leadership and administrative skills, and for maintaining a high level of customer service for lab personnel despite challenging circumstances.

- Research Ecologist *Al Medina*, Flagstaff, Arizona, received a recognition award from the Bureau of Land Management's Utah State Office and the Grand Staircase National Monument for his review of rangeland standards and practices for the Monument.

- The Remote Sensing and Photogrammetry Society honored Mathematical Statistician *Ray Czaplewski*, Fort Collins, Colorado, with its 2004 Best Letter Award for his paper titled "Can a Sample of Landsat Sensor Scenes Reliably Estimate the Global Extent of Tropical Deforestation?" The paper evaluates the methods used by the Food and Agricultural Organization of the United Nations to estimate the status and trends of the world's tropical forests.



- *Alan Watson*, Research Social Scientist in Missoula, Montana, was selected as a Fellow in the Academy of Leisure Sciences. The Academy was founded in 1980 to promote the intellectual advancement of leisure sciences. He is one of approximately 70 Fellows recognized for their outstanding contributions to the field.



- The Station was a co-recipient of a technology transfer award from the Federal Laboratory Consortium (FLC). The award recognizes support provided by the Wildland-Urban Interface Fuels Management and Forest Health Restoration project in Flagstaff, Arizona, toward development of FIRETEC, a fire behavior model that was developed at the Los Alamos National Laboratory in Los Alamos, New Mexico. The Station provided the study area for testing FIRETEC and support for modeling through an interagency agreement.
- The National Weather Service presented the Stations' Fort Valley Experimental Forest in Arizona with a Certificate of Appreciation for being a cooperative weather observer. Weather observations at Fort Valley have been reported to the National Weather Service since 1909. Find out more at www.rmrs.nau.edu/fortvalley.

RMRS Partnerships

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

- **National Forest Systems.** Forest supervisors and managers compose the Station's largest customer segment or stakeholder group. The Station supports several national missions, including: the National Agroforestry Center; Fire Sciences Laboratory; Aldo Leopold Wilderness Research Institute; and the Nonmarket Valuation, Natural Resource Assessment and Ecology and Management, Cultural Heritage, and Stream Systems Technology units. National Forest Systems rely heavily on Station staffs to provide scientific information and assistance in implementing the Endangered Species Act, Clean Water Act, Clean Air Act, and other environmental legislation.
- **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, and Department of Defense.
- **Other Federal Non-land Management Agencies.** The Rocky Mountain Research Station provides regular consultation to the Environmental Protection Agency, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Natural Resources Conservation Service and Bureau of Indian Affairs in non-land management functions. For instance, the Station created and supports the Rocky Mountain Center, a computer modeling system that provides real-time, high-resolution weather intelligence that assists in fire and smoke management in the Interior West. Partners include the National Oceanic and Atmospheric Administration, National Weather Service, Environmental Protection Agency, state agencies, universities, and others. Information is available at www.fs.fed.us/rmc.
- **State, Local and Other Public Agencies.** Our Interior West Resource Inventory unit is the Station's largest unit 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.
- **Industry.** The forest products industry is primarily concentrated in the northwestern part of our territory in Idaho and Montana. It has traditionally been an important customer for tree improvement, forest productivity, mensuration, insect and disease, and engineering technology research at our Moscow, Idaho, and other labs. The Station collaborates 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.
- **Tribal Governments.** The Station supports a number of working relationships with several Tribal governments, including fuels reduction/ exotic plant removal studies with the Navajo Cochiti Pueblo (NM), fire effects consultation with the Navajo Tribe (AZ), conservation education programs with the Salish-Kootenai Tribe (MT), and riparian restoration work with the White Mountain Apache Tribe in Arizona.
- **International Cooperation.** Station scientists took 133 trips to other countries in 2004 to cooperate with scientists, universities, institutions, and government agencies on a variety of natural resources projects and issues. For instance, a Station scientist with the Aldo Leopold Wilderness Research Institute in Missoula, Montana, was invited to Parks Canada national headquarters in Ottawa, Ontario to provide a summary of results from research conducted in the far Eastern Arctic of Canada. The Institute's research in social sciences is contributing to management plans in Canada's National Parks. In addition, a Fort Collins scientist was invited to spend a week at the York office of the Stockholm Environmental Institute in the UK where he helped develop an ozone deposition model for use with the United Nations Economic Commission for Europe Convention on the Long-Range Transboundary Air Pollution program.

Grants and Agreements

Universities and Cooperative Research

The Station participates in five Cooperative Ecosystems Studies Units, established as collaborative efforts between universities and Federal agencies to provide technical assistance and education to Federal land management, environmental and research agencies and their partners. The Station maintains 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. In fiscal year 2004, we conducted $13.5 million in cooperative research with 46 universities and 30 non-university cooperators. Cooperative research is an important component of accomplishing our research mission.

Community Involvement

Station employees regularly leave their laboratories and offices to take science to people in the community. They give presentations to landowners, 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. For example:

- Each year, the Station proudly sponsors the Flagstaff Festival of Science, held in Flagstaff, Arizona. This year, scientists participated in the Festival's "Science in the Park," an event that gives families a chance to see what the science organizations in the community are working on. As part of the Festival, the Station hosted an open house at the Fort Valley Experimental Forest. Scientists were also part of the "In School Presentations Program," visiting local schools and talking about Forest Service research.
- Employees at our Boise, Idaho, laboratory participated in "Boise RiverSweep 2003," a massive cleanup effort of the Boise River. Scientists helped organize a flotilla of rafts, kayaks, canoes, scuba divers, and waders to clean 6 miles of the channel.
- A scientist at the National Agroforestry Center in Lincoln, Nebraska, was an invited workshop presenter at the National Outreach Conference – Survival Strategies for Small and Limited-Resource Farmers and Ranchers, held in San Diego, California. The meeting helped identify, develop, and promote successful risk management strategies that can be utilized by these groups to remain economically viable in the rapidly changing agricultural environment.
- The Station was a primary sponsor and organizer of the 5th Annual Tu B'Shevat Festival in Scottsdale, Arizona. Tu B'Shevat is the "Birthday of the Trees" in Israel. The event reflects 17 years of cooperation between the Forest Service and the Jewish National Fund, which is responsible for forestry and land development in Israel.
- A scientist with our Albuquerque, New Mexico, laboratory attended the Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) 19th Annual Career Fair and Training Conference in Des Moines, Iowa, serving as a judge for the graduate and undergraduate poster competition and working with students in career tracking. MANRRS is a national society that welcomes people of all racial and ethnic groups, and provides its student members with support to become productive citizens through mentoring, networking, engaging them in leadership development activities, and by promoting interaction between students, professional members, and other organizations and institutions.

- Staff at the National Agroforestry Center in Lincoln, Nebraska, were once again present with their "Trees to the Rescue" hands-on module at the 10th Annual Earth Wellness Festival, held in Lincoln. The event has hosted nearly 30,000 students and teachers, enabling them to discover and explore the relationships and interdependency of land, water, air, and living resources.
- Employees with our Moscow, Idaho, laboratory helped evaluate entries at the Moscow School District Science Fair; and researchers at our facilities in Missoula, Montana served as judges at the Montana Science Fair, held in Missoula.
- The Station's Bitterroot Ecosystem Management Research Project in Missoula, Montana, helped sponsor an evening of public presentations in Hamilton, Montana, where scientists presented on-going research on weeds, birds, mammals, thinning, and prescribed burning.
- Fort Collins, Colorado, researchers hosted forestry students from the University of Tennessee for a spring camp at the Manitou Experimental Forest. Students were introduced to Colorado forest ecosystems, toured recent wildfires, and participated in field exercises.
- National Agroforestry Center staff, Lincoln, Nebraska, participated in the Folsom Zoo's Care-for-Bear Days, held in Lincoln. More than 500 children visit the zoo during this event. Employees presented information on "Working Trees for Wildlife and More," and introduced parents and children to the Forest Service, Smokey Bear, and the good and bad about forest fires.
- Researchers from our Reno, Nevada, laboratory led a yearly field tour of the Great Basin Ecosystem Management Project, attended by members of the Yomba-Shoshone Tribe, employees of land management agencies, and students and faculty from regional and collaborating universities.
- Station employees give regularly and freely of their time and talents within their communities. Some of the many contributions in 2004 included: high-school class mentoring; participation in the Big Brother-Big Sister program; working with food co-ops; serving on local committees, boards and associations; preparing meals for the Meals-On-Wheels program; serving in local church functions; members of Lions Club and other service organizations; and serving as volunteers for local fund-raisers and charity groups.

Outreach to Under Represented Segments of Society

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 is held each October at the Station's Fraser Experimental Forest in central Colorado. Since 1993, researchers have sponsored the weekend camp for Hispanic high school students throughout northern Colorado and southern Wyoming. They are introduced to natural resource subjects such as hydrology, forestry, wildlife, entomology, climate, and forest surveying. For more information, visit http://lamar.colostate.edu/~mhmartin.

- The American Indian Math and Science (AIMS) Camp is hosted annually in Polson, Montana, by the Station, the Salish-Kootenai College, and the Flathead Reservation. Fifth and sixth graders from Tribal schools participate in a variety of events, including natural resource management activities, career opportunities, education requirements for natural resource disciplines, leadership, communications, problem-solving skills, tribal cultures, and environmental awareness.

Students participate in a field lecture at the AIMS Camp.

- The Nature High Summer Camp, held at the Great Basin Experimental Education Center in Ephraim, Utah, 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.

Natural Resources Conservation Education Program

The Forest Service's Natural Resources Conservation Education Program annual funding is used as seed money to encourage the growth of education partnerships among the Station, States, and local educators. In addition to the Hispanic Natural Resources Career Camp, the Nature High Camp and the AIMS Camp, activities also include:

- Scientists at our Flagstaff laboratory participated in the annual Flagstaff Festival of Science, now in its 15th year. The week-long event provides opportunities for the Forest Service to share natural resources research through in-school and after-school presentations.
- Flagstaff personnel also support and participate in Camp Colton, held annually on the slopes of the San Francisco Peaks in northern Arizona. Here, Project LIFE (Life In the Flagstaff Environment) is presented to students in the Flagstaff Unified School District. About 1,000 6th graders take part each year in the 5-day camp, consisting of a series of outdoor-related classes. The students learn how to live in a wilderness setting, appreciate the natural environment, understand their involvement in the environment, and gain a sense of responsibility to preserve nature and its beauty and wonder for future generations.
- The FireWorks Educational Trunk and Curriculum is a self-contained "trunk" of creative, interactive teaching materials for grades 1-9 that describes how fire affects forests. Created by scientists at the Fire Sciences Laboratory in Missoula, Montana, it is available on loan through the Montana Natural History Center (406-327-0405).
- The "Living with Fire" interactive touch screen computer program teaches visitors to the Fire Visitor Center at the Aerial Fire Depot in Missoula, Montana, about wildfire, the role fire plays in nature, and how wildfires are suppressed. It is also available on the Internet at: http://www.fs.fed.us/rm/fire_game.

To find out more about the Rocky Mountain Research Station:

Visit our Internet Web site at www.fs.fed.us/rm. You'll find information on:

- Our research program, including our mission, research themes and highlights, strategic planning, and a map of our Station territory
- Our laboratories, research work units, and experimental forests
- An updated section on fire research and fire-related issues
- A listing of Station personnel
- Available Station publications, including electronic Web site publications and ordering information
- Links to other Forest Service and natural resources-related sites

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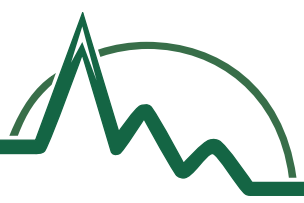

ROCKY MOUNTAIN RESEARCH STATION