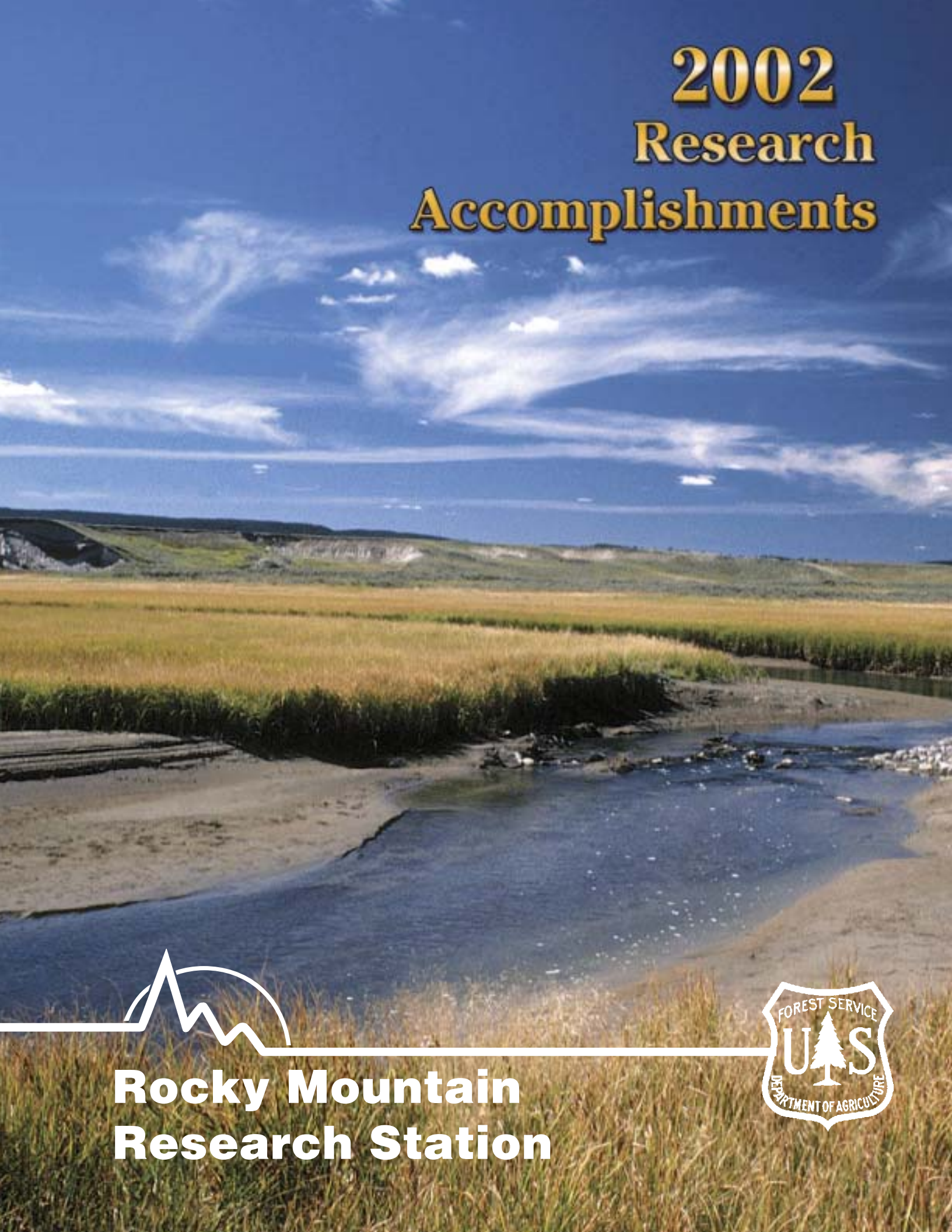


2002 Research Accomplishments

Rocky Mountain Research Station

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station

2002 Research Accomplishments

Contents

A Look at RMRS

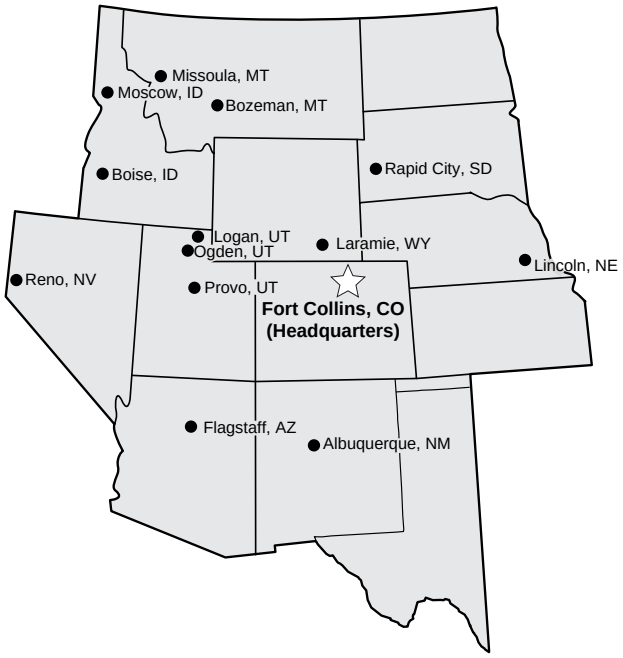
The Rocky Mountain Research Station is one of six regional units that make up the USDA Forest Service Research and Development organization – the most extensive natural resources research organization in the world. We maintain 12 field laboratories throughout a 14-state territory encompassing the Great Basin, Southwest, Rocky Mountains and parts of the Great Plains. The Station employs 443 permanent full-time employees, of which 112 are 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.

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:

- We seek to be an unbiased source of scientific information.
- We provide tools that consider the multidisciplinary nature of natural resource decisions.
- We recognize that resource managers need scientific information that is integrated and developed for application.



Our scientists are working to:

- Continually improve resource management through research and monitoring
- Reduce costs and expand the value of resource inventory programs
- Develop restoration techniques for land disturbed by mining, overgrazing, fire and other activities
- Study how changes in riparian and aquatic ecosystems affect the quantity and quality of water and native fisheries
- Help land managers understand the diversity, productivity and sustainability of native plant communities
- Investigate the relationships between people and natural resources, and the role human culture has played in ecosystems
- Anticipate and manage weeds, insects, diseases, fire and other disturbances

- Develop new technology and fire behavior models to help save lives, property and forest resources
- Provide information needed to sustain wildlife populations
- Continue developing a scientific basis for protecting and restoring wilderness ecosystems
- Determine how forest ecosystems respond to atmospheric factors such as air pollution and how smoke from forest and range fires may affect global change

Administration and Support Services Staff

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: Operations, Computer Systems, Facilities Management, Financial Management, Library Services, Human Resources, Public Affairs, Publishing Services, Safety/Health/ Environment, Civil Rights, Statistics, Budget, Grants and Agreements, Procurement and Purchasing.

Director's Office Staff

Station Director: Marcia Patton-Mallory
Deputy Station Director: John Toliver
Assistant Station Directors for Research:
Jim Saveland
Janine Powell
Thomas Quigley
Alison Hill
Assistant Station Director for Operations:
Jim Haskell

Rangeland Research in the Interior West

Written and compiled by Rick Fletcher

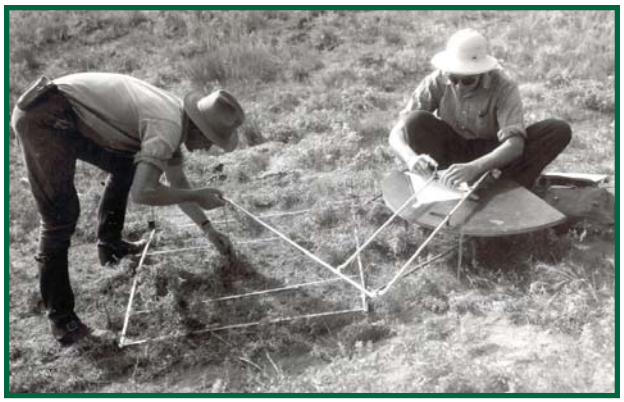
When the Forest Service was established in 1905, few guidelines existed for managing our Nation's forests and rangelands. One of the earliest uses of these public lands, especially in the West, was for domestic livestock grazing. In the early 1900's, about 1.5 million cattle and horses and 6 million sheep grazed rangelands throughout the western U.S. However, without good management guidelines, this resource quickly became overgrazed. Herds suffered heavy losses during droughts and blizzards, and many areas experienced flooding and erosion.

In 1910, to help address these rangeland issues, the Forest Service established an Office of Grazing Studies in Washington, D.C. By 1911 regional offices were operating in the Southwest (Albuquerque) and Rocky Mountain (Denver) regions. These offices had three main assignments: 1) range reconnaissance and management plan development; 2) technical range administration; and 3) grazing studies. Work soon expanded to include plant identification, plant growth and development, poisonous plants, natural revegetation, reseeding, forage production and utilization, degree and seasons of use, livestock handling and wildlife observations.

Two early experimental areas that helped lay the foundation for rangeland studies were the 51,000-acre Santa Rita Range Reserve, established in southern Arizona in 1903, and the 193,000-acre Jornada Range Reserve, established in 1911 in southern New Mexico (they were both transferred from the Bureau of Plant Industry to the Forest Service in 1915 and later called experimental ranges).

Early work at these sites focused on: 1) determining the best way to manage the lands in order to restore, improve and maintain them at a sustained basis for productivity; and 2) determining methods for handling

Studying fenced, ungrazed plots on the Jornada Range Reserve in New Mexico, 1916.



Early range studies at the Utah Experiment Station.

cattle to obtain the best returns over a period of time. These studies helped develop important rest-rotation grazing systems for desert grasslands.

By 1900, central Utah was the locale for heavy sheep grazing, typical of a number of areas in the Intermountain West where high, cold desert valleys were not suitable for crop agriculture. Livestock, particularly sheep, were grazed in the valleys and Great Basin desert in the winter and moved to mountain ranges in the summer. However, overgrazing resulted in devastating floods coming out of the canyons along the Wasatch Plateau and Wasatch Front. These floods caused great and repeated damage to communities located in the valleys. It was this flooding that provided the impetus for establishing the Utah Experiment Station in 1912 (later named the Great Basin Experiment Station) where researchers worked to develop guidelines for managing mountain ranges to control erosion and flooding.

Around this time, another story was unfolding in the Great Plains grasslands. The Enlarged Homestead Act of 1909 offered free land to those who would cultivate this massive region of "as-far-as-the-eye-can-see" rolling grasses. The Act, combined with a growing market demand for wheat during and after World War I, motivated "sodbusters" to settle previously bypassed grasslands and plow them for cultivation.

In 1917, with the United States entry into WWI, the number of animals that grazed on the national forests and rangelands increased dramatically. Studies of the increasing numbers of sheep and cattle being grazed on national forests soon showed severe overgrazing. Range conditions were so poor that sheep permittees were unable to produce the amount of lamb meat that they expected. The term "carrying capacity" of the range surfaced and became a controversial issue because it determined how many animals a rancher could place on Government land. This controversy resulted in a 1924 Forest Service report on public and private fees. Stock owners immediately expressed objections to the study, leading to congressional hearings and passage of the McSweeney-McNary Act of 1928, which called for enhanced research activities on public forests and rangelands.

As the need for range research increased, two important sites were established in Colorado: the Manitou Experimental Forest (1936), near Colorado Springs, and the Central Plains Experimental Range (1939) near Nunn. At Manitou, extensive studies were undertaken on plant species and methods of reseeding, along with pasture tests of the intensity, seasons and systems of cattle grazing to develop guides for range cattle management for the ponderosa pine Front Range area. The Central Plains Experimental Range was a center of grazing studies until it was transferred to the Agricultural Research Service in 1954. Throughout the next five decades, the importance of rangeland and grassland research intensified.

Today, public and private rangelands and grasslands comprise 80 percent of the western U.S. Controversy continues to surround these lands that are fragile and difficult to manage under the best of circumstances. The Rocky Mountain Research Station's research program has a multi-faceted, widespread focus on rangeland and grassland issues that are critical to land managers and planners throughout the West. The following represent those efforts.

- A portion of the Station's rangeland research in the Southwestern U.S. is based out of the Forestry Sciences Laboratory in Albuquerque, N.M. (http://www.fs.fed.us/rm/albuq/). Several studies are underway. One is focused on the impacts of livestock and wildlife grazing on terrestrial vertebrate species. Work is: 1) describing and classifying habitat types on grazed lands in the Southwest; 2) determining species which are sensitive to

In 1936, plots were established on the Manitou Experimental Forest, CO, to study the kinds and amounts of vegetation effective for controlling rangeland erosion.

grazing and their source habitats; 3) developing ecological/life history summaries for each species; 4) characterizing regional patterns of biodiversity; and 5) developing models of species occupancy for different land covers and land use areas. The final product will be a multi-volume report which examines all species of terrestrial and aquatic vertebrate in the Southwest, and select plant species.

Researchers are also studying the spread of the yellow starthistle weed. Once established, it out-competes native vegetation and makes pastureland and rangeland unusable. Scientists are evaluating control methods using different treatment combinations of fire, herbicide use and reseeding with perennial grasses.

Many threatened and endangered species (e.g., black-footed ferret, burrowing owl, Aplomado falcon, swift fox) depend on prairie dog colonies. In the Chihuahua Desert grasslands of the Southwest, Station scientists are studying how experimental fire and mowing treatments, in combination with bison grazing, affect black-tailed prairie dogs, and if fire can facilitate the expansion and movement of established prairie dog colonies into areas from which they have been extirpated.

Other efforts at our Albuquerque facility focus on: 1) the feasibility and cost effectiveness of using improved road building techniques and stream channel realignment to restore riparian conditions to rangeland meadows; and 2) grazing impacts on the southwestern willow flycatcher (federally listed under the Endangered Species Act). Results are being used to provide specific habitat guidelines for riparian management and

Researchers in New Mexico are investigating the use of fire as a tool for managing yellow starthistle.

restoration efforts. This cooperative work was awarded the first Clarence Burch Award by the Quivira Coalition – a non-government organization focused on resolving grazing conflicts.

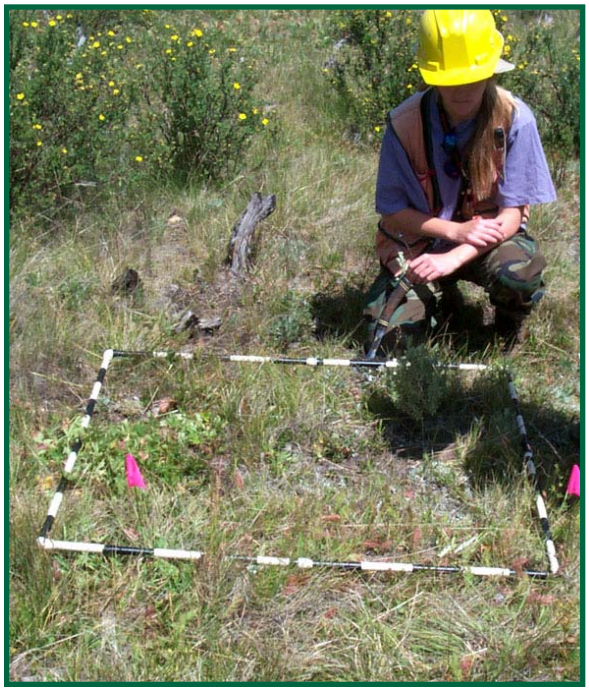
- At our Flagstaff, AZ laboratory (http://www.rmrs.nau.edu/lab/), work is underway in oak savanna ecosystems of the Mexico/U.S. borderlands. Researchers are studying the use of prescribed fire to restore degraded rangelands and improve wildlife habitat. Related studies focus on the effects of season of burning and grazing interactions on watersheds. Scientists are also evaluating the effects of grazing and other disturbances on threatened, endangered and sensitive fish species in southwestern riparian ecosystems.
- Several projects at our Utah laboratories focus on rangeland studies. The Shrub Sciences Laboratory in Provo (http://www.fs.fed.us/rm/provo/) recently celebrated its 25th anniversary by hosting the symposium "Shrubland Ecosystem Genetics and Biodiversity," and published the proceedings. Over the years, dozens of scientists have conducted research and development, centered on shrubland ecosystem ecology and experimental range management.

Methods to control cheatgrass, an exotic, invasive annual grass that dominates millions of hectares of degraded rangeland in the West, are underway at our Provo facility. Scientists have documented seed germination and studied the biological control of cheatgrass by the naturally occurring fungal disease head smut. Work has been completed on the effects of seeding perennial grasses after wildfires to increase the cover and density of perennial plants. Studies are also underway on using seed mixes of traditional adapted but introduced species, native species and a combination of both to provide maximum forage value and cover.

Scientists and cooperators are also developing guidelines for maintaining and increasing sage grouse populations on public lands.

Work continues on seed quality and seed germination for a wide variety of shrubs, grasses and forbs that are useful in land rehabilitation and restoration. These seed tests are facilitating the use of a wide array of plant materials in rehabilitation and restoration efforts. Work is also underway on native grass and forb species collection, culture and use for rehabilitation after disturbances, such as wildfires.

- The Station's Forest Inventory and Analysis unit in Ogden (http://www.fs.fed.us/rm/ogden/) is evaluating indicators for monitoring rangelands. The result will be a paper that describes four rangeland health indicators and interpretation criteria that can be used to characterize rangeland health and functionality.
- At our Reno, NV laboratory (http://www.fs.fed.us/rm/main/labs/reno.html), research centers on restoring and maintaining the integrity of Great Basin riparian ecosystems and watersheds. For instance, scientists are studying the effects of sagebrush encroachment and water table depths on meadow ecosystems. Results will help managers create a mosaic of ecosystem types with riparian corridors that more closely resemble predisturbance conditions.
- Scientists at our Boise, ID laboratory (http://www.fs.fed.us/rm/boise/) conducted research on Idaho's Snake River Plain to examine the efficacy of Oust™



Methods and procedures are being developed to test and evaluate indicators for assessing rangeland health.

herbicide applied at low rates to control highly competitive annual grasses (cheatgrass and medusahead), thereby helping establish fuel breaks, recover remnant native perennials in degraded communities, and establish seeded native species in annual grasslands following fire. In a related study, carbon application to increase nitrogen sequestration by soil microorganisms is being studied as a nonherbicidal approach to cheatgrass control. Reductions of up to 77 percent in cheatgrass biomass have been obtained.

Finally, scientists are studying the seed biology of skeletonweed, the major perennial noxious weed invading southwestern Idaho rangelands. Research results attribute its ability to spread rapidly following wildfire to its prolific seed production, wide seed dispersal, ability to germinate under a variety of environmental conditions, and secondary dormancy in some seeds. Results of this work will help facilitate recovery processes, stem the loss of shrub steppe species and communities, protect restoration efforts, and reduce wildfire size and frequency.

- Work at our Missoula, MT Forestry Sciences Laboratory (http://www.fs.fed.us/rm/wildlife/genetics/) is examining how invading weeds affect insects, small mammals, birds, deer and elk – all of which depend upon native plants for habitat needs. Studies are underway on the effects of biological and chemical control of weeds. Results will help land managers control exotic plants and improve wildlife habitat.
- Biological control is an important tool for managing noxious weeds in western forests and rangelands. Scientists in Bozeman, MT are cooperating with researchers in Eurasia to understand the natural history of weeds, and develop biological control methods.
- At our Center for Great Plains Ecosystem Research in Rapid City, SD (http://www.fs.fed.us/rm/sd/), Station scientists, in cooperation with those in Fort Collins, examined Great Plains biodiversity trends in two journal papers: "Recent Biodiversity Patterns in the Great Plains: Implications for Restoration and Management" (*Great Plains Research* 9:277-313), and "Applicability of Montreal Process Criterion I: Conservation of Biological Diversity to Rangeland Sustainability" (*International Journal of Sustainable Development and World Ecology* 7:81-96). They found evidence that increasing land use intensity has actually benefited those species adapted to cultivation and humans. Areas of intense land use have become hot spots for exotic bird species such as rock doves, European starlings and house sparrows. In contrast, over a third of the native bird species associated with grasslands have decreased over the last 30 years. Results from this work are being used to develop and evaluate indicators of sustainable rangeland management and may serve as a model for other countries with significant rangeland resources.

Researchers have also developed new tools that evaluate and monitor the health of rangelands. One is the Seral Stage Classification and Monitoring Model, which helps land managers determine the effects of land management actions on rangeland vegetation. For instance, it can measure the impact of grazing on plant succession and help set grazing guidelines. It also provides information on wildlife habitats, livestock-wildlife interactions and their relationships to plant communities. Another beneficial tool is the Robel pole that helps predict the average amounts of standing vegetation, such as grass, for livestock management and wildlife habitat. This monitoring technique is saving range specialists precious time and resources over previous methods.

Leafy spurge is one of the more serious invasive plants throughout much of the Northern Great Plains. Researchers at Rapid City are part of the TEAM Leafy Spurge, in cooperation with the Agricultural Research Service, that is evaluating the use of the flea beetle to control leafy spurge. Results so far are very promising. Significant reductions in leafy spurge cover and density occurred concomitantly with an increasing abundance of beetles, with several study sites experiencing 100 percent reductions in leafy spurge, and a simultaneous increase in cover and diversity of natural vegetation.

On the Pawnee National Grassland in Colorado, scientists are studying habitat characteristics of nesting

sites of the Mountain Plover, a bird proposed to be listed under the Endangered Species Act. Research shows that plant structure and bare ground patches are important to nest site selection, as are areas mowed or burned during early spring. Results will help wildlife managers use grazing and/or prescribed burning to manipulate prairie habitats to attract nesting plovers.

Scientists at Rapid City are also evaluating plant production on the Dakota Prairie National Grassland. This study will provide invaluable information on long- and short-term effects of drought on grazing resources for livestock and wildlife.

Finally, research in the Badlands National Park and Buffalo Gap National Grassland in South Dakota is helping to identify and improve habitat for the black-tailed prairie dog. Studies on the Sheyenne National Grassland in North Dakota are focusing on the western prairie fringed orchid, a federally listed threatened plant. Models are identifying soil characteristics important to the orchid, which will assist land managers in providing critical habitat.

- At our Fort Collins, CO headquarters, scientists used scenario analysis techniques, involving input from forage experts, to project use of grazed forages in the U.S. from 2000 to 2050. These data, useful to managers throughout the U.S., estimate future forage demand scenarios and examine factors that are anticipated to impact the use of grazed forages in the South, North and West regions of the Nation.

Plant production studies on the Dakota Prairie National Grassland are providing invaluable information on long- and short-term effects of drought on grazing resources for livestock and wildlife.

Scientists also conducted a technical assessment of the Montreal Process criteria and indicators (C&I) for sustainable management of temperate and boreal forests, formalized in the Santiago Declaration of 1995 (see: http://www.mpci.org/home_e.html), by evaluating their applicability to rangelands. These C&I consider sustainability from a triad of economic, ecological and legal-social factors. The Station assessment formed the scientific basis for the ensuing work of the Sustainable Rangelands Roundtable (see next paragraph), and has a central objective – develop protocols that monitor the contributions of rangelands to the long-term sustainable development of the United States.

The Station is a participant in the Sustainable Rangelands Roundtable – a group of stakeholders representing conservation groups, the livestock industry, local, state and federal government, and universities, committed to the task of identifying a common set of factors for assessing rangeland sustainability. A series of meetings have been conducted to distinguish a set of criteria and indicators embodying social, economic and ecological factors that will form a framework for multi-scale assessments of rangelands and rangeland use in the United States. Availability of such information on a national scale will foster informed, sound decision-making relative to the sustainability of benefits derived from rangelands. More information is available at http://www.cnr.colostate.edu/RES/srr/index.html.

National Fire Plan Research Update

Forest Service Research and Development (R&D) has sustained an active program of research since the 1920's and remains the world's leader in wildland fire science and related fields. In Fiscal Year 2002, R&D received $26.4 million through the National Fire Plan to continue to address four strategic goals: firefighting capacity, rehabilitation and restoration, hazardous fuels reduction and community assistance. With this funding, R&D initiated 285 studies (new or continued) in all 50 states, hired 55 new scientists (15 permanent) and 170 technicians (4 permanent), and established 162 new cooperative studies and contracts with universities and other research partners totaling $8.3 million. The Rocky Mountain Research Station receives nearly one-third of the National Fire Plan funds for R&D.

Firefighting Capacity

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. For instance, Station scientists installed an antenna on the roof of the Fire Sciences Laboratory in Missoula, MT, to receive data from NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) instrument onboard the Terra satellite. Since May 2002, researchers have produced daily images of fires nationwide, in collaboration with the NASA Goddard Flight Center, the University of Maryland and the Forest Service Remote Sensing Applications Center. The satellite receiving station

NASA satellite image.

supports research that will help improve the ability to detect fires in real time and enhance smoke forecasting capabilities. Information gathered through satellite imagery can be used to map out burn scars to more accurately estimate the amount of pollutants emitted by fires, and help track smoke plumes and improve smoke forecasts. Eventually, the data will be useful in monitoring health hazards due to smoke plumes and aid in determining ideal conditions for prescribed burns. The receiving station's quick turn around time will ultimately make this space-age tool a real-time, on–the-ground tool for fire operations managers.

Rehabilitation and Restoration

Minimizing postfire erosion and flooding damage and helping native vegetation recover in burned areas are topics actively being investigated by 12 teams of National Fire Plan researchers. Scientists at the Station's Aquatic Sciences Laboratory in Boise, ID, recently

hosted a workshop to summarize the potential risks and benefits of wildfire on aquatic ecosystems. As a result of the workshop, Forest Service scientists and cooperators are gathering information on the linkages between fire history and stream channel characteristics, the relationships between fire disturbances and fish populations, and methods of quantifying the physical and biological responses of streams to fire. More about the workshop is available at http://www.fs.fed.us/rm/boise/teams/fisheries/fire/workshopdescription.htm.

Funds provided for research on restoration and rehabilitation of fire-adapted ecosystems through the National Fire Plan have also provided the needed boost to tackle the far-reaching and intractable problem of exotic and invasive weeds.

In the sagebrush-grass and pinyon-juniper woodlands of the Southwest, the increased dominance of exotic fire-adapted annual weeds is a big problem. Once weeds such as cheatgrass get a toe-hold, the ecosystem is often propelled into a downward spiral of increased fire frequency, fewer native herbs and shrubs, and even more cheatgrass. Scientists at the Shrub Sciences Laboratory in Provo, UT, are looking at the genetic structure of populations of several forb, grass and shrub species to see where the native plants' strengths and weaknesses lie in the competition against exotic weeds. They are also evaluating the possibility of using a naturally occurring smut fungus as a biological control for cheatgrass. In addition, researchers are learning about the importance of a proper seedbed for the successful establishment of seeded plants after fire. Results of this work will provide managers with more effective means of controlling cheatgrass and the added option of using native plants to restore these fire-ravaged ecosystems.

Counting cheatgrass seedlings on a burned plot.

Since 1998, Station scientists, in collaboration with other Forest Service researchers and forest managers, have been installing paired watershed studies following wildfires to evaluate the effectiveness of burned area rehabilitation efforts. Results will help design treatments that reduce hillside erosion and stream sedimentation.

Hazardous Fuels Reduction

New investigations are underway 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.

The Rocky Mountain Research Station has entered into a collaborative interagency agreement with the Department of Energy at Los Alamos National Laboratory (NM) to conduct research and development of predictive models of fire behavior needed to support fuels reduction thinning treatments, wildfire mitigation efforts, planning for prescribed burns, and evaluating potential fire behavior. With further validation and development, these models can be used as training, planning and risk assessment tools. Outputs expected from this research will contribute significantly to the development of simpler, more efficient models.

At the Station's Fire Sciences Lab, researchers have developed sets of coarse-scale fire regime condition class data tables and maps that are being utilized for planning on a national scale.

As part of the Landfire Project, scientists are developing a comprehensive package of spatial data

layers, models and tools in support of analyses for prioritization and planning to initiate the implementation of the National Fire Plan, both nationally and locally.

Community Assistance

Station researchers are working to provide managers with information they can use in helping communities increase their wildfire preparedness. Other research is focused on understanding individuals' beliefs, attitudes and knowledge related to fire and fuels management treatments.

Studies have helped define how homes in the wildland-urban interface ignite during wildfires. Through a combination of computational modeling, quantitative experiments and examination of case studies, researchers have discovered that characteristics of the home ignition zone (exterior characteristics and immediate surroundings) are key to whether or not the home will burn. Research indicates that, in most cases, the big flames of high intensity fires do not occur close enough to homes to directly cause ignitions. Instead, homes ignite from lower intensity surface fires spreading to a home and/or from firebrands (lofted burning embers) igniting the homes directly. Findings are featured in a new video, "Wildfire: Preventing Home Ignitions," sponsored by the Firewise Communities USA Project.

Researchers are studying how homes ignite during wildfires.

Technical Assistance

The Station assembled a team of scientists and professionals to conduct a case study analysis of the 2002 Hayman Fire in Colorado's Front Range. These efforts will improve our understanding of extreme fire events and the effectiveness of fuel treatments and suppression. The Hayman Fire Case Study Analysis is available at http://www.fs.fed.us/rm/hayman_fire.

Joint Fire Sciences Program

In addition to supporting the National Fire Plan, Station scientists have also been awarded numerous projects from the Forest Service/Bureau of Land Management co-funded Joint Fire Sciences Program.

The support for fire research provided through the National Fire Plan in Fiscal Years 2001 and 2002 has enabled 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. Plans are underway for a formal evaluation of the Forest Service National Fire Plan Research Program at the end of Fiscal Year 2003 or early in 2004 to determine the need for future adjustments.

For more information on the Rocky Mountain Research Station's involvement in the National Fire Plan, select from the "Fire" menu at http://www.fs.fed.us/rm.

Accomplishments

During 2002, The Rocky Mountain Research Station:

- Produced 598 technical publications and journal articles (a partial listing is available on the Station's website at http://www.fs.fed.us/rm/main/pubs.html).
- Provided 196 tours to educational and professional groups.
- Presented 176 short courses and training sessions to educational and professional groups.
- Offered 198 invited presentations before scientific organizations.
- Presented 417 audiovisual presentations on research findings.
- Gave 167 presentations to lay audiences.

Examples of Other accomplishments include:

- Scientists organized workshops in Mexico that provided scientific and technical support for a study to inventory and monitor ecosystem resources in that country through CAMESA (Consortium for Advancing the Monitoring of Ecosystem Sustainability in the Americas).
- A Fort Collins scientist spent two months in Guadalajara and Colima, Mexico teaching statistical methods for forest inventory and consulting on the design of Mexico's national forest inventory and monitoring systems.
- The Station helped organize the conference "Fire, Fuels Treatment and Ecological Restoration: Proper Place, Appropriate Time," held in Fort Collins, CO, and will publish the proceedings.
- The National Agroforestry Center (NAC) co-sponsored and co-organized the International Association for Landscape Ecology – United States Regional Association annual symposium. The event provided a comprehensive forum for discussing the integration of socio-economic and socio-political perspectives in the theory and practice of landscape ecology.
- The NAC conducted its 3rd Annual 1890 Faculty Training Workshop in Agroforestry at Alabama A&M University. The event was designed to help 1890 university faculty incorporate information on agroforestry practices into their teaching and extension efforts.
- Scientists with the NAC hosted members of the Chinese Environmental Protection Bureau and the China Environmental Protection Foundation. The technical exchange introduced the Chinese officials to agricultural techniques used in the conditions, and how to select, locate and design conservation buffers to solve problems and meet landowner objectives.
- The NAC supported the Specialty Forest Product Production and Marketing workshop, which took place in Nebraska City, NE and covered the production, processing and marketing of specialty forest products.
- Scientists at our Boise, ID laboratory hosted a major workshop on Fire and Aquatic Ecosystems. The event focused on fire history and management; fire and physical processes structuring aquatic habitats; and fire and biological processes structuring aquatic communities (http://www.fs.fed.us/rm/boise/teams/fisheries/fire/workshopdescription.htm).

Assessment of forage growth under tree cover was one of the field exercises from the 1890 University Faculty Agroforestry Workshop.

"Our reclamation staff has been working with Station fishery scientists on the Boise River Project since 1999. Your researchers have been incredibly helpful to our management and technical staff by providing study design guidance, pertinent technical literature, and management and conservation recommendations for federally listed species in reclamation projects. Information and assistance provided by your fisheries staff has been essential in the development of our work and management plans." (Tammy Salow, Fishery Biologist, US Bureau of Reclamation, Boise, ID)

- Our Flagstaff, AZ laboratory hosted a Watershed Restoration Practices workshop for resource specialists from the state of Guanuajuato, Mexico. The event was part of an international cooperative effort to provide information on watershed condition assessment, restoration technologies and range management.
- Scientists at Flagstaff also co-sponsored the International Union of Forestry Research Organizations Working Party 7.01.02 "Tree Resistance to Insects" meeting in Flagstaff. Representatives from 10 countries attended.
- A Flagstaff laboratory scientist is a co-editor and chapter author of a new book titled *Mechanisms and Deployment of Resistance in Trees to Insects*. The book reviews the major worldwide literature on mechanisms and deployment of resistance in trees to insects (http://www.wkap.nl/prod/b/1-4020-0618-7).
- Albuquerque scientists helped author UNESCO's *Encyclopedia of Life Support Systems (EOLSS) – a Living Body of Knowledge on Sustainable*

Development. The publication, which has contributions from over 6,000 of the world's foremost scholars, experts and policy-makers in all major fields, from over 100 countries, presents current knowledge of global relevance for decision support towards sustainable development and global security.

- Scientists from Logan, UT, Boise, ID and Bozeman, MT spent eight days in Jalisco, Mexico working with biologists on how best to manage that country's Natural Protected Areas. They also hosted a week-long field tour for natural resource managers, biologists and students from Jalisco. The group discussed land management and research issues common to both countries.
- Logan, UT and Fort Collins, CO-based research foresters presented a 2-day workshop on aspen ecology and management to 45 land managers from the Forest Service's Northern Region.
- A Moscow, ID lab scientist worked with the U.S. Fish and Wildlife Service in Hawaii to set up a study on how decomposition in the mineral soil is affected by different management techniques and forest overstory types.
- A Moscow scientist visited Switzerland to work with scientists from the Swiss Forestry Research Institute to evaluate management impacts on wood decomposition and soil productivity.
- A scientist from our Aldo Leopold Wilderness Research Institute in Missoula, MT spent four weeks in South Africa serving as an advisor to help articulate the values and stakeholders of wilderness protection in that Country, and helping to obtain agreement on the crucial qualities of wilderness within the cultural and historical context of South Africa and threats to those qualities.
- A new software product developed by researchers at our Fire Sciences Laboratory, Missoula, MT, and funded by the Joint Fire Sciences Program, called FIREMON, provides managers a consistent, standardized fire effects monitoring system that can be applied in a wide range of environmental conditions (http://www.firelab.org/firemon).
- Provo, UT scientists were guests of the Inner Mongolian Academy of Forest Sciences, China. They collaborated with scientists on common research issues and presented lectures and a feature paper.

"In my position as Soil Scientist on the Dakota Prairie Grasslands and Regional Office Soils Program Leader, I have had the opportunity to utilize the work of your scientists extensively. Debbie Page-Dumroese, Pete Robichaud and Dan Uresk have provided literature and data to assist us in establishing appropriate protocols for collecting base line data for soil quality monitoring, erosion control and sedimentation rates. The quality of information and assistance provided by researchers will allow us the capability to transfer our knowledge to other agencies, conservation groups and universities with a sound scientific base." (Sharon Ross, Regional Soil Scientist, USDA Forest Service, Northern Region, Missoula, MT)

- Station scientists and retirees worked with the Salt Lake City Olympic Planning Team to help minimize disturbance to the environment and rehabilitate construction scars on mountainsides. Researchers also presented an environmental program to middle school students on how science is used to protect the environment.

"Since 1994, the US Fish and Wildlife Service has worked closely with your scientists to obtain information on bull trout and other inland salmonids. Information provided by scientists, along with published papers, have been extremely useful to our organization. The Station continues to provide us with high-quality scientific data and analyses for fish and their habitats. Your scientists are widely recognized and respected experts. Their work is critical to the successful conservation of native fish and their habitats." (Shelley Spalding, US Fish and Wildlife Service, Lacey, WA)

Research Highlights

The Ecological Impacts of Exotic Plants

Exotic plant invasions dramatically reduce the diversity of native plant communities and can alter ecological processes in ways that disrupt ecosystem function. Weed invasions present a particular challenge to achieving watershed health and restoration because virtually any management action taken results in disturbance that favors weeds. For example, thinning treatments aimed at restoring forest health and reducing fire risk introduces disturbance and creates hotter, dryer conditions that favor weed invasion. The pervasiveness of the weed invasion problem requires that weed control strategies be incorporated into virtually all management activities. Yet remarkably little is known about the specific effects of weed invasion on native plants, wildlife, and ecosystem function. Moreover, the few tools that have proven effective at combating weed invasions also exhibit ecological side effects that can impact valuable resources. The Station's Wildlife Ecology Research Unit in Missoula, Montana is conducting studies to understand the consequences of weed invasion for native plants and wildlife, and to determine the ecological efficacy of current weed control strategies in order to provide Forest Service managers with the tools needed to make effective management decisions.

Research indicates that exotic plants like spotted knapweed significantly impact many important native species ranging from plants to insects and songbirds. Spotted knapweed is one of the most widespread and aggressive invasive plants in the western United States. It dramatically reduces many native plant species, including some of the most valuable community dominants. Moreover, when spotted knapweed displaces native plant communities, it impacts habitat quality for wildlife species. For example, preliminary data indicate that knapweed invasion impacts songbirds such as chipping sparrows, exhibiting negative effects on their abundance, breeding, and site fidelity. Such impacts are likely due to declines in food resources provided by native plants and insects.

Additional studies examining the use of insect biological control agents released for the control of spotted knapweed indicate that, although the biocontrols have not controlled spotted knapweed, they have had unintended effects on native species. For example, biological control insects have become a food source for deer mice that has increased populations of this native rodent, possibly to the detriment of other native species and humans. Preliminary studies suggest that deer mouse populations elevated by the biocontrol may, in turn, impact native species through predation of insects and plant seeds. Elevated deer mouse populations may also increase the risk of hantavirus infection in humans

Deer mouse foraging on spotted knapweed plant.

that results in hantavirus pulmonary syndrome because deer mice are the primary vectors for this deadly disease. Additional studies suggest that herbicide treatment of knapweed restores deer mice to natural densities, thereby alleviating the non-target effects of the biocontrols. Effects of such herbicide treatments on native plants and wildlife are also being examined in the context of current forest restoration strategies, such as prescribed burning.

This research has provided profound insights into weed invasions and weed management and has been highlighted in *Natural History* magazine (April 2002) and numerous newspaper articles. The publication, Non-target Effects of an Introduced Biological Control Agent on Deer Mouse Ecology, published in 2000 in *Oecologia*, won the Station's Best Scientific Publication Award for Early Career Scientist in 2000. Collectively, this research will provide critical information about 1) which native plants and animals are impacted by weed invasions, and 2) how, when and where weed control measures such as herbicide treatments and biological control are effective. Such information will help managers achieve the Forest Service's goals for restoration and maintenance of America's national forest resources.

Find out more about studies at the Missoula laboratory at http://www.fs.fed.us/rm/wildlife/genetics/. Reading references include:

Ortega, Y. K., D. E. Pearson, and K. S. McKelvey. In Review. Effects of Exotic Plant Invasion and Introduced Biological Control Agents on Native Deer Mouse Populations.

Pearson, D. E., and Y. K. Ortega. 2001. An Indirect Dispersal Pathway for Spotted Knapweed Seeds Via Deer Mice and Great-horned Owls. *Canadian Field-Naturalist* 115(2):354.

Pearson, D. E., Y. K. Ortega, K. S. McKelvey, and L. F. Ruggiero. 2001. Small Mammal Communities and Habitat Selection in Northern Rocky Mountain Bunchgrass: Implications for Exotic Plant Invasions. *Northwest Science* 75(2):107-117.

Pearson, D. E., K. S. McKelvey, and L. F. Ruggiero. 2000. Non-target Effects of an Introduced Biological Control Agent on Deer Mouse Ecology. *Oecologia* 122(1):121-128.

Pearson, D. E. 1999. Deer Mouse Predation on the Biological Control Agent, *Urophora* spp., Introduced to Control Spotted Knapweed. *Northwestern Naturalist* 80(1): 26-29.

Measuring and Estimating Erosion Following Wildfire

Following wildfires, forest managers need to estimate the amount of soil erosion that may occur. This estimate is used to determine the risk of losing forest soil productivity as soil is eroded, or of damaging resources such as fish habitat or water supply reservoirs as sediment is carried downstream. Measurements of soil erosion are also needed by managers to estimate erosion from future fires in the same area and to design burned area rehabilitation efforts. Researchers use these measurements to develop and validate erosion models. During this past year, scientists at the Moscow, Idaho laboratory have addressed both aspects of soil erosion prediction, fieldwork and model enhancement.

The year following the 2000 fire season in the Bitterroot Valley of Montana, research funds from the National Fire Plan were used to gather additional field data about wildfire impacts. An experiment was designed to measure soil erosion at low and high stand densities, and lower and higher burn indices. Soil surface cover and soil properties were measured; precipitation was recorded at each site; and erosion was measured with silt fences, a technique developed by Station scientists. Erosion was measured following seven rainfall events in the summer of 2001. Average total erosion rates varied from 0.4 to 136 t/ha (0.2 to 50 t/a) in the year following the fire. The four sites did not experience the same storm patterns, and so the sites receiving the most intense storms exhibited the greatest erosion rates. The burn indices were not a good indicator of erosion. The vegetation density before the fire appeared to be a good indicator of observed soil erosion, as did the amount of surface residue. The average of the observed erosion rates was similar to the erosion rate predicted by our online prediction software FSWEPP (Watershed Erosion Prediction Project), although the current software could not address the observed variability.

During the past two years, the FSWEPP erosion prediction software has become the tool of choice for many forest managers, and is run online from two web sites. On the average, over 2000 runs are made each month to estimate soil erosion following fire or forest operations, or from forest roads. In July 2002, researchers received a national Forest Service technology transfer award for this software.

These two activities demonstrate a good example of the research balance between fieldwork and model development to provide the necessary information and tools to manage our nation's forest resources. Learn more by visiting http://forest.moscowfsl.wsu.edu/engr.

Additional details are available online at: http://forest.moscowfsl.wsu.edu/fswepp/, http://fsweb.moscow.rmrs.fs.fed.us/fswepp/ (Forest Service WEPP interfaces); http://forest.moscowfsl.wsu.edu/engr/reports/0006_FSWEPP.pdf (Forest Service WEPP interfaces, presented at the 2000 ASAE Annual International Meeting); and http://www.fs.fed.us/rm/pubs/rmrs_gtr94.html (Robichaud, P. R. and R. E. Brown. 2002. Silt Fences: an Economical Technique for Measuring Hillslope Soil Erosion. Gen. Tech. Rep. RMRS-GTR-94. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 24 p.).

This researcher is scraping out sediment accumulated behind a silt fence to estimate soil erosion.

Climate Change and Forest Insects

Forest insect pests are the most pervasive and important agents of disturbance in North American forests, impacting an estimated area 45 times that of fire, with an economic impact that is almost 5 times as great. The same attributes that result in an insect herbivore being termed a "pest," predispose them to population disruption through climate change, and in particular, global warming. Although many pest species have co-evolved relationships with forest hosts that may or may not be deleterious from a long-term ecological perspective, disruption of these relationships holds the potential for catastrophic consequences. Scientists at the Logan, Utah laboratory are evaluating the potential disruption of the outbreak ecology for two native forest pests, the mountain pine beetle and spruce beetle, and for one potential introduced pest, the gypsy moth. These evaluations involve the synthesis of both historic and projected climate, validated pest models, and forest cover type distributions expressed across landscapes of interest.

In general terms, results indicate intensification in all aspects of outbreak behavior. For mountain pine beetle, results from this work indicate a potential invasion of new habitats, including high-elevation five-needle pines and jack pine, by mid century. These predictions have important economic and ecological consequences, including the possibility of mountain pine beetle populations breaching to the north the previously insurmountable barrier of the Great Plains. Implications for the high elevation pines, and of immediate interest, whitebark pine, is that these pines will be subjected to a disturbance stress that they are evolutionarily not well adapted to contend with. For spruce beetle, studies have provided insights into the current massive tree mortality that occurred during the 1990s across landscapes ranging from Alaska to central and southern Utah. The extent of this mortality is unprecedented in historical times, and may have resulted in a shift from spruce forest to grasslands in parts of Alaska. Record setting warm weather, and in particular a concurrent shift from semi- to uni-voltinism (one generation every two years to one generation every year) has been implicated as precipitating these outbreaks.

Outbreaks of forest insects are the major disturbance agent in North American forest ecosystems.

Questions of interest for an introduced, exotic pest are much different than those for a native insect. The first issue to be addressed is how likely is the introduction of a particular pest? Some forest insects have such a high likelihood of introduction that considerable effort and expense is justified in evaluating this question. Such is the case for gypsy moth. Due to the lifestyle of the moth, and the social conditions of rapid growth in the west, introduction of this serious defoliator to the western United States is almost guaranteed, and has in fact occurred many times in the past. Once an introduction occurs, the question becomes, how serious is the threat for establishment? For gypsy moth the major concern is impact on aspen, a sensitive species already experiencing serious decline. Under current climate conditions, there is little likelihood of gypsy moth becoming established in aspen. However, the situation is projected to dramatically change by the end of this century, with over 97% of the aspen in Utah predicted to have a high probability for successful establishment.

Additional information on forest insect research can be found at http://www.usu.edu/beetle. Details on these studies are available in:

Hansen, E.M., B.J. Bentz, and D.L. Turner. 2001. Physiological Basis for Flexible Voltinism in the Spruce Beetle (Coleoptera: Scolytidae). *The Canadian Entomologist* 133:805-817.

Hansen, E.M., B.J. Bentz, and D.L. Turner. 2001. Temperature-based Model for Predicting Univoltine Brood Proportions in Spruce Beetle (Coleoptera: Scolytidae). *The Canadian Entomologist* 133:827-841.

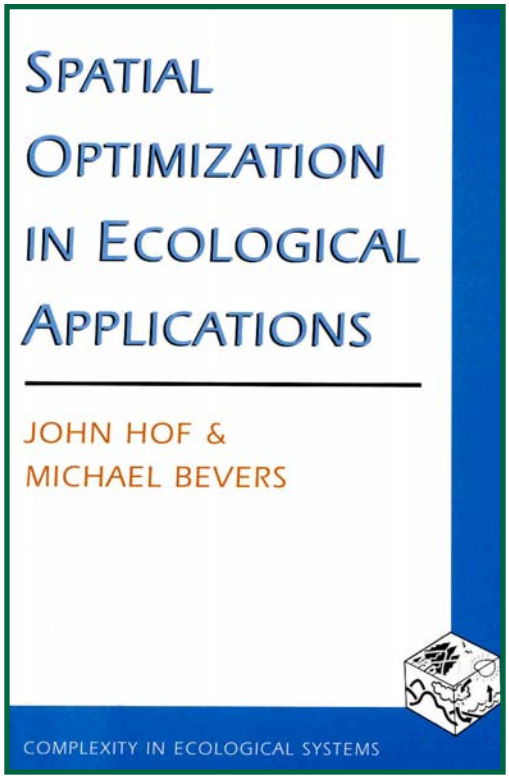
Logan, J.A. and J.A. Powell. 2001. Ghost Forests, Global Warming, and the Mountain Pine Beetle (Coleoptera: Scolytidae). *American Entomologist* 47(3):160-173.

Logan, J.A. and B.J. Bentz. 1999. Model Analysis of Mountain Pine Beetle (Coleoptera: Scolytidae) Seasonality. *Environmental Entomology* 28(6):924-934.

Spatial Optimization in Ecological Applications

Whether discussing habitat placement for the northern spotted owl or black-tailed prairie dog, or strategies for controlling exotic pests, this new book, titled *Spatial Optimization in Ecological Applications*, explains how real-world problems can be solved by capturing ecological relationships across the landscape with pragmatic optimization models. The authors use linear programming technologies widely available today that make it possible to include many thousands of constraints and still be confident of being able to solve the problem at hand.

The book is organized into four parts: Simple Proximity Relationships, Reaction-Diffusion Models, Control Models, and Using Optimization to Develop Hypotheses About Ecosystems. Chapters cover: managing sedimentation, managing stormflow, optimizing natural regeneration in any-aged forest management, habitat placement for the northern spotted owl, habitat placement for the black-footed ferret, habitat placement for the black-tailed prairie dog, habitat placement for the western prairie fringed orchid, capturing edge effects, controlling exotic pests, controlling wildfire, capturing multi-scaled ecological limiting factors, and modeling carbon fixation in trees. The authors seek to preserve the goal of optimality while realistically exploring, through a series of detailed case studies, the extent to which the complexity of actual ecosystems can be rendered through mathematical programs. Optimizing the spatial placement of management actions on the landscape is central to sustainable forest management throughout the world. It allows managers to minimize any adverse impacts of human activity on the ecological system or to maximize any positive impacts that are feasible with limited resources.



This book is a follow-up to *Spatial Optimization for Managed Ecosystems* (by the same authors), which lays out the basic theory and fundamental methodology of spatial optimization. The new book takes this well-received work to the stage of application. Both are published in the *Complexity in Ecological Systems Series* by Columbia University Press.

For more details, see Hof, J. and M. Bevers. 2002. *Spatial Optimization in Ecological Applications*. New York: Columbia University Press, 257p.

Additional information on this and related work is available at http://www.fs.fed.us/rm/analytics.

Restoring White Pine Ecosystems

White pine blister rust was inadvertently introduced to western North America in 1910. As few white pines were resistant to the disease, mortality spread across the West. Today, less than 10 percent of the historic 5 million acres of the western white pine cover type remains in Inland Northwest forests, and mortality is similar for whitebark pine. The forests that replaced white pines are more prone to diseases and insects, and are missing keystone species that determine the ability of other plant and animal species to persist in the community.

Genetic resistance in western white pine to blister rust has been demonstrated, and a breeding program based on this resistance has developed western white pine seedlings that are about 66 percent resistant. Further development will bring resistance to about 80 percent. Surveys in test plantations show consistently lower infection and mortality in genetically improved western white pine compared to unimproved stock. Even at the site where 93 percent of genetically improved stock was infected, 34 percent of these improved trees were still alive at age 26, while 100 percent of the unimproved stock had died by age 12.

Growing genetically improved western white pine seedlings for more than 25 years under field conditions has demonstrated the stability of resistance under annually varying infection conditions. Research results also show that needle morphology can play a role in some forms of resistance to white pine blister rust infection. For example, Station scientists found that needles of susceptible families had wider and larger stomata than those of resistant families. Until recently, methods for studying DNA from blister rust spores were hindered by small spore size and thick spore walls. New techniques have been developed to efficiently extract DNA to better define rust population structure and disease progression in forests.

In high elevation whitebark pine stands, the Clark's nutcracker readily disperses seed throughout individual stands. However, DNA data indicates that nutcrackers rarely disperse seed across large forest gaps. Genetic structure of whitebark pine stands throughout the Inland Northwest indicates that information on seed movement could provide one method for recovery of whitebark pine ecosystems.

Cooperative research continues with the Inland Empire Tree Improvement Cooperative, Forest Service Northern Region, the University of Idaho, and various land management agencies. The white pine breeding program will work to incorporate additional resistance mechanisms into white pine seedlings and develop cultural treatments that promote the growth and survival of white pine. Scientists say that white pine ecosystems

Gathering blister rust samples in Yellowstone National Park.

can be restored to health and vigor, but it is going to take a concerted effort among forest managers in the Inland Northwest. Details on this and other work at the Moscow, Idaho laboratory can be found at http://forests.moscowfsl.wsu.edu/gems.

Additional information is available in:

Fins, L.; Byler, J.; Ferguson, D.; Harvey, A.; Mahalovich, M.F.; McDonald, G.; Miller, D.; Schwandt, J.; Zack, A. 2002. Return of the Giants: Restoring Western White Pine to the Inland Northwest. *Journal of Forestry* 100:20-26.

Richardson, B. A., Brunsfeld, S. J., and Klopfenstein, N.B. 2002. DNA from Bird-dispersed Seed and Wind-disseminated Pollen Provides Insights into Postglacial Colonization and Population Genetic Structure of Whitebark Pine (*Pinus albicaulis*). *Molecular Ecology* 11: 215-227.

Richardson, B. A., Klopfenstein, N. B., and Brunsfeld, S. J. 2002. Assessing Clark's Nutcracker Seed-caching Flights Using Maternally Inherited Mitochondrial DNA of Whitebark Pine. *Canadian Journal of Forestry Research* 32: 1103-1107.

Woo, K-S, Fins, L., McDonald, G. I., and Wiese, M. V. 2001. Differences in Needle Morphology Between Blister Rust Resistant and Susceptible Western White Pine Stocks. *Canadian Journal of Forestry Research* 31: 1880-1886.

Zambino, P. J. 2002. Dry Grinding at Near-ambient Temperatures for Extracting DNA from Rust and Other Fungal Spores. *BioTechniques* 33: 48-51.

Fire Suppression Expenditure Forecasts

Anti-deficiency regulations require the Forest Service to monitor actual and expected emergency fire suppression expenditures to ensure they remain within budgetary authorizations. Hence, starting in June of each year, the State and Private Forestry Fire and Aviation Management unit provides the office of the Chief, the Office of Management and Budget, and congressional stakeholders with monthly forecasts of total, fiscal year fire suppression expenditures. The Rocky Mountain Research Station developed and implements the forecasting tool and process that makes all this possible.

Statistical models for forecasting fire suppression expenditures were developed for each Forest Service region and the Washington Office. The response (forecasted) variable was regional, monthly, fire suppression expenditures. Predictor variables vary by region but reflect regional fire activity, as available through the Incident Management Situation Reports. Regional fire activity data are extensive, including the number of acres burned and the number of fires in each region, by fire-fighting agency, and the regional totals. Information contained in the Situation Reports is the most accurate, up-to-date available. Statistical models are updated annually to reflect newly-available information and changing fire-fighting circumstances.

The statistical models used to produce monthly forecasts of annual expenditures start with June of each year. The actual forecast process consists of three steps. *Step 1* –Starting with the end of May, the financial accounting system is queried to retrieve actual month-end, year-to-date fire suppression expenditures for each region. *Step 2* –Pertinent, year-to-date fire activity information is accumulated from the Situation Report and provided to the NICC (National Interagency Coordination Center) manager at NIFC (National Interagency Fire Center), who makes forecasts of expected regional fire activity for the upcoming months of the fiscal year. *Step 3* –Armed with expenditure information and forecasts of fire activity, our statistical models are used to forecast predicted expenditures, by region, for each of the remaining months of the fiscal year. Those forecasts are added to the actual year-to-date expenditures to produce a forecast of total fiscal year fire suppression expenditures for each region. Regional forecasts are aggregated into a national total and a statistical confidence interval (an upper and lower bound for the forecast) is calculated. The completed forecast package along with graphics and interpretative remarks are then provided to Forest Service and other managers. During the 2002 fire season, this information was made available as early as June. Twice-monthly forecasts were typically within 10 percent of what actually occurred.

Details on this forecasting tool are available in Gebert, K. and E. G. Schuster. 1999. *Predicting National Fire Suppression Expenditures*. Pages 21-30 *in* Proceedings of the Symposium on Fire Economics, Planning and Policy: Bottom Lines, 1999 April 5-9; San Diego, CA; General Technical Report PSW-GTR-173. Berkeley, CA; USDA, Forest Service, Pacific Southwest Research Station.

Learn more about the economic aspects of forest management on public lands at http://www.fs.fed.us/rm/missoula/4802.

Station scientists developed tools that help forecast fire suppression expenditures.

Improving Methods and Prioritization for Forest Road Decommissioning

Forest roads provide many important benefits, but can be maintenance and environmental liabilities for the agencies that manage them. As a consequence, many public land managers are choosing to decommission roads to reduce these liabilities to manageable levels.

Given constraints imposed by available time and funds and by a public desiring unimpeded access to public lands, there is an urgent need for systematic prioritization of roads to decommission, and to efficiently use resources to accomplish the goals of decommissioning. From this point of view there is little information on the relative effectiveness of alternative treatments for a range of goals from watershed protection to soil productivity improvement. Closely related is the lack of existing standards for minimal restoration, allowing anything from a berm at the road entrance to full recontouring with soil amendments and culvert removal to be listed as "restoration." Such inconsistencies lead to problems in accountability and credibility.

A road is ripped as part of the process of road decommissioning. Because roads can have dramatic effects on watersheds and aquatic ecosystems, and because removing roads can be very expensive, research at the Rocky Mountain Research station has evaluated the effectiveness of road obliteration techniques and developed new tools to help prioritize the removal of roads.

Scientists at the Boise, Idaho laboratory are focusing on physical processes influencing and influenced by roads within an aquatic ecological context. A series of research products have built analyses and tools to improve prioritization of projects and the efficacy of treatments.

Ecological principles and theory provide a sound basis for selecting among alternative prioritization packages for a road network. An important early step is to examine the spatial patterns of road erosion and road sediment contributions to fish bearing streams. Besides the very simple approach of remedying the greatest contributors, efforts can be made to focus on individual tributaries to create fine scale "refuge" networks allowing temporary escape from reaches with elevated contributions of fine sediment. Maps for such analyses can be produced using inventories of roads combined with relationships between a road's characteristics, use, and maintenance and its sediment production.

The effectiveness of treatments depends to some extent on the effort applied. Road ripping, considered a medium level of effort, increases the surface hydraulic conductivity to values higher than common rain intensities recorded for 15 and 30-minute durations, but does not restore the natural hydrology of the site. On some soils, the collapse of the soil as it is saturated can recompact the soil nearly to the initial density of the road. On sites with ripping or recontouring, vegetation is slow to establish and plant cover can be thin for many years because of the low water holding capacity of the soils. Using extra effort to add organic materials and nutrients, such as may be obtained from mill waste and biosolids, may be a good way to improve the strength after wetting and water holding capacity of soils. Such a step may improve recovery of soil productivity as well.

Find out more by visiting http://www.fs.fed.us/rm/boise, or in the following publications:

Luce, C.H., B.E. Rieman, J.B. Dunham, J.L. Clayton, J.G. King, and T.A. Black, 2001, Incorporating Aquatic Ecology into Decisions on Prioritization of

Road Decommissioning. *Water Resources Impact* 3(3), 8-14.

Luce, Charles H., 1997, Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads. *Restoration Ecology* 5(3):265-270.

Luce, C.H. and T.A. Black, 2001, Spatial and Temporal Patterns in Erosion from Forest Roads, In Influence of Urban and Forest Land Uses on the Hydrologic-Geomorphic Responses of Watersheds, M.S. Wigmosta and S.J. Burges, Editors, American Geophysical Union, Washington, D.C. pp. 165-178.

Luce, C.H. and B. Wemple, 2001, Introduction to the Special Issue on Hydrologic and Geomorphic Effects of Forest Roads. *Earth Surface Processes and Landforms* 26(2), 111-113.

Luce, C.H. and T.A. Black, 1999, Sediment Production from Forest Roads in Western Oregon. *Water Resources Research* 35(8): 2561-2570.

Luce, C.H. and T.A. Black, 2001, Effects of Traffic and Ditch Maintenance on Forest Road Sediment Production, In Proceedings of the Seventh Federal Interagency Sedimentation Conference, March 25-29, 2001, Reno, Nevada. pp. V67–V74.

Luce, C.H. and T.A. Black, 2001, Tools for Road Erosion and Landslide Analysis in GIS, http://www.fs.fed.us/rm/boise/teams/soils/Presentations/Charlies's Roads GIS.htm

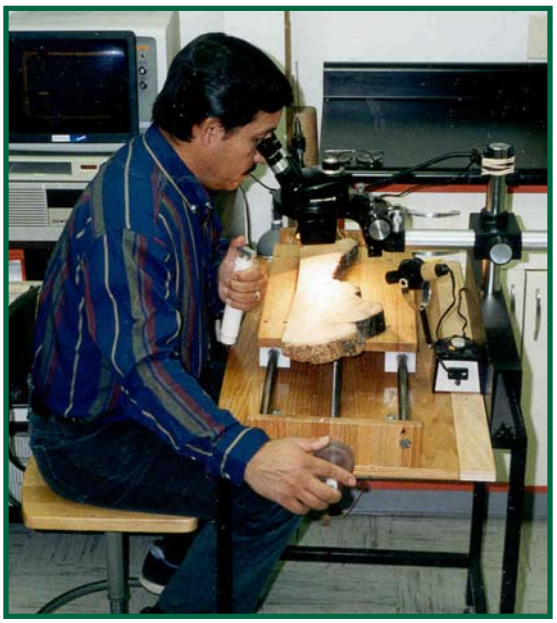
Fire Frequency Decreases with Latitude – At Least It Used To!

Chronologies of fire histories in ponderosa pine in Colorado and Wyoming, reconstructed from trees scarred by fire over more than four centuries, show several correlations with latitude. Fire-free intervals tended to be shorter in the southern stands than in the north. Fires in the south also tended to be early in the season, with late-season fires in the north. Superimposing calculated drought severity indexes on plots of fire years showed, not surprisingly, that fire years were dry, but in the south were preceded by wet years. This supports the idea that fuels may have been limiting southern forests where fire intervals were shorter, and that longer intervals in the north permitted greater fuel buildup between fires.

Knowing these patterns could be of great help to those planning suppression of catastrophic fires, except for one thing: the coming of Euro-American settlers effectively put a damper on forest fires for nearly a century, so that the forests – and the fire patterns within them – are now much different. With changes in our philosophy on the costs and benefits of fire, it will likely take a long time to reach – or understand – equilibrium with fire in forests.

Learn more at http://lamar.colostate.edu/~rwu4451. Additional information is available in:

Brown, Peter M., and Wayne D. Shepperd. 2001. Fire History and Fire Climatology Along a 5 Degree Gradient in Latitude in Colorado and Wyoming. *Palaeobotanist* 50:133-140.



Scientists can reconstruct the history of fire in forests by dating patterns of fire scars in cross-sections of trees.

A New Approach for Measuring Belowground Carbon Allocation in Forests

The earth's carbon cycle has been getting much attention lately because of the rapid increase in carbon dioxide in the atmosphere and its influence on climate. While scientists have made progress in understanding this carbon cycle, many key questions remain. For example, of all the carbon released by burning fossil fuels, only half remains in the atmosphere each year. Where does the rest of the carbon go? Will the current sink remain indefinitely, or will it 'saturate' or fill up? Making good policy about how to manage carbon emissions from fossil fuels requires good information on the sources and sinks for carbon in the biosphere and their size and longevity.

One of the least understood components of the carbon cycle is the carbon that plants send belowground to make and support roots. Of the carbon taken from the atmosphere in photosynthesis, roughly half is sent belowground. Knowing exactly how much carbon plants send belowground and its fate will allow a much better understanding of forest carbon cycles, and better predictions of how changes in climate will change the amount of carbon stored there.

Measurements of carbon sent belowground are tough and uncertain because root production, mortality and respiration are difficult to measure. Also, scientists suspect that much of the carbon plants send belowground is used by fungi that act as roots (mycorrhizae)—and these are much more difficult to measure than roots. What was needed was a new approach that bypassed the difficulties of measuring individual roots and fungi.

Researchers adapted and tested a carbon 'budget' approach for measuring belowground carbon allocation. The carbon budget approach works like a bank account or a bathtub—if you know how much you are spending and your balance, you can calculate your income. They measured the carbon leaving the system through soil respiration, inputs from litter, and changes in the storage (carbon in roots, soil, and litter), and calculated belowground carbon allocation from these measurements. They found that this technique produced very accurate estimates of belowground allocation, providing a reliable tool with which to measure a very large flux of carbon.

This tool is being used to show how changes in climate, fertility, and competition change the amount of carbon allocated belowground. These studies show that increased fertility and water availability can dramatically lower carbon allocation, but competition (fewer or more trees) has no effect on allocation. With enough measurements in different locations, scientists can uncover 'rules' for carbon allocation and make better predictions about how forests and the carbon stored in them will respond to a changing climate.

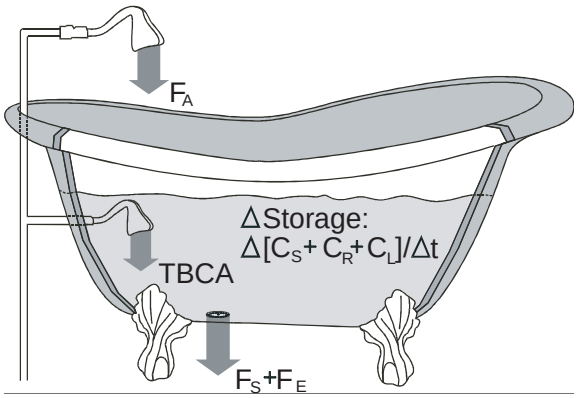
This and related research is highlighted at http://www.fs.fed.us/rm/rwu4352. Additional information is in:

Giardina CP and MG Ryan. 2002. Total Belowground Carbon Allocation in a Fast Growing Eucalyptus Plantation Estimated Using a Carbon Balance Approach. *Ecosystems 5*: 487-499.

Litton CM, MG Ryan, DB Tinker, and DH Knight. 2002. Below- and Above-ground Biomass in Young Post-fire Lodgepole Pine Forests of Contrasting Tree Density. *Canadian Journal of Forest Research*.

Litton CM. 2002. Above- and Below-ground Carbon Allocation in Post-fire Lodgepole Pine Forests: Effects of Tree Density and Stand Age. PhD Thesis, University of Wyoming.

Stape, JM. Production Ecology of Clonal Eucalyptus Plantations in Northeastern Brazil. PhD Thesis, Colorado State University.



Analogy for mass balance approach to estimate total belowground carbon allocation (TCBA). The flux of water into the tub from the underwater faucet can be calculated by measuring water into and out of the tub, and any water stored in the tub.

Smoke Management Guide for Prescribed and Wildland Fire: 2001 Edition

A new comprehensive smoke management guide has been developed by scientists at the Fire Sciences Laboratory in Missoula, Montana, along with other Agency experts, the U.S. Fish and Wildlife Service, the Nature Conservancy and a private consultant.

Chartered by the National Wildfire Coordinating Group (NWCG), the 2001 edition of Smoke Management Guide for Prescribed and Wildland Fire, addresses methods for avoiding or reducing adverse impacts of smoke on human health and welfare. A suite of potential smoke management practices and techniques are not only suggested in the guide, but their relative effectiveness and regional specific applicability are also provided. It emphasizes both emission and impact reduction methods that have been found to be practical, useful and beneficial. Readers will also find a greatly expanded discussion of air quality regulatory requirements, reflecting the growing complexities and demands on today's fire practitioners. Information was acquired through three regional workshops held in collaboration with the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards (OAQPS). Over 80 experts contributed comments and suggested revisions to drafts of the Guide. The EPA's OAQPS is considering adoption of the Guide as its primary reference document for Best Available Control Methodology with respect to smoke emissions from wildland fires.

Fire practitioners from NWCG agencies and their partners, local and county governments, non-governmental organizations, industry and private landowners, along with air quality managers and anyone who needs to manage smoke responsibly, will find this desktop guide beneficial. It is available from the National Interagency Fire Center, attn: Great Basin Cache Supply Office, 3833 S. Development Ave., Boise, ID, order # NFES1279, price $3.91; Fax: 208-387-5573. The document can be downloaded (pdf format) at http://www.nwcg.gov/pms/pubs/SMG-72.pdf.

Additional information on research at the Fire Sciences Laboratory is available at http://ww.firelab.org.

Smoke plume from a wildfire during stable atmospheric conditions. (photo by Roger Ottman)

The Role of Fire in Ecosystem Processes and Sensitive Species in Southwestern Grasslands

Historically, the black-tailed prairie dog (*Cynomys ludovicianus*) ranged from Canada to Mexico throughout the Great Plains and west to Arizona, but the species is now considered uncommon or extirpated in many areas of its former range. Many threatened and endangered species depend on prairie dogs and their colonies (e.g., black-footed ferret, burrowing owl, Aplomado falcon, swift fox). Because the black-tailed prairie dog significantly influences ecosystem functions, it has been considered a grassland keystone species. Scientists at the Albuquerque, New Mexico Laboratory are conducting studies in the Chihuahuan Desert grassland, applying experimental fire and mowing treatments, in combination with bison grazing, around pre-existing prairie dog colonies to examine the effects of fire on these sensitive species. Results will help determine whether fire can facilitate the expansion and movement of established black-tailed prairie dog colonies into areas from which they have been extirpated. The long-term management goal of this study is to use fire to catalyze a self-sustaining dynamic between bison and prairie dogs. Preliminary results have been highlighted in the August 2002 issue of *Scientific American*. This research is being done in cooperation with New Mexico State University, The Jornada Experimental Range of the Agricultural Research Service, and the Turner Endangered Species Fund.

Find out more about studies at the Albuquerque laboratory by visiting http://www.fs.fed.us/rm/albuq.

Scientists are studying the effects of experimental fire on prairie dogs.

How Will Climate Change Affect Forests?

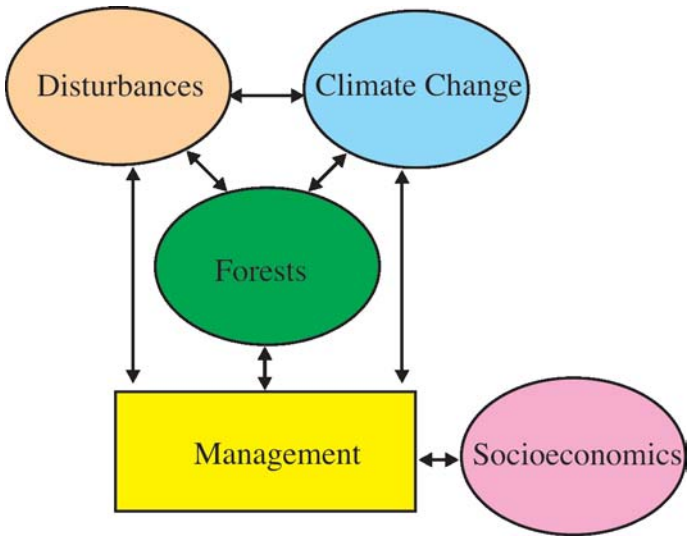
Early studies on the effects of climate change on forests focused on the ability of tree species to tolerate temperature and moisture changes. Many scientists are now recognizing – through modeling studies – the importance of climate changes on disturbance regimes that determine the character of forests. Trees can live for centuries, and have slowly evolved to co-exist with natural disturbances such as fire, drought, insects, diseases, and severe storms, but how will they be affected by a relatively rapid change in climate? In their article "Climate Change and Forest Disturbances" in the journal *BioScience*, a group of scientists with wide-ranging backgrounds discuss how climate change may affect forests by altering the frequency, intensity, duration, and timing of these natural disturbances, plus the relatively new phenomenon of introduced species.

Scientists say that some effects will be positive, some negative, some may cancel each other out, and effects will likely vary geographically. A major problem, however, is uncertainty: we are entering uncharted waters. Thus, the authors suggest a variety of strategies for coping with the possible effects of climate change:

- Managing the system before the disturbance to reduce vulnerability and enhance recovery.
- Managing the disturbance itself to reduce impacts.
- Managing recovery to speed processes and reduce future vulnerability.
- Managing to determine the impacts of disturbances and effectiveness of recovery efforts – the concept of adaptive management.

Read about it in:

Dale, Virginia M., Linda A. Joyce, Steve McNulty, and others. 2001. Climate Change and Forest Disturbances. *BioScience* 51(9): 723-734.



Interactions among disturbances, climate change, forests and management strategies.

Biological Control of Noxious Weeds

The invasion of weeds onto forested lands of the Northern Rockies, especially following wildfires is becoming an increasingly important problem, which up to now has been managed by spraying chemical herbicides. Research is underway at the Bozeman, Montana laboratory to develop and implement a new management option, biological control, the importation, release, and establishment of the natural enemies of these weeds.

Demonstration projects against yellowstar thistle and leafy spurge are now in their fifth and sixth years and have been found to be an effective method to convince land managers that biological control will work in our forest environment.

Research to find and test new biological control agents for forest weeds in 2002 culminated in the USDA issuing scientists a permit to release a root boring moth that attacks rush skeletonweed. A colony of this insect is presently being reared at the Bozeman laboratory and researchers are working with the Boise National Forest in Idaho to make an initial field release.

The foliage feeding Cinnabar moth, which was released in Montana in 1997, is now so well established that its host, the poisonous weed tansy ragwort, has completely disappeared over hundreds of acres around the original research plots on the Flathead National Forest. Releases made in 1999, in an area burned by wildfires on the Kootenai National Forest were confirmed in 2002 to also be established and rapidly expanding, and scientists expect this moth to successfully control this population of tansy in three to five more years.

A setback was finding that this biological control agent has failed to establish in adjacent unburned forested lands. This year, five new releases were made in unburned areas under tightly controlled conditions, which will allow monitoring of these populations to determine what environmental factors are preventing establishment in unburned habitats. As a backup, scientists are continuing efforts to find other biocontrol agents that may work in unburned habitats. They have been researching a small flea beetle, the larvae of which attacks the roots of tansy, which they hope will be more successful in this habitat. Previous efforts to introduce this beetle were unsuccessful probably because the insect used originated from Italy and was not adapted to Montana winters. However, three years of research on the biology, taxonomy, and feeding behavior of a new flea beetle from Switzerland, resulted in obtaining a permit to release this insect in North America. Researchers are presently rearing a colony of this insect in the Bozeman Laboratory in preparation for the first field releases in spring 2003.

In June 2002, scientists returned to Montana with approximately 9000 adult stem-boring weevils, *Mecinus janthinus*, obtained through APHIS from nursery sites in Nelson, B.C. established by cooperators in the B.C. Ministry of Forests and Agriculture and Agri-Food Canada. Twenty new releases of *M. janthinus* were made on both yellow and Dalmatian toadflax. Montana release sites are currently located on Forest Service, BLM, private, municipal and tribal lands. In July, grid-sampling plots were set up on sites previously established by the Biocontrol Lab at Montana State University-Bozeman, and on Forest Service releases made in 2002. General vegetation and specific toadflax parameters were recorded and will continue to be monitored at study sites in burned and non-burned areas to determine if increase in weed abundance and distribution is correlated with fire events. In addition, spatially-registered foliar damage ratings and adult mortality data from toadflax stem dissections will be used to evaluate how habitat alteration by wildfire impacts agent efficacy in host location, host attack and dispersal. Observations from established sites indicate that this agent requires approximately four years on a site to become well established. One of these sites was a release on yellow toadflax, thought to be a poor target host for this agent.

Find out more about these studies at http://www.fs.fed.us/rm/ecology. Additional reading is offered in:

Markin, George P. 2001. Notes on the Biology and Release of *Caloptilia* sp nr. S*chinella* (Walsingham) (*Lepidoptera: Gracilariidae*), a Biological Control Moth for the Control of the Weed Firetree (*Myrica faya* Aiton) in Hawaii. Proc. Hawaiian Entomological Society. 35: 67-76.

Trainor, M. A.; Maxwell, B. D.; and Markin, G. P. 2002. Quantifying Tansy Ragwort (*Senecio jacobaea*) Recruitment and Population Dynamics in Northwestern Montana. In: WSSA Abstracts, 2002 Meeting of the Weed Science Society of America. February 11-15, 2002; Reno, NV. Vol. 42. 15.

Trainor, Meghan A., Bruce D. Maxwell, and George P. Markin. 2002. Variability in Tansy Ragwort (*Senecio jacobaea*) Population Dynamics in a Range of Environments. In: The Ecological Society of America Abstracts, The Ecological Society of America 87th Annual Meeting and Society for Ecological Restoration 14th Annual International Conference. August 4-9, 2002; Tucson, AZ.

Flea beetles being released on leafy spurge on the south fork of the Boise River, Sawtooth National Forest, ID.

Leafy spurge has been eradicated by the flea beetle and native grasses and forbs are beginning to grow on the cleared hillside.

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 FY2002 Station Appropriation: $36,659,000
Total Outside Funding: $19,499,327
Total National Fire Plan Funding: $8,192,000
Total Number of Scientist Years: 112 (scientist year = one scientist working one full year)

(In addition to the outside funding shown above for the research work units, the Station's library and publications units are supported by $155,000 in outside funding.)

Forest Service Research and Development in Arizona

The Rocky Mountain Research Station maintains five research work units in Arizona. These units are located at the Southwest Forest Science 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 Southwest ecosystems. The Station's Fort Valley Experimental Forest is located near Flagstaff on the Coconino National Forest.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
Southwest Forest Sciences Complex
2500 S. Pine Knoll
Flagstaff, AZ 86001
(928) 556-2001
Fax: (928) 556-2130
(http://www.fs.fed.us/rm/main/labs/flagstaff.html)
(http://www.rmrs.nau.edu/lab)

Total FY2002 Appropriations: $5,502,000
Total Outside Funding: $1,864,578
Total National Fire Plan Funding: $1,379,395
Total Number of Scientist Positions: 13

Research Work Units

• Wildland-Urban Interface Fuels Management and Forest Health Restoration in the Southwest (RMRS-4156)

FY2002 Appropriation: $1,667,000

Outside Funding: $736,688

National Fire Plan Funding: $397,979

Number of Scientist Years: 1

Mission: Investigate ways to reduce the risk of catastrophic wildfires in wildland-urban interface areas and restore and sustain the health and productivity of southwestern forest ecosystems.

• Sustainability of Southwest Forest and Woodland Terrestrial Ecological Systems (RMRS-4251)

FY2002 Appropriation: $1,837,000

Outside Funding: $1,100,910

National Fire Plan Funding: $185,458

Number of Scientist Years: 5

Mission: Acquire, develop and apply new knowledge and technology to guide ecosystem management to sustain selected, but critical, components – soils, flora, fauna, habitats – of population, community and landscape ecological systems in southwestern forests and woodlands.

This white-breasted nuthatch nestling was banded to help study population demographics of secondary cavity nesting species.

"For over 10 years, we have been involved with scientists at your Flagstaff laboratory, determining habitat needs and trends for the Mexican spotted owl (MSO) and northern goshawk. The resulting flow of information has guided the Region in development of standards and guidelines for forest and grazing management. Regional Wildland Urban Interface projects with related long-term studies will be instrumental in refining our knowledge of effects on MSO, providing critical information, and offering a scientific basis for use in expected future litigation." (Larry Cosper, USDA Forest Service, Wildlife, Fish and Rare Plants, Southwestern Region, Albuquerque, NM)

Collecting data to determine the effects of forest thinning on Mexican spotted owls and their prey, Lincoln National Forest, NM.

• Sustainability of Riparian Ecological Systems in Southwestern Forests and Woodlands (RMRS-4302)

FY2002 Appropriation: $865,000

Outside Funding: $22,000

National Fire Plan Funding: $397,979

Number of Scientist Years: 3

Mission: Investigate the interrelationships among hydrologic, geomorphic, and biotic processes that affect fish habitat, riparian vegetation, channel dynamics, and instream water flow. Work is underway to help determine, predict and manage the effects of prescribed fires, wildfires, grazing, vegetation management, and other activities on riparian ecosystems.

• Ecological Roles of Insects and Pathogens in Coniferous Forests of the Interior West (RMRS-4152)

FY2002 Appropriation: $715,000

Outside Funding: $5,000

National Fire Plan Funding: $397,979

Number of Scientist Years: 3

Mission: Understand the roles of insects and pathogens as agents of disturbance and regulators of ecosystem processes in western coniferous forests. Scientists are also developing methods to assess and predict their effects for use in the decision support and planning processes used by forest managers, silviculturists, and forest health protection specialists.

• Achieving Ecosystem Management in Southwestern Borderlands (RMRS-4651)

FY2002 Appropriation: $418,000

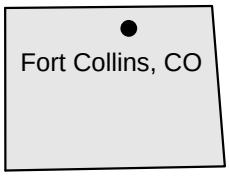
Outside Funding: $0

Number of Scientist Years: 1

Mission: Develop methods to restore natural processes and sustain the health and productivity of grassland and woodland ecosystems in the Borderlands area of the Southwestern United States and Mexico.

"Since 1993, we have been closely involved in a cooperative program of work with your scientists in Flagstaff, investigating the relationships of land management activities to the water quality and aquatic habitats of the Apache Trout streams on the West Fork Grazing Allotment. The Station provided our Forest with high-quality scientific data and analyses about fish and their habitats, and ungulate effects on Apache Trout recovery streams, complete with recommendations. It is cutting edge work that is critical to the successful management of these native fish species and their habitats." (John Bedell, Forest Supervisor, Apache-Sitgreaves National Forest, Springerville, AZ)

Forest Service Research and Development in Colorado



The Rocky Mountain Research Station maintains seven research work units and the Stream Systems Technology Center, all located at Station headquarters in Fort Collins, Colorado. Three of the units have national charters. They support the Forest Service and other federal land management agencies on technology related to natural resource inventory, monitoring, economics and 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 located 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 located 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.

USDA Forest Service
Rocky Mountain Research Station
2150 Centre Ave., Bldg. A
Fort Collins, CO 80526
(970) 295-5000
Fax: (970) 295-5959
(http://www.fs.fed.us/rm/main/labs/ftcollins.html)

Total FY2002 Appropriation: $7, 264,000
Total Outside Funding: $2,211,280
Total National Fire Plan Funding: $1,007,683
Total Number of Scientist Years: 28

Research Work Units

• Research to Sustain Fish and Watershed Components of Aquatic and Riparian Ecosystems in the Central Rocky Mountains and Northern Great Plains (RMRS-4352)

(This unit is co-located in Fort Collins and Laramie, WY at the Station's Forestry Sciences Laboratory, 222 South 22nd Street, Laramie, WY 82070, [307] 742-6621, Fax: [307] 745-2397)

FY2002 Appropriation: $1,756,000

Outside Funding: $511,925

Number of Scientist Years: 6

Mission: Better understand aquatic and riparian ecosystems, particularly the interactions between vegetation, hydrology, water channels, and aquatic habitat and fisheries, and how they are affected by land and water management practices.

As part of the Cold-land Processes Field Experiment, scientists collect ground, airborne and satellite data to help develop tools for forecasting, estimating and modeling water and energy balances in cold regions.

• Sustaining Alpine and Forest Ecosystems Under Atmospheric and Terrestrial Disturbances (RMRS-4451)

FY2002 Appropriation: $1,870,000

Outside Funding: $221,107

National Fire Plan Funding: $868,390

Number of Scientist Years: 7

Mission: Develop and refine the knowledge and technology needed to understand, model and manage vegetation and ecosystem processes that help sustain alpine, forest, and woodland ecosystems.

"Station entomologists continue to assist our forest health personnel in testing research applications for control of bark beetles. This work is absolutely critical to successful completion of our bark beetle control projects." (Mike Retzlaff, Regional Economist, USDA Forest Service, Rocky Mountain Region, Denver, CO)

• Research on Sustaining Social, Biological and Physical Components of Colorado Front Range Ecosystems (RMRS-4653)

FY2002 Appropriation: $105,000

Outside Funding: $1,024,355

Number of Scientist Years: 1

Mission: Devise strategies to manage public lands along the Colorado Front Range in ways that will sustain ecosystems while addressing the needs and desires of society.

• Forest Inventory and Monitoring Environmetrics (RMRS-4804)

FY2002 Appropriation: $678,000

Outside Funding: $157,054

Number of Scientist Years: 3

Mission: Develop, validate, and transfer scientifically credible methods of mathematical statistics for the Forest Inventory and Analysis programs across the United States to assist in more timely and useful inventory and monitoring of forest lands.

• Identification and Valuation of Wildland Resource Benefits (RMRS-4851)

FY2002 Appropriation: $1,021,000

Outside Funding: $74,290

Number of Scientist Years: 5

Mission: Develop new methods and test the validity and reliability of current methods used to measure people's values for natural resources, including environmental amenities. Research emphasizes the relationships of human values and experiences to attributes of the environment and economic transactions. Scientists also assist resource managers in applying state-of-the-art economic and social science analyses.

Work is underway to develop methods for measuring the values people place on natural resources.

• Natural Resource Assessment, Ecology, and Management Science Research (RMRS-4852)

FY2002 Appropriation: $986,000

Outside Funding: $0

National Fire Plan Funding: $139,293

Number of Scientist Years: 5

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.

"Since 2001, we have been involved with Brian Kent and various research cooperators in applying the Values/Objectives/Attitudes/Behaviors work to Forest Planning. The White River National Forest used this research to improve responsiveness to local interests and bolster the social effects analysis." (Mike Retzlaff, Regional Economist, USDA Forest Service, Rocky Mountain Region, Denver, CO)

• Stream Systems Technology Center

FY2002 Appropriation: $848,000

Outside Funding: $222,549

Mission: Identify the streamflow regimes needed to maintain instream and riparian values for different water channel types. Specialists determine the consequences of changed flow regimes to on-site and downstream channel functions and values. They also identify how instream flow needs are affected by water diversions and land use activities.

"Larry Schmidt assisted me and others in planning and conducting an organization-building exercise for the BLM National Science and Technology Center's Division of Science. Thank you so much for making Larry available to generously spend his time with us. This challenging workshop was a success in large measure as a result of his contributions as a facilitator." (Charisse Sydoriak, Bureau of Land Management)

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 the 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 Forest on the Idaho Panhandle National Forests.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
316 East Myrtle Street
Boise, ID 83702
(208) 373-4340
Fax: (208) 373-4391
(http://www.fs.fed.us/rm/boise)

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
1221 South Main Street
Moscow, ID 83843-2321
(208) 883-2321
Fax: (208) 883-2318
(http://www.fs.fed.us/rm/main/labs/moscow.html)
(http://forest.moscowfsl.wsu.edu)

Total FY2002 Appropriations: $5,510,000
Total Outside Funding: $1,750,115
Total National Fire Plan Funding: $1,381,784
Total Number of Scientist Years: 17

Research Work Units

• Watershed and Aquatic Ecosystem Research (Boise) (RMRS-4353)

FY2002 Appropriations: $1,952,000

Outside Funding: $844,361

National Fire Plan Funding: $277,789

Number of Scientist Years: 5

Mission: Conduct research on aquatic and terrestrial processes and the effects of disturbance to assist managers in conserving diverse, resilient and productive aquatic ecosystems. Findings will help managers prioritize limited resources and focus conservation and restoration efforts while addressing other management goals.

This scientist is estimating the abundance of fish by snorkeling in streams with a broad range of habitat and environmental conditions. Models developed from these studies can be used to improve the information collected by biologists working on sensitive species, and to guide more efficient use of monitoring and inventory funding.

"The technical assistance provided by Nancy Shaw regarding native plants has been invaluable to our success. This cooperative working atmosphere between the Rocky Mountain Research Station and our nursery is extremely important to the overall success of both our programs." (Clark Fleege, Nursery Manager, USDA Forest Service, Lucky Peak Nursery, ID)

"Our office has been working closely with your Boise Aquatic Sciences Lab to gain a better understanding of the relationship of temperature with the distribution of interior Columbia River Basin salmonids. EPA has utilized this expertise for several projects since 1997. The Lab's work has been an important piece and is critical to EPA's efforts to develop meaningful temperature criteria for use by the states and tribes of the Pacific Northwest and the Rocky Mountain regions. Your work is always of the highest quality and professional standards. Products and information we receive from your lab have a high level of credibility within the scientific community." (Donald Martin, Senior Natural Resource Advisor, Environmental Protection Agency, Coeur d'Alene, ID)

• Forest Ecosystem Development and Management (Moscow) (RMRS-4155)

FY2002 Appropriations: $1,450,000

Outside Funding: $93,917

National Fire Plan Funding: $397,979

Number of Scientist Years: 4

Mission: Conduct research on ecological processes and forest dynamics that expands our understanding of Interior West forest biology and ecological genetics in support of forest science and management.

• Root Diseases and Soil Biology (Moscow) (RMRS-4552)

FY2002 Appropriation: $1,052,000

Outside Funding: $183,000

National Fire Plan Funding: $198,990

Number of Scientist Years: 5

Mission: Conduct research on the role of microbes as they regulate the growth, development and/or restoration of western conifer ecosystems; evaluate how microbes are affected by forest mangement; and develop methods for preserving or modifying key processes to enhance long-term forest sustainability, productivity, health and vigor.

"Our Coeur d'Alene field office has been closely involved with researchers at our Moscow laboratory, dealing with blister rust and root diseases. The expertise of Geral McDonald in building a blister rust model has been especially crucial. In addition, we have been involved in cooperative projects with Barbara Bentz, testing the efficacy of verbenone pouches for protecting trees and stands from mountain pine beetle attack. The results of these projects should provide a valuable tool in managing mountain pine beetle in whitebark pine and lodgepole pine stands." (John Schwandt, Forest Health Protection, USDA Forest Service, Northern Region, Coeur d'Alene, ID)

• Soil and Water Engineering (Moscow) (RMRS-4702)

FY2002 Appropriation: $1,056,000

Outside Funding: $628,837

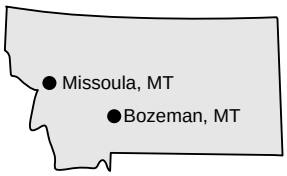
National Fire Plan Funding: $507,026

Number of Scientist Years: 3

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

"Personnel from the Rocky Mountain Research Station have been extremely service oriented. I have much praise for their generosity and cooperation in helping use their research products. Some recent examples: Nick Crookston helped us out with efforts on endangered species. On short notice, we asked Kevin Ryan and Rick Stratten of the Missoula Fire Lab to help us develop a FARSITE fire behavior analysis for a fire shelter entrapment investigation report. They used fuel-modeling information from their Southern Utah Fuels Demonstration Project to create a fire behavior scenario for us. Jack Cohen cleared a jam-packed schedule to speak at our Great Basin Fuels Committee meeting in Jackson Hole, WY. Bobbie Bartlett helped us analyze the NVDI greenness maps for a politically sensitive situation in Nevada. The list could easily go on and on." (Dave Thomas, Regional Fuels Specialist, USDA Forest Service, Ogden, UT)

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

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
1648 South 7th Avenue
MSU Campus, Bldg. 278
Bozeman, MT 59717-0278
(406) 994-4852
Fax: (406) 994-5916
(http://www.fs.fed.us/rm/main/labs/bozeman.html)

Aldo Leopold Wilderness Research Institute
790 East Beckwith
PO Box 8089
Missoula, MT 59807
(406) 542-4190
Fax: (406) 542-4196
(http://www.wilderness.net/leopold)

Intermountain Fire Science Laboratory
PO Box 8089
5775 West Highway 10
Missoula, MT 59802
(406) 329-4848
Fax: (406) 329-4825
(http://www.fs.fed.us/rm main/labs/miss_fire.html)

Total FY2002 Appropriations: $7,854,000
Total Outside Funding: $7,354,963
Total National Fire Plan Funding: $3,116,971
Total Number of Scientist Years: 28

Research Work Units

• Forest Ecology and Management (unit is co-located in Bozeman and Missoula) (RMRS-4151)

FY2002 Appropriation: $1,217,000

Outside Funding: $174,583

National Fire Plan Funding: $716,362

Number of Scientist Years: 5

Mission: Provide knowledge and guidelines to sustain ecosystem integrity, improve forest health, and enhance social values in the Central and Northern Rocky Mountains, including Montana, east-central Idaho, northwest Wyoming, and northern Utah.

On the Tendefoot Creek Experimental Forest, MT, scientists collect data on winter precipitation as they study ecosystem-based treatments of sustainable forest management of lodgepole pine forests.

"Ward McCaughey and his staff from your Missoula, MT facility have been the critical link between the research community and the Lewis and Clark National Forest. Fire history studies implemented on the Experimental Forest have provided valuable insights to the development of multi-aged lodgepole pine stands in the Northern Rockies. The Forest expects to benefit directly as a result of the studies on recently implemented harvest projects." (Timothy Benedict, District Ranger, Lewis and Clark National Forest, White Sulphur Springs, MT)

"The University of Montana has developed a strong working relationship with Ward McCaughey at your Bozeman, MT laboratory and Robert Ahl at your Missoula, MT laboratory. We are presently collaborating on several research projects, including a study of snow accumulation, snowmelt and soil water storage in thinned lodgepole pine stands at the Tenderfoot Creek Experimental Forest. The results of this research will provide critical information to support the sustainable management of northern Rocky Mountain forests and their associated aquatic resources." (Dr. Scott Woods, School of Forestry, University of Montana, Missoula, MT)

• Wildlife Ecology in Rocky Mountain Landscapes (unit is co-located in Laramie, WY and Missoula) (RMRS-4201)

FY2002 Appropriation: $1,036,000

Outside Funding: $1,504,071

Number of Scientist Years: 4

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

Studies are underway on the invasive knapweed, which appears to reduce native plant and insect resources that form the diet of many wildlife species, such as the chipping sparrow.

• Economic Aspects of Forest Management on Public Lands (Missoula) (RMRS-4802)

FY2002 Appropriation: $368,000

Outside Funding: $208,412

National Fire Plan Funding: $179,070

Number of Scientist Years: 2

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

• Bitterroot Ecosystem Research Program (Missoula) (RMRS-4654)

FY2002 Appropriation: $426,000

Outside Funding: $15,000

Number of Scientist Years: 0.3

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.

• Aldo Leopold Wilderness Research Institute (Missoula)

FY2002 Appropriation: $887,000

Outside Funding: $637,186

National Fire Plan Funding: $397,979

Number of Scientist Years: 4

Mission: Develop knowledge needed to improve management of wilderness and other natural areas to assure high-quality experiences while maintaining ecosystem integrity. The Institute, which is the nation's only federal research facility dedicated to this task, provides a national center for scientists from different disciplines and land management agencies to address wilderness research needs.

"Since 1994, the Bitterroot National Forest has worked closely with the Rocky Mountain Research Station labs in Missoula and the University of Montana in a unique partnership called the Bitterroot Ecosystem Management Research Project. This partnership has resulted in a host of research projects which have helped forest managers with questions associated with managing weeds to restoring dry, low-elevation ponderosa pine ecosystems. Most recently, many research projects were developed to help land managers and others understand the effects and ecosystem relationships as a result of the fires of 2000. This partnership has proven to be invaluable." (Jeanne Higgins, Stevensville Ranger District, Bitterroot National Forest, Montana)

The Fire Sciences Laboratory in Missoula is the world's leading facility for research on wildland fire. The following three research work units collaborate to provide the science and technology needed by managers to understand fire and smoke behavior and fire effects to better manage the forests and rangelands of the U.S. and around the world.

Research Work Units

• Fire Behavior (RMRS-4401)

FY2002 Appropriation: $1,589,000

Outside Funding: $1,131,873

National Fire Plan Funding: $397,979

Number of Scientist Years: 5

Mission: Conduct research on wildland fire behavior to help land managers in prefire planning and management, fire suppression, and prescribed burning to better manage and protect the environment, life, and property.

• Fire Effects (RMRS-4403)

FY2002 Appropriation: $1,377,000

Outside Funding: $2,816,959

National Fire Plan Funding: $397,979

Number of Scientist Years: 6

Mission: Determine the effects of fire on forest, range, and wetland ecosystems. Researchers provide practical guides and information systems so that land managers can better apply fire effects knowledge in land management decisions. Their findings provide a scientific basis for when and how to use prescribed fire to treat fuels and restore fire-dependent ecosystems, and manage vegetation in the wildland-urban interface.

Collecting fuel samples during a fire/fire surrogate prescribed burn. Research results will help determine the consequences and tradeoffs of alternative fire and fire surrogate restoration treatments.

"Our Region has partnered with the Rocky Mountain Research Station to better understand the consequences of the Hayman and other large wildfires. Researchers and our fire specialists have worked together to improve knowledge of ecological, economic and social impacts of fire. These data will help the assessment of potential fuels reduction, rehabilitation and wildfire strategies." (Mike Retzlaff, Regional Economist, USDA Forest Service, Rocky Mountain Region, Denver, CO)

• Fire Chemistry (RMRS-4404)

FY2002 Appropriation: $954,000

Outside Funding: $866,879

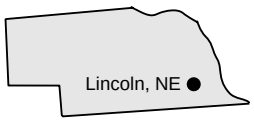
National Fire Plan Funding: $1,027,582

Number of Scientist Years: 2

Mission: Characterize fuel composition, combustion processes, and smoke emissions from wildfires and prescribed burning in tropical, temperate and boreal ecosystems. Research results provide critical information on the extent of biomass burning and smoke emissions that can be applied to improve smoke management, regional air quality, and global atmospheric chemistry and climate models.

"Following the significant fire event of 2000 on the Bitterroot National Forest, RMRS scientists provided technical assistance and advice on the Burned Area Recovery Project. This information has been used extensively by Bitterroot managers and those from other National Forests in planning and implementing post-fire recovery projects. Our forest also benefited from the assistance of the Station's Dr. Kevin Ryan, who organized and managed a scientific peer review of the Burned Area Recovery Draft Environmental Impact Statement. Reviewer's comments were used to strengthen the science used in the final EIS." (Spike Thompson, Deputy Forest Supervisor, Bitterroot National Forest, MT)

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 agroforestry technical information

USDA Forest Service
Rocky Mountain Research Station
National Agroforestry Center
University of Nebraska - East Campus
Lincoln, NE 68583-0822
(402) 437-5178
Fax: (402) 437-5712
(http://www.fs.fed.us/rm/main/lab/lincoln.html)
(http://www.un/edu/uac)

Total FY2002 Appropriations: $626,000
Total Outside Funding: $151,684
Total State and Private Funding: $415,000
Total Number of Scientist Years: 2

Research Work Units

• Tree-based Buffer Technologies for Sustainable Land Use in the Central U.S. (RMRS-4551)

FY2002 Appropriation: $626,000

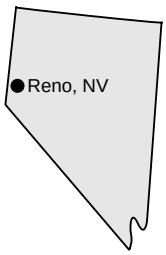
Outside Funding: $151,684

Number of Scientist Years: 2

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.

Research is helping understand how riparian and upland tree buffers protect water quality, enhance aquatic and terrestrial environments, and sequester carbon.

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 are examining 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 Road
Reno, NV 89512
(775)784-5329
Fax: (775) 784-4583
(http://www.fs.fed.us/rm/main/labs/reno.html)

Total FY2002 Appropriations: $514,000
Total Outside Funding: $202,732
Total National Fire Plan Funding: $119,394
Total Number of Scientist Years: 2

Research Work Units

• Ecology, Paleoecology, and Restoration of Great Basin Watersheds (RMRS-4252)

FY2002 Appropriation: $301,000

Outside Funding: $0

National Fire Plan Funding: $119,394

Number of Scientist Years: 1

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.

• Great Basin Interdisciplinary Ecosystem Management Project (RMRS-4655)

FY2002 Appropriation: $213,000

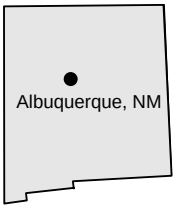
Outside Funding: $202,732

Number of Scientist Years: 1

Mission: Achieve a better understanding of the structure and functioning of riparian ecosystems and watersheds within the Great Basin, and develop management guidelines for maintaining or restoring their integrity.

As part of an effort funded by the Joint Fire Sciences Program, these crews are condicting prescribed burns in central Nevada to study the effects of fire on, and recovery of, pinyon-juniper ecosystems.

Forest Service Research and Development in New Mexico



The Rocky Mountain Research Station maintains three research work units at the Forestry Sciences Laboratory in Albuquerque, New Mexico. In 2001, the lab co-located with the Forest Service's Southwestern Region at a new facility in downtown Albuquerque.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
333 Broadway S.E., #115
Albuquerque, NM 87102-3497
(505) 724-3660
Fax: (505) 724-3688
(http://www.fs.fed.us/rm/main/labs/albuq.html)

Total FY2002 Appropriations: $1,618,000
Total Outside Funding: $1,105,252
Total National Fire Plan Funding: $709,198
Total Number of Scientist Years: 9

Research Work Units

• Ecology, Recovery, and Sustainability of Grassland and Riparian Ecosystems and Wildlife in the Southwest (RMRS-4351)

FY2002 Appropriation: $743,000

Outside Funding: $1,042,952

National Fire Plan Funding: $382,060

Number of Scientist Years: 5

Mission: Develop new methods and knowledge needed to restore damaged ecosystems and recover sensitive and endangered species resulting from disturbances and degradation of southwestern and southern-plains grasslands and riparian areas.

Scientists are evaluating the use of herbicides, reseeding, biocontrol and fire as methods for controlling the yellow starthistle weed that has invaded parts of the Southwestern U.S.

"Just wanted to let you know how much I have relied upon the excellent book you put together on grazing issues in the Southwest. I have used it as a reference time and time again. It is so thoroughly researched and well-written. I have found it to be an outstanding resource." (Michele Merola Zwartjes, USDA Forest Service, Fort Collins, CO)

"During the last three years, scientists at your Albuquerque laboratory have been hard at work developing knowledge on status and trends of selected populations of threatened and endangered species, game, neotropical migratory birds and management indicator species. This work will culminate in grazing assessments for a number of species and scientific support to regulations concerning monitoring of habitat and population trends." (Larry Cosper, USDA Forest Service, Wildlife, Fish and Rare Plants, Southwestern Region, Albuquerque, NM)

• Ecology, Diversity, and Sustainability of Soil, Plant, Animal, and Human Resources of the Rio Grande Basin (RMRS-4652)

FY2002 Appropriation: $418,000

Outside Funding: $0

Number of Scientist Years: 1

Mission: Provide new information on the Rio Grande Basin ecosystem, with primary focus on the central basin in New Mexico. Studies focus on the influence of watersheds and management activities on riparian systems, biological diversity of riparian areas, and socioeconomic and historic responses to changes in land use.

• Cultural Heritage Research (RMRS-4853)

FY2002 Appropriation: $457,000

Outside Funding: $62,300

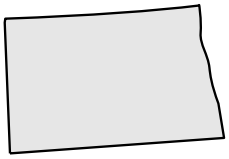
National Fire Plan Funding: $327,138

Number of Scientist Years: 3

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.

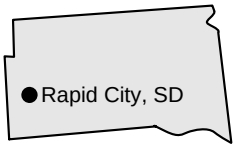
"The Rocky Mountain Research Station continues to provide leadership in areas related to values of users in the Southwest. In particular, Carol Raish's work on the cultural aspects of livestock ranching and other pieces have great application in our management. This type of work provides insights to the many different values and beliefs our stakeholders process. Other scientists throughout the Station have always been quick to respond and eager to help apply their research on the ground." (Davie Seesholtz, Regional Social Science Coordinator, USDA Forest Service, Taos, NM)

Forest Service Research and Development in North Dakota



Although there are no Station research work units currently located in North Dakota, the Station conducts research throughout the Great Plains that benefits the residents of North Dakota. For instance, the research work unit located in Rapid City, South Dakota is working to protect and restore grassland ecosystems while providing benefits and maintaining commodity outputs. Scientists are also investigating ways to maintain viable populations of such animal and plant species as the black-footed ferret, swift fox, ferruginous hawk, mountain plover, burrowing owl, the prairie fringed orchid, milkvetch, and Dakota buckwheat. Finally, work is underway 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, the Center for Great Plains Ecosystem Research, in Rapid City.

USDA Forest Service
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Forestry Sciences Laboratory
1730 Samco Road
Rapid City, SD 57702
(605) 394-1960
Fax: (605) 394- 6627
(http://www.fs.fed.us/rm/main/labs/rapidcity.html)

Total FY2002 Appropriations: $809,000
Total Outside Funding: $134,627
Total Number of Scientist Years: 3

Black-backed (pictured) and three-toed woodpeckers are being studied to learn more about their foraging and nesting habitats, estimated populations, human-induced disturbances, and if the habitat capability model HABCAP represents an accurate depiction of habitat selection patterns.

Research Work Units

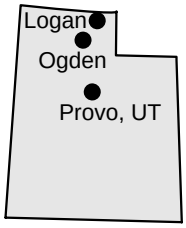
• Management for Sustainable Ecological Systems on the Northern and Central Great Plains (RMRS-4254)

Mission: Increase knowledge and develop technology to manage for sustainability the grassland and forested ecological systems of the Great Plains. Scientists are studying the mechanisms and processes that affect populations of both plants and animals, including threatened, endangered and sensitive species. Work is underway on the ecological community relationships between and among plants, animals and livestock in the prairies and forests of the Great Plains. Understanding these relationships and applying these principles is crucial for landscape management and monitoring. Scientists are also investigating how ecological stresses influence the sustainability and viability of landscapes.

"The Station has assisted and benefited the Black Hills National Forest Phase II Amendment Process by providing valuable support in the scoping process, which enhanced the effectiveness of public involvement for the forest plan; in peer reviewing and publishing our animal and plant species assessments, thereby improving their scientific credibility; and in providing useful citations through research in the Black Hills, resulting in a more informed staff that can better carry out the amendment to the Black Hills Forest Plan." (Mike Retzlaff, Regional Economist, USDA Forest Service, Rocky Mountain Region, Denver, CO)

"In a word, the research staff at RMRS has been truly cooperative, customer-oriented, and generous with their time and energy. I'm always amazed at the deep commitment these men and women have in furthering the cause of land management and conservation using scientific practices developed through research." (Dave Thomas, USDA Forest Service, Ogden, UT)

Forest Service Research and Development in Utah



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

The Station 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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Forestry Sciences Laboratory
860 North 12th East
Logan, UT 84321
(435) 755-3590
Fax: (435) 755-3560
(http://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/main/labs/ogden.html)
(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/main/labs/provo.html)

Total FY2002 Appropriations: $6,547,000
Total Outside Funding: $4,722,431
Total National Fire Plan Funding: $477,575
Total Number of Scientist Years: 10

Research Work Units

• Disturbed Land Reclamation (Logan) (RMRS-4301)

FY2002 Appropriation: $256,000

Outside Funding: $473,580

Number of Scientist Years: 2

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

Researchers are studying the ability of wetlands to attenuate the mobility of selenium and other trace elements from early mining operations, thus protecting downstream waters.

"Since 1998, the USGS Minerals Resources Program has collaborated with Michael Amacher at your Logan Laboratory to investigate transport and retention of selenium through a wetland formed from seepage at the base of a mine dump in Idaho. The release and mobility of selenium in the environment is a topic of critical importance to both ecosystem and human health concerns. Through our collaboration, we've been able to assess the concentrations of selenium in surface and porewaters, sediments, soils and vegetation. We've begun to identify and understand the processes that distribute selenium between these environmental reservoirs, as well as the

processes that make selenium available to bioreceptors. To date, the collaboration has produced two open-file reports, and currently there are two book chapters, one journal article and another open-file report in preparation." (Lisa Stillings, US Geological Survey, Reno, NV)

• Bark Beetle Disturbance Ecology (Logan) (RMRS-4501)

FY2002 Appropriation: $623,000
Outside Funding: $71,885
Number of Scientist Years: 2
Mission: Develop a scientifically credible knowledge base of ecological disturbances associated with bark beetles in coniferous forests. Apply this information in effective management options designed to maintain or restore these forests into productive, sustainable ecosystems at stand, landscape, and regional levels.

"Forest Health Protection entomologists in Idaho and Utah have been working cooperatively with Station entomologists to address a number of issues regarding native bark beetles. Research by your scientists has contributed significantly to the forest health extension program we administer to federal and state resource management agencies in the Rocky Mountain area. Previous and ongoing Station research continues to be an excellent resource for us and our federal and state cooperators." (Steve Munson, Forest Health Protection, Intermountain Region, USDA Forest Service, Ogden, UT)

• Interior West Resource Inventory, Monitoring and Evaluation (Ogden) (RMRS-4801)

FY2002 Appropriation: $4,491,000
Outside Funding: $2,360,971
Number of Scientist Years: 1
Mission: Maintain a comprehensive inventory of the status and trends of the country's diverse forest ecosystems, their use, and their health.

"The Forestry Sciences Laboratory in Ogden, UT has conducted a series of studies, through an agreement with the U.S. Geological Survey, on the effects of selenium on natural resources in the Phosphate Mining District of Southeastern Idaho. These studies have provided the Caribou-Targee National Forest with critical data for both administration of active phosphate mines and criteria for mine clean-up decision making." (Jack Troyer, Regional Forester, Intermountain Region, USDA Forest Service, Ogden, UT)

Forest inventory data is collected to help determine and track the status and trends of the nation's forests.

• Shrubland Biology and Restoration (Provo) (RMRS-4253)

FY2002 Appropriation: $1,177,000

Outside Funding: $1,815,994

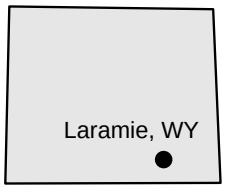
National Fire Plan Funding: $477,575

Number of Scientist Years: 5

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

The Bureau of Land Management has a long-running cooperative program with the Shrub Sciences Laboratory in Provo, UT to provide restoration expertise and solutions to Great Basin BLM personnel. Station scientists have been instrumental in developing plant materials and technology to restore degraded public lands. These advances and technical assistance have been very important in improving the success of our Burned Area Emergency Stabilization and Rehabilitation Program and wildlife habitat restoration efforts. We have always appreciated the dedication of your scientists and the important contributions that they have made to the science of restoration and getting this information to BLM employees through publications, workshops, individual technical assistance and scientific symposiums." (Mike Pellant, Rangeland Ecologist, Bureau of Land Management, Boise, ID)

Forest Service Research and Development in Wyoming



The Rocky Mountain Research Station maintains one research work unit at the Forestry Sciences Laboratory in Laramie, WY. The project is co-located at Station headquarters in Fort Collins, CO. 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.

USDA Forest Service
Rocky Mountain Research Station
Forestry Sciences Laboratory
222 South 22nd Street
Laramie, WY 82070
(307) 742-6621
Fax: (307) 745-2397
(http://www.fs.fed.us/rm/main/labs/laramie.html)

Total FY2002 Appropriations: $1,756,000
Total Outside Funding: $511,925
Total Number of Scientist Years: 6

Research Work Units

• Research on Sustaining Fish and Watershed Components of Aquatic and Riparian Ecosystems in the Central Rocky Mountains and Northern Great Plains (RMRS-4352)

(project is co-located at Station headquarters in Fort Collins, CO)

FY2002 Appropriation: $1,756,000

Outside Funding: $511,925

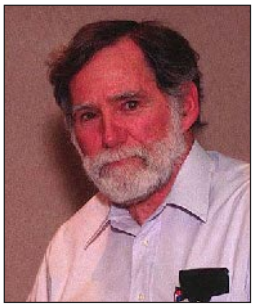
Number of Scientist Years: 6

Mission: Develop guidelines to sustain aquatic and riparian ecoysystems by studying vegetation patterns, runoff, and stream characteristics and how nutrients and chemicals move through forested watersheds. Findings describe how these factors affect fish such as native cutthroat trout.

"Station scientists have been important partners with the Rocky Mountain Region Species Conservation Project. They have reviewed species assessment protocols, helped explore reference model concepts, and provided consultation for the aquatic/riparian/wetland ecosystem assessment effort. Benefits to our Region include the added value of critical science rigor, clarification of critical features of the reference models, and clear direction for this strategic regional project, which is vital to making species and ecosystem assessments useful for alternative analysis and decision making." (Mike Retzlaff, Regional Economist, USDA Forest Service, Rocky Mountain Region, Denver, CO)

Honors and Awards

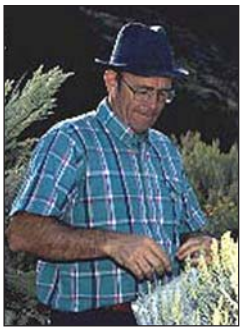
- Project Leader Kevin Ryan was part of a team that received the National Park Service's Crystal Owl Award. He was noted for helping develop an interdisciplinary training course that focuses on evaluating fire effects on cultural resources. The information presented helped the Park Service rewrite its fire management plans.
- Project Leader Deborah Finch and Wildlife Biologist Scott Stoleson received the Clarence Burch Award for their partnership work with scientists, ranchers, private landowners and public land managers to gain a better understanding of the complex ecological issues involving the critically endangered southwestern willow flycatcher.
- Research Forester Russ Graham was presented with the 2002 Celebration of Natural Resources Award by the University of Idaho's College of Natural Resources. He was noted for making significant contributions to integrated natural resources management.
- Ecologist Susan Meyer was honored by the Utah Water Conservation Forum with the Water Conservation Citizen Award for her leadership and commitment to using Utah's water wisely through the use of native plants in horticulture and restoration.
- Project Leader Durant McArthur received the Shrub Research Consortium's Distinguished Service Award for his exceptional work in the field of shrubland research.
- Research Physical Scientist Jack Cohen was presented with the Golden Smokey Bear Award from the national Cooperative Forest Fire Prevention Program for outstanding research, prevention and education work in the field of structural ignitions.



Kevin Ryan

Deborah Finch

Scott Stoleson



Durant McArthur

Russ Graham

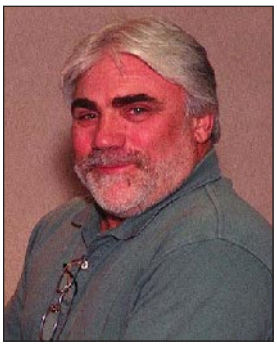
Susan Meyer

Jack Cohen

- As co-author of the paper "Effective Population Size and Genetic Conservation Criteria for Bull Trout" (*North American Journal of Fisheries Management* 21:756-764), Project Leader Bruce Rieman received an honorable mention for the Stephen Phelps Memorial Award, presented by the American Fisheries Society.
- The Station received an Outstanding Achievement Award for "continued success in unsubsidized placement of Senior Community Service Employment Program enrollees for Program Year 2000." The program offers training opportunities for eligible senior citizens with the goal of placing them in unsubsidized employment.
- Scientists at our Flagstaff, AZ laboratory are members of the Upper Verde River Adaptive Management Partnership that received the Forest Service Chief's 2000/2001 National Rural Community Assistance Action Award. The Partnership addresses and applies science to difficult resource management issues along the Upper Verde River, AZ.
- Research Entomologist George Markin received the Regional Forester's Honor Award from the Forest Service's Northern Region for his work on the Cooperative Tansy Ragwort Control Project.
- Biological Technician Susan Garvin received the Forest Service Chief's Volunteer Program Award in the category of Forest Service Employee – Research for her work in coordinating volunteers for the Rock Canyon (Utah) Restoration Project.
- The Forest Service Northern Region recognized Project Leader Len Ruggiero and Research Ecologist Kevin McKelvey with Special Recognition Awards and Certificates of Appreciation for their enthusiasm, support, professionalism and outstanding working relationships with the Region.
- Project Leader Bill Block (not pictured) and Research Wildlife Biologist Curt Flather received national Certificates of Merit from Forest Service headquarters for helping develop the Agency's proposed new Planning Rule.

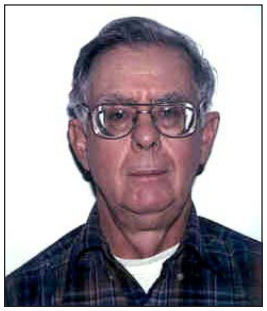
Bruce Rieman

Susan Garvin



Len Ruggiero

Kevin McKelvey



George Markin

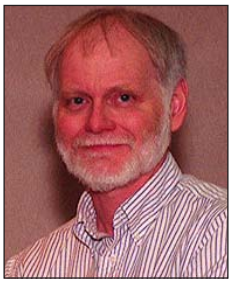
Curt Flather

- Project Leaders Linda Joyce and George Peterson, along with Research Forester Russ Graham, were recognized by Forest Service headquarters with Certificates of Merit for helping develop the Science Consistency Review Guidelines. This is the process used to determine whether an analysis or decision document is consistent with the best available science.
- Publications Distribution Leader Dick Schneider received a national Forest Service Customer Service Chief's Award for outstanding leadership in national and international service to customers for two research stations and the Forest Service' Chief's Office.
- Project Leader Bill Elliot received a national Forest Service Technology Transfer Chief's Award for his work on the Watershed Erosion Prediction Project for forest conditions.
- Project Leader Linda Joyce was appointed to the National Technical Advisory Committee that provides technical advice to the Department of Energy and the National Institute for Global Environmental Change.
- Program Manager Greg Ruark was selected to be the U.S. representative on the United Nation's "Ad Hoc Technical Expert Group on Biological Diversity and Climate Change," and was also selected as a U.S. delegate to the United Nations Forum on Forests.

The Station presented its Best Scientific Publication, Early Career Scientist Publication and Technology Transfer Publication awards, along with Outstanding Administration and Research Support awards:

- The Best Scientific Publication Award went to the team of Len Ruggiero, Keith Aubrey, Steven Buskirk, Gary Koehler, Charles Krebs, Kevin McKelvey and John Squires for their book *Ecology and Conservation of Lynx in the United States*. The publication has had a tremendous impact on the conservation of the threatened Canada lynx and provides a template for bringing scientific methodology to the table for future conservation of threatened and endangered species.
- Michael Schwartz received the Early Career Scientists Publication Award for *DNA Reveals High Dispersal Synchronizing the Population Dynamics of Canada Lynx*. He, along with co-authors Kevin McKelvey and Len Ruggiero employed modern DNA technology to test opposing hypotheses in a popular debate regarding the nature of lynx population structure.

Richard Schneider



Bill Elliot

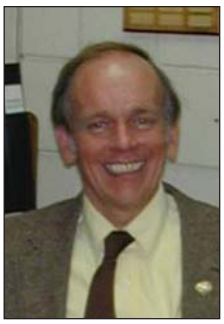
Greg Ruark

Len Ruggiero

Kevin McKelvey

Linda Joyce

George Peterson



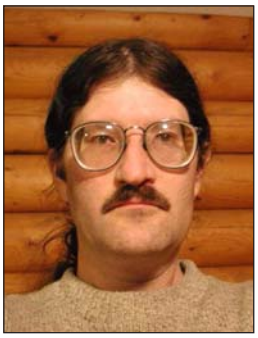
Russ Graham

John Squires

Michael Schwartz

- The Technology Transfer Publication Award was presented to Bill Elliot and David Hall for *Forest Service Water Erosion Prediction Project*, which covers an internet-based computer program that provides users around the globe with access to massive, otherwise unfriendly databases in an efficient user-friendly package.
- Statistician Rudy King was honored with the Outstanding Science Support Award. He was recognized for his excellent understanding of applying statistics to problems in natural resource science and his focus on service to Station scientists.
- Secretary Virginia Wilson received the Outstanding Lab/Project Support/Secretaries Award for an exceptional service attitude and being integral to the operations of the Station Leadership Team.
- Jean Wheeler, Property Management Specialist, was presented the Outstanding Customer Service Award for her accomplishments in facility and operations duties.
- The Outstanding Administrative Team Award was presented to the Station's Fiscal Group for support to the Station and the Arapaho-Roosevelt National Forest in areas of payments and collections related to grants and agreements.
- Librarian Carol Ayer received the Open Category Award for her work in finding and establishing an electronic journal alerting service for Station employees. The service e-mails tables of contents from journals that employees select so that they can be current with the literature.
- The Customer Appreciation Award was given to Statistician Rudy King. He was recognized for overall exceptional service to Station scientists in the area of statistical support.
- Project Leader Bill Elliot received Technology Transfer Awards for his work on the Water Erosion Prediction Project for forest conditions. To make this complex technology available, Elliot and his staff developed an Internet set of interfaces customized for forest conditions and presented the information to Forest Service employees in workshops around the western U.S.

Virginia Wilson



David Hall

Carol Ayer

Jean Wheeler

Rudy King

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 Forest Inventory and Monitoring Environmetrics, 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. These include the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife 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, our fire research program has long had working relationships with NASA on remote sensing and global change projects, and scientists have a growing partnership with the U.S. Geological Survey EROS Data Center for applications of satellite imagery for FIA, Fire Research and National GPRA Assessments. In addition FIA scientists are working with the USDA Natural Resources Conservation Service to improve forest inventory and monitoring data.
- **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), and conservation education programs with the Salish-Kootenai Tribe (MT).

- **International Cooperation.** Station scientists took 116 trips to other countries in 2002 to cooperate with scientists, universities, institutions and government agencies on a variety of natural resources projects and issues. For instance, Mathematical Statistician Hans Schreuder and Research Coordinator for the Americas Cele Aguirre Bravo helped plan and organize CAMESA (Consortium for Advancing the Monitoring of Ecosystem Sustainability in the Americas) workshops in Mexico that provided scientific and technical support for a study to inventory and monitor ecosystem resources in that country. Our scientists also assisted the Food and Agricultural Organization of the United Nations in designing the Global Forest Resource Assessment for 2010.

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 2002, we conducted $6.3 million in cooperative research with 27 universities and 20 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:

- The Station's Flagstaff laboratory helped support the Arizona Association for Environmental Education's "Environmental Education: A NETwork in Progress Conference 2001," held on the Northern Arizona University Campus. Employees hosted interpretive bird walks to view the fall migrants and winter resident birds of Flagstaff.
- Each year, the Station is proud to help sponsor the annual Flagstaff Festival of Science. In 2002, scientists participated in Science in the Park, an event that provides the public a chance to see what the science-based organizations in Flagstaff do. The Station sponsored interactive activities that introduce youth to science at our Flagstaff laboratory. Employees also participated in the "In School Presentations" program, visiting local schools and talking to students about how birds survive extreme weather and discussing the Station's bird research.
- Researchers hosted an open house at the Fort Valley Experimental Forest, near Flagstaff, AZ. The event gave the community an opportunity to learn about the history of the Forest with a self-guided tour and other information.
- Research Forester Gerald Gottfried assisted the Tonto National Forest (AZ) and the Agency's Middle East Program in planning and conducting activities for the Third Annual Tu B'Shevat Festival in Scottsdale, AZ. The Forest Service and the Jewish National Fund (JNF) are primary

sponsors of the event. The Agency and the JNF, which is responsible for forestry in Israel, have been cooperating for 15 years in the areas of fire control and prevention, natural resource management, formal education exchanges, and collaborative research.

- Employees at our National Agroforestry Center in Lincoln, NE participated in the 8th Annual Nebraska Regional Science Bowl. Scientists worked with students and answered questions on topics ranging from astronomy to zoology.
- As part of the "Trout in the Classroom" program, Fisheries Biologist Dona Horan created a presentation called "All About Trees," and presented it to high school classes in Boise, ID. The program is sponsored by Trout Unlimited and State Fish and Game agencies.
- National Agroforestry Center Biologist Julie Lamphere introduced 7th graders at Lincoln Culler Middle School, Lincoln, NE, to agroforestry, ecosystems and other natural resources issues, including how trees work for people, what is needed for viable ecosystems and why they are important.
- Scientists at our National Agroforestry Center, Lincoln, NE participated in the Earth Wellness Festival in Lincoln, where over 3,000 5th graders and teachers discovered and explored the relationships and interdependency of land, water, air and living resources. They also presented "Trees to the Rescue," a 25-minute hands-on session exploring the benefits of windbreaks, and "Fish Habit-At," which introduces students to fish behavior, the scientific method, and ecosystem management.
- Staff at the National Agroforestry Center took part in the "Care for Bears Day" at the Folsom Zoo in Lincoln, NE. They made presentations on Forest Service bear conservation activities and the role of working trees for wildlife on private lands.
- Ecologist Jane Kapler Smith was invited by the Alaska Division of Forestry to teach at the first "Fire Behavior, Ecology and Management" course, offered for Alaska middle school teachers in Homer, AK. She presented information on fire behavior and fire prevention/management concepts.
- The Station provided support for the "Colorado Cares" work day at the Manitou Experimental Forest, where over 900 volunteers conducted rehabilitation work on severly burned areas of the Hayman Fire.
- Employees of the Boise, ID laboratory helped organize and participated in "Boise River Sweep 2002," a massive cleanup effort of 6 miles of the river that flows through Boise.
- The National Agroforestry Center conducted its 3rd Annual 1890 Faculty Training Workshop in Agroforestry at Alabama A&M University. The event was designed to help 1890 university faculty incorporate information on agroforestry practices into their teaching and extension efforts.

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.
- 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.

My name is Jessica and I attended the Hispanic Career Camp the past two years. The people involved, as well as the camp overall, have been very inspirational. I am very proud to announce that in the fall, I will attend the Colorado School of Mines while studying Chemical Engineering. Each of you has been a great source of encouragement." (Hispanic Natural Resources Career Camp student)

"We wish to express our gratitude to you and everyone else involved in the American Indian Math and Science Camp. Our daughter attended the camp this year. Seldom have we been so impressed with an educational program, and I know she will remember her experience as one of the most important of her childhood. It was obvious to us that at the AIMS Camp, the students were learning as much about critical thinking skills and natural science as they do during several months of regular school. You have created an environment with just the right mix of discipline, fun and academics." (Parents of AIMS Camp student)

Natural Resources Conservation Education Program

The Forest Service's Natural Resources Conservation Education Program provides funding to the Station every year that 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:

- The Environmental Science Day Camp is a summer event held at the Station's Fort Valley Experimental forest near Flagstaff, Arizona. Students from 11 to 14 years of age learn how forest restoration affects wildlife, insects and vegetation. The camp is a cooperative event between Northern Arizona and the Rocky Mountain Station. Funding is provided by the Arizona Advisory Council on Environmental Education and the Natural Resource Conservation Education Program.
- Scientists at our Flagstaff laboratory also participate in the annual Flagstaff Festival of Science, now in its 13th year. The week-long event provides opportunities for the Forest Service to share natural resources research through in-school and after-school presentations.
- 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. It was created by scientists at the Fire Sciences Laboratory in Missoula, Montana. FireWorks 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 available on the Internet at: http://www.fs.fed.us/rm/fire_game.

Students participate in field lectures at the AIMS Camp.

To find out more about the Rocky Mountain Research Station:

Visit our Internet website at http://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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