



United States Department of Agriculture

SCIENCE SUPPORTING



STEWARDSHIP

ROCKY MOUNTAIN RESEARCH STATION



Forest Service

Rocky Mountain Research Station

July 2019

RMRS Vision: Our Science Improves Lives and Landscapes



“Scientific tools and shared stewardship are helping us to change the trajectory towards a more desirable future for this country’s wild places.”

– John Phipps,
Deputy Chief for State and Private Forestry /
Former RMRS Station Director



photo: K. Oldberg, USFS

Our scientists collaborate across boundaries to provide science-based guidelines appropriate for all lands restoration.

RMRS Science Supports Shared Stewardship

Shared stewardship is about working together in an integrated way to make decisions for the land. The USDA Forest Service (USFS) works collaboratively with stakeholders to set landscape-scale priorities and to invest in projects that will have the most impact. USFS Research & Development has played a key role in developing and supporting the USDA Shared Stewardship Strategy. **Shared stewardship has always been, and will always be, a part of the way we do business at the Rocky Mountain Research Station.**

Rocky Mountain Research Station (RMRS) develops and delivers innovative science and technology to improve the health and use of forests and grasslands.

photo: S. Hillebrand, USFWS

Science and Collaboration

Science plays a vital role in collaborative forest and grassland planning. State of the art tools and methods and innovative knowledge translate to opportunities for large-scale land management. Managers make trade-offs as they juggle social, economic, and ecological values. Science helps describe the implications of these trade-offs. Continuous monitoring and data analysis improves management practices and teaches us how to be the best stewards for the land in the future. **Science is the tool we use to help objectively determine how we can do the right work, in the right places, at the right scale to address land and resource management challenges.**



Science provides collaborators the tools and information needed to make the best decisions for the land and society.

Science at Rocky Mountain Research Station

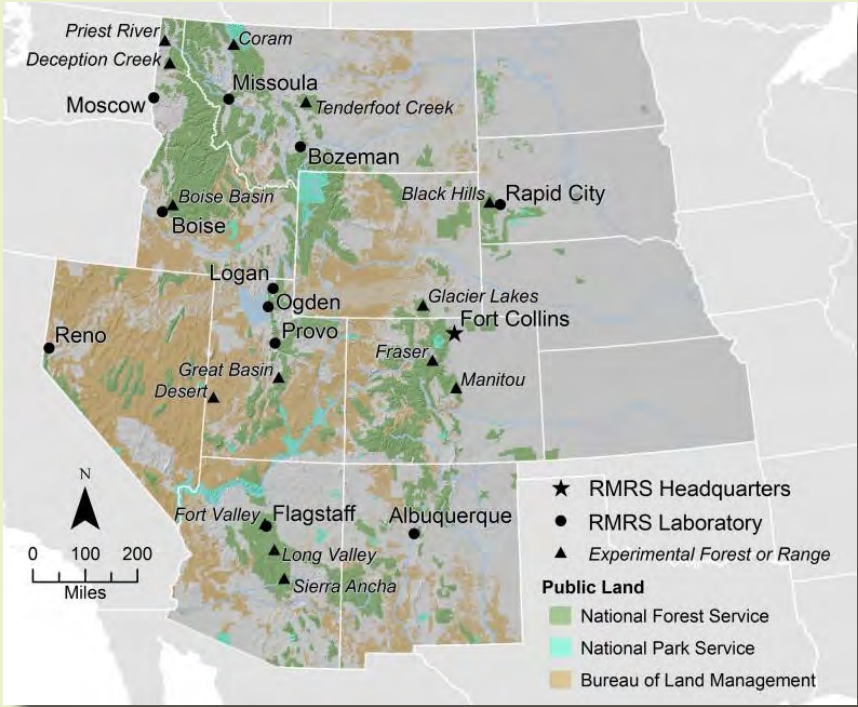
RMRS’ scientific resources allow us to tackle complex problems and deliver the best available science to our diverse stakeholders. **Our researchers and collaborators co-develop solutions across a spectrum of ecosystem types and biological, ecological, physical, and social science disciplines.** Laboratory and field research are informed by long-term ecological research on our RMRS administered Experimental Forests and Ranges.

Some of our continuous datasets go back over a century and offer invaluable insight into how ecosystems change over time. These data are particularly useful as we work to adapt to a changing climate. Forest Service Research and Development is an independent scientific organization, which provides credibility to the research that is used to address these complex challenges.

The Station employs approximately 400 permanent full-time employees, of which

100 are research scientists. RMRS scientists have a unique depth and breadth of research experience and are true experts in their fields. We take pride in a long history of partnering, co-producing, and building strong interagency and interdisciplinary collaborations. **We leverage our science and relationships to achieve meaningful outcomes on the ground.**

RMRS has the unique scientific resources to develop and share innovative research and technology to improve land management outcomes. While our geographic footprint spans 12 States with 14 laboratory locations in the Interior West, our research has global impacts.



Stewardship On the Ground:

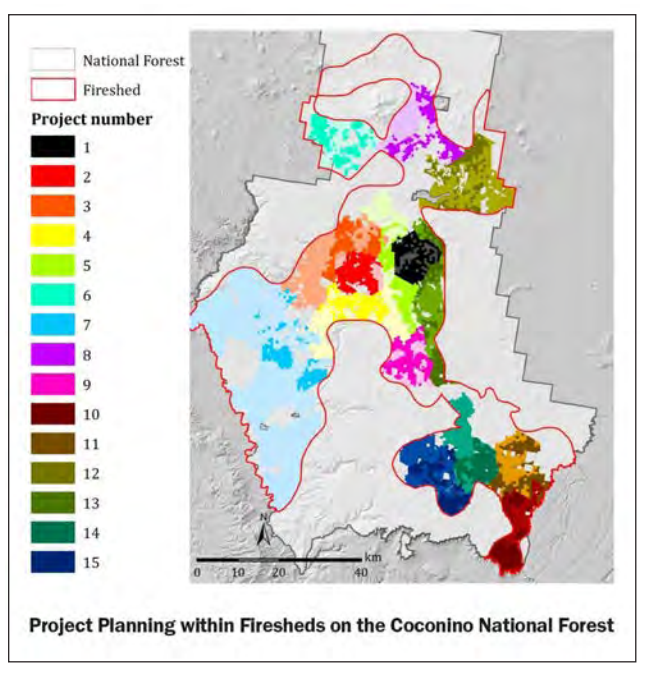
Science in Action

RMRS Scenario Planning Supports Shared Stewardship Outcomes

Faced with multiple and often conflicting objectives, **land managers across agencies need tools to prioritize investments, and do the right work, in the right places, at the right scale.** Decision-makers need the ability to explore the consequences of the trade-offs they make and the capacity to forecast the potential outcomes of the diverse projects planned every fiscal year. **Scientists at RMRS have worked over the last decade to develop a Scenario Planning Framework that provides scientific guidance to managers as they work across boundaries to identify and evaluate forest and fire management priorities, trade-offs, and outcomes.**

This interdisciplinary project brings together scientists from landscape planning, fire ecology, operations research, and economics to link national policy with on-the-ground implementation. **The Scenario Planning Framework demonstrates how working at the smaller scale of a single project can support objectives at the larger scale of an entire forest or region.** This information allows for cross-boundary planning at the landscape scale and meaningful conservation outcomes.

photo: USFS



Slide Fire on cliffs of Oak Creek Canyon, Coconino National Forest, Arizona, May 22, 2014. (Photo Service photo by Brady Smith).



photo: B. Smith, USFS

RMRS scientists developed the Scenario Planning Framework to help land managers work across agency and land ownership boundaries to increase fire resiliency at the scale of large (50,000–200,000 acre) fire events. The tools developed for the Scenario Planning Framework have many on-the-ground applications such as prioritizing treatment areas for reducing wildfire risk in the wildland-urban interface. **The Scenario Planning Framework is part of the scientific foundation of the shared stewardship strategy.**

Co-Developing Science-Based Solutions to Restore Frequent Fire Forests

Our General Technical Reports (GTRs) Provide Scientific Guidance for Restoration

Historically, mixed conifer and ponderosa pine forests in the western United States experienced relatively frequent fire, which kept them open, grassy, and parklike. Over the last century, these forests have become crowded with small trees, and more vulnerable to catastrophic wildfire, insect

epidemics, and disease. Managers and decision-makers need locally relevant science to restore these forests to make them more able to accept fire, and more resilient to future change. RMRS and collaborators are providing this science.

Restoring Composition and Structure in Southwestern Frequent-Fire Forests (RMRS-GTR-310) has become the go-to source

for answers to important ecological questions about Southwest forest restoration. This GTR provides recommendations for restoring the elements of frequent fire forests in the southwestern U.S. that prevent uncharacteristic wildfire. Not only does forest restoration reduce the frequency of uncharacteristic wildfire, it also enhances wildlife habitat and aesthetic value and offers local economic opportunities to support restoration by including industry as



Photo: P. Brown



PARTNERS

USDA USFS (RMRS, Southwestern Region), National Wild Turkey Federation, New Mexico Game and Fish, Mt. Taylor Mill



photo: B. Smith, USFS

“Workshops are critical to getting the best science applied on the ground and encouraging dialogue among scientists, managers, and the public.”

—Don Delorenzo,
USFS Southwestern Region,
Director of Wildlife, Fish and Rare
Plants (Retired).

a partner. Authors of RMRS-GTR-310 and their partners hosted practitioner workshops to demonstrate how to use the document as a source for Southwestern Forest Plan revisions.

One of our best and most recent examples (2018) of knowledge co-development is Principles and Practices for the Restoration of Ponderosa Pine and Dry Mixed-Conifer Forests of the Colorado Front Range (RMRS-GTR-373).

This restoration framework emerged out of the need for local forest science to support the Front Range Collaborative Forest Landscape Restoration Program and is the result of a decade of collaboration. RMRS scientists responded to the concerns of managers who needed locally relevant science to address the unique landscape ecology and challenges of performing forest



Photo: K. Puikkonen,
Colorado State University

Ponderosa pine forests in the Colorado Front Range have become uncharacteristically dense and prone to catastrophic wildfire. Collaboration between RMRS, academics, land managers, and other stakeholders has been key for developing locally relevant solutions to reduce wildfire risk at a landscape scale and restore frequent-fire forests.

restoration on Colorado’s Front Range. Here, forest systems were historically characterized by a mixed-severity fire regime. **RMRS-GTR-373 synthesizes the best available science to provide managers with the information they need to design restoration projects with natural variation in mind, and to help determine where and how to conduct restoration at a meaningful scale.** Because the report was co-produced by scientists and partners from so many disciplines and stakeholder groups, the restoration principles and practices accommodate multiple objectives and meaningful landscape outcomes.



PARTNERS

The Nature Conservancy, USDA USFS (RMRS, Rocky Mountain Region), CFRI, The Wilderness Society, USGS, Rocky Mountain Tree-Ring Research, NRCS, Southern Rockies Fire Science Network



photo: E. Kitayama, USFS

Collaborating with the Colorado Forest Restoration Institute

The Front Range forest restoration framework was co-developed by a diverse set of collaborators including managers, scientists, NGOs, and academics. The Colorado Forest Restoration Institute (CFRI) was one key partner in the multi-year effort to compile, write, and disseminate RMRS-GTR-373. CFRI staff were integral members of the author team, and worked in tandem with RMRS communications staff to host nearly 200 land managers and stakeholders at science delivery field workshops.



COLORADO FOREST RESTORATION INSTITUTE

Independent, Credible Science Supports the Forest Service Mission

CASE STUDY: Rare species not a species after all

The Arapahoe snowfly was thought to be an extremely rare stonefly found in only a few small streams in northern Colorado. Because of its limited presence, the U.S. Fish and Wildlife Service (USFWS) designated the stonefly as a candidate species under the Endangered Species Act. However, RMRS’ National Genomics Center used robust molecular genetic testing techniques to determine that the Arapahoe snowfly was not a distinct species, but instead was an F1 hybrid of two more common stoneflies.

RMRS’ scientific independence gives these results credibility with regulatory, legislative, and legal entities. The USFWS is expected to drop the snowfly from consideration as a candidate species. Planners can now reprioritize conservation dollars and resources to focus on other species and projects.



Arapahoe snowfly (photo by Chris Verdone, C.P. Gillette Museum of Arthropod Diversity at Colorado State University).

photo: R. Hagerty, USFWS

Great Basin Native Plant Project Restores Native Ecosystems

The [Great Basin Native Plant Project \(GBNPP\)](#) is a multistate collaborative research project led by RMRS scientists in Utah and Idaho and the BLM Plant Conservation Program. **GBNPP’s goal is to improve the availability of native plant materials—especially seeds—and to provide the knowledge and technology required for their use in restoring diverse native plant communities across the Great Basin.**

In addition to collecting native seed, GBNPP supports researchers and land managers in developing sound management and successful restoration practices in the face of threats from invasive species, shifting fire regimes, and climate change. One project

focuses on increasing the seed production of native species, so that less time and resources are spent on collecting these seeds for restoration seed mixes.

GBNPP has a library of technical information for practitioners about plant selection, weed control,

irrigation, pollination, and plant propagation—much of which is derived from RMRS work/studies. This project gives managers the tools they need to complete rangeland restoration projects in accordance with the best available restoration science.



PARTNERS

- Federal:** USDA USFS (RMRS and Northern, Southwestern Regions), Agricultural Research Service, Natural Resources Conservation Service; BLM Plant Conservation Program, U.S. Army Corps of Engineers, USGS
- Arizona:** Northern Arizona University
- California:** University of California
- Idaho:** Boise State University, College of Western Idaho, University of Idaho, Morley Nelson Birds of Prey National Conservation Area
- Utah:** Brigham Young University, Utah State University, Utah Division of Wildlife Resources, Utah Department of Natural Resources
- Nevada:** University of Nevada, University of Nevada Cooperative Extension
- Oregon:** Eastern Oregon Stewardship Services, Oregon State University, Malheur Experiment Station, Institute for Applied Ecology, Conservation Biology Institute
- Texas:** Texas Tech University
- Tribal Nurseries
- Private Contractors and Landowners

“Having the right seed in the right place at the right time makes a major difference in the health of our landscapes.”

—Sally Jewell, Former U.S. Secretary of the Interior.

Research Informs Management Outcomes:

RMRS scientists in collaboration with the Utah Department of Natural Resources demonstrated that the initial seed mix used for postfire seeding can have a strong influence on later plant community composition. Managers now know that carefully formulating seed mixes for postfire restoration sites can promote long-term management objectives.

photo: USFS

RMRS Teams up with Tribal Nurseries to Restore Western Ecosystems

RMRS scientists on the [Reforestation, Nurseries, and Genetics Resources \(RNGR\) Team](#) work to serve tribal nurseries through technology transfer, supporting outreach efforts, and responding to research needs. Native seed is a vital component of restoration in sagebrush and other ecosystems in the west. Since 2001, the RNGR team has emphasized outreach to Tribes in order to foster long-term collaborations focusing on native plants, nurseries, and educational activities. Tribal nurseries support the transition to using native, local plants in restoration projects. Tribal nurseries across the nation have diverse interests and goals, and may be focused on culturally significant plants, native foods, reforestation, restoration of habitat, or cultural restoration needs. Tribes are working to preserve traditional ecological knowledge and to develop and enhance native plant production for spiritual, medicinal, cultural, land restoration, and educational purposes.



photo: J. Pinto, USFS

RMRS scientists on the Reforestation, Nurseries, and Genetics Resources Team work to serve the diverse interests and needs of tribal nurseries through technology transfer. Because tribal nurseries operate with many different goals, there are many opportunities for scientists to hear and respond to research needs.

The Sagebrush Science Framework Identifies Priority Areas for Conservation and Restoration in the Sagebrush Biome

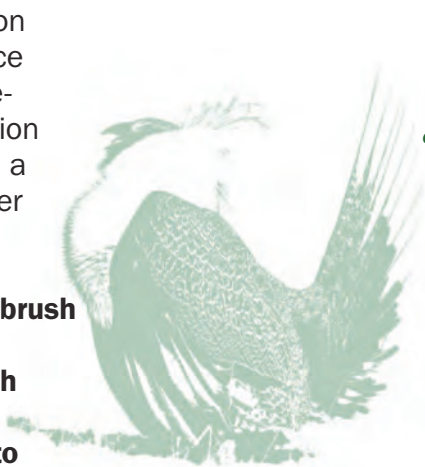
The need to conserve sagebrush habitat and protect the greater sage-grouse has sparked an unprecedented collaborative conservation effort. The sagebrush biome is vast and complex, and it is vital to use limited resources efficiently to target conservation and restoration.

The two-part Sagebrush Science Framework provides the science basis for decision making, as well as management implications of those decisions. RMRS scientists led the effort with BLM, USFWS, USGS, and other State and Federal partners to create an innovative science-based tool to determine priority areas for conservation and restoration. The Framework focuses on resilience to stress and disturbance and resistance to invasive annual grasses. Those areas that are

currently in good condition but low in resilience and resistance are likely good candidates for conservation and restoration.

The Sagebrush Science Framework (Part II) combines resistance and resilience maps and data, such as USFWS defined Greater sage-grouse Priority Areas of Conservation, breeding habitat models, and fire risk models to further assist managers

in on-the-ground decision making. When resistance and resilience and sage-grouse habitat information are overlaid together on a map, it provides a clearer picture of which areas should be prioritized for management. The Sagebrush Science Framework provides managers with credible, independent scientific information to prioritize conservation and restoration areas.



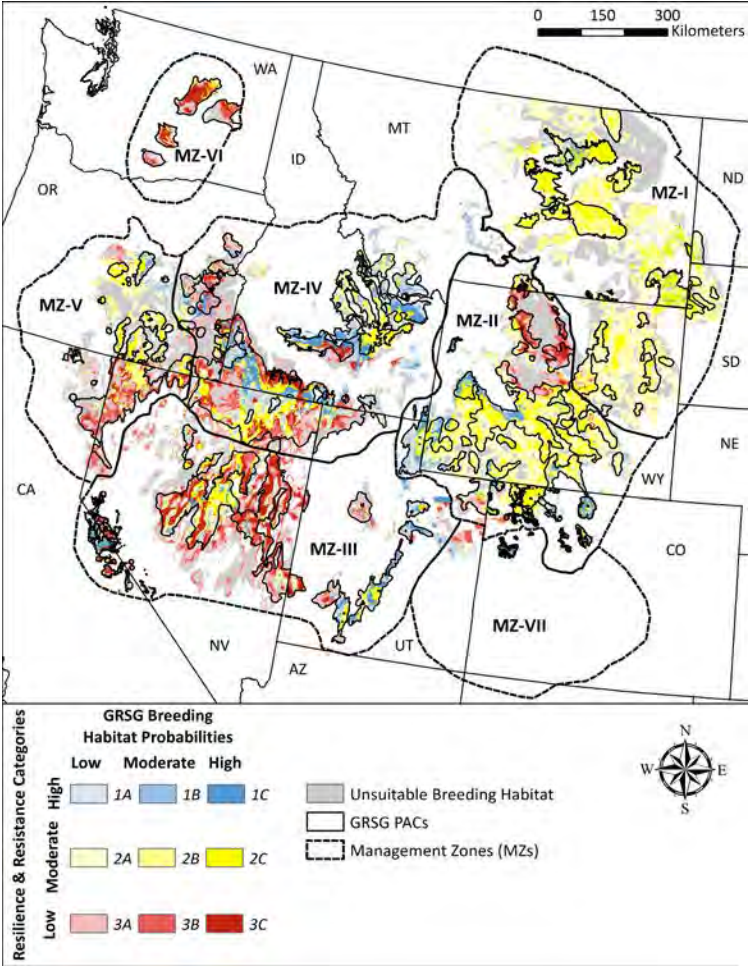
“This has been the most exciting thing in my 38-year career, where everybody’s sitting at the table, and everybody’s ideas are being considered.”

—Ken Mayer, WAFWA wildlife ecologist



**PARTNERS**

USDA USFS (RMRS, National Office, Intermountain Region, Pacific Southwest Region) and NRCS, BLM, USFWS, USGS, University of Wyoming, Western Association of Fish and Wildlife Agencies, Wyoming Game & Fish Department, Nevada Department of Wildlife, Colorado Parks & Wildlife



The Sagebrush Framework gives managers planning tools for using limited resources to prioritize conservation and restoration areas. For instance, the map above shows areas with the highest probability of sage grouse breeding success in dark blue.

Science as a Bridge to Collaboration: The Missoula County Wildfire Protection Plan

The RMRS [Fire Modeling Institute \(FMI\)](#) performs complex analyses focused on fire behavior, fire effects, and geospatial modeling. **Scientists at FMI have the tools that communities, counties, and states need to do effective planning for wildfire risk mitigation.** FMI, in partnership with the independent nonpartisan research agency

“[The Local Area Cohesive Strategy Working group is] co-managing and co-producing with almost every entity in the Missoula area and having some real influence and traction.”

—Colin Hardy, RMRS Program Manager (retired)

Headwaters Economics, played a crucial role in developing the Missoula County Community Wildfire Protection Plan (CWPP). The CWPP process was so successful that it inspired the formation of the Local Area Cohesive Strategy Working Group, a self-formed group that incorporates most agencies working in fire in Missoula County (city open space, county commissioners, tribes, federal agencies, and NGOs).

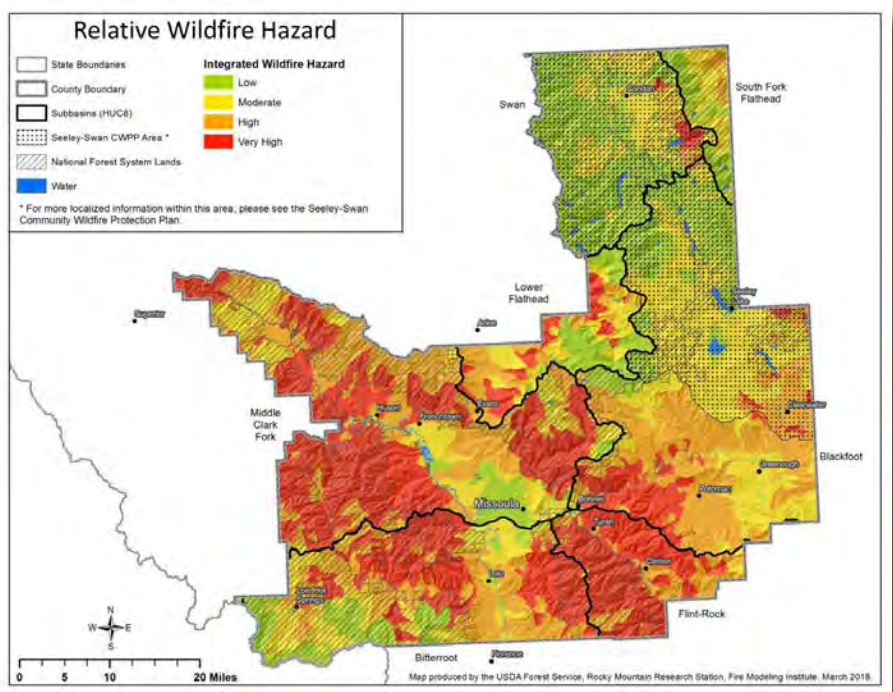
FMI serves as a communication bridge between practitioners who apply fire on the landscape and regulators permitting prescribed fire actions. Improved communication facilitated

by FMI is resolving long-standing information gaps between practitioners and regulators. FMI is now working with Headwaters Economics to design CWPPs in communities across the West. Building trusting partnerships through co-production of knowledge has a powerful impact. **RMRS’ Fire Modeling Institute shows that using science to improve fire management partnerships leads to better shared stewardship outcomes on a national scale.**



photo: USFS

photo: USFS



Scientists at RMRS’ Fire Modeling Institute have developed partnerships with consulting agencies and stakeholders to incorporate the best available science into Community Wildfire Protection Plans across the West. Shown above is a map of the relative fire hazard in Missoula County.

PARTNERS

USDA USFS (RMRS, Northern Region), BLM, Montana Department of Natural Resources and Conservation, Missoula County, Missoula County Board of County Commissioners, Missoula County Fire Protection Association, City of Missoula Development Services, City of Missoula Fire Department, Missoula Rural Fire District, Headwaters Economics, The Nature Conservancy, Clearwater Resource Council, Confederated Salish and Kootenai Tribes

Wildfire Risk Management Science (WRMS) Team—A Success Story of Preplanning for Fire and Co-Managing Fire Risk

RMRS' Wildfire Risk Management Science (WRMS) Team has developed and applied scientific tools to pre-plan for fire using a risk management approach, and given land managers a formal process for developing landscape-scale wildfire response options before the fire season even begins. When the Pinal Fire was ignited by a lightning strike on the Tonto National Forest in 2017, the WMRS Team, the Forest Supervisor, district-level leadership, and local fire managers had been planning for it since 2016 using a framework of potential fire operational delineations (PODs—see inset).

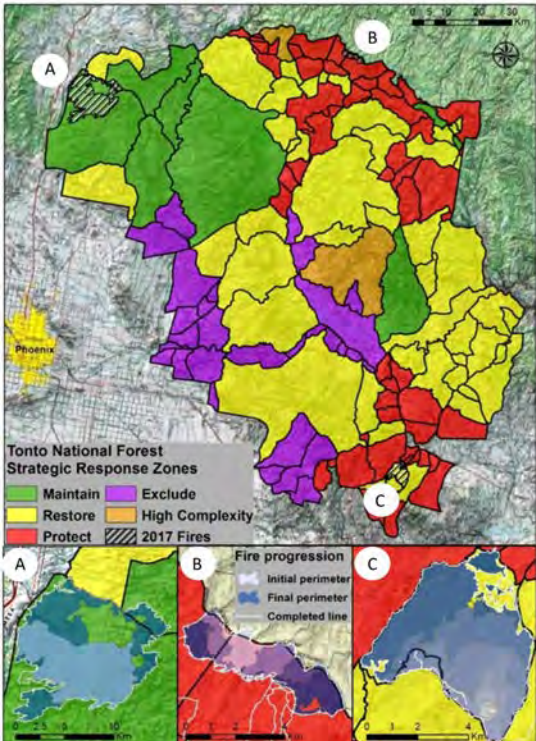
Sometimes, fires resulting from natural ignitions can be strategically managed to achieve goals similar to

Beyond Partnership: A Window into How Shared Stewardship Can Work

RMRS engaged Forest and District-level leadership, and fire and resource management staff as collaborative partners while designing PODs for the Tonto National Forest. Leadership from the Globe Ranger District then took a proposal to the Globe city council, Mayor's office, and County commissioners to engage them directly in the decision to manage the Pinal Fire for objectives beyond full suppression.

a prescribed fire: ecological restoration, watershed health, reduced risk of catastrophic wildfire, and reduced future fire suppression costs. The PODs framework helps managers weigh a portfolio of values, current conditions, and most likely fire outcomes to determine the most appropriate fire management objectives. When values are likely to benefit, the right kind of fire can be managed for restoration objectives rather than immediately suppressed. When the Pinal Fire ignition occurred in the pre-identified POD,

managers had confidence that the fire could be used to help restore the forest. Instead of suppressing the fire, they managed fire behavior in a way that improved the health and resilience of the forest. Collaborative pre-planning and co-produced science saved taxpayer money and resulted in essentially a 7,500-acre fuel treatment that reduces fire risk for the long term.



Potential Wildfire Operational Delineations (PODs) on the Tonto National Forest help Incident Response Teams manage to wildfire in a pre-planned, strategic way. For example, in green/maintain areas, fire managers would be most likely to manage natural ignitions rather than suppress them, as they did in the case of the Pinal Fire. (Photo Credit: RMRS, Kit O'Connor)

How we do it: PODs Science

Potential Wildfire Operational Delineations (PODs) combine local firefighter and manager knowledge with advanced spatial analysis. They vary in size, are drawn irrespective of jurisdictional boundaries, and correspond to potential control points for a fire (roads, ridgelines, drainages, previous fuel treatment boundaries, recent burns, or anything else that might give firefighters on the ground an advantage). Where PODs are preplanned, they advise managers what their initial response should be in a particular area in the event of ignition.

CASE STUDY: PODs on the Tonto National Forest

- Maintain:** areas that are predicted to experience a positive outcome from fire.
- Restore:** areas where fire under the right conditions could convert an area to the “maintain” class.
- Protect:** areas that are predicted to experience a negative outcome from fire.
- Exclude:** areas specific to Tonto National Forest where invasive grasses are converting fire-resistant Sonoran Desert into fire-prone savannah.
- High Complexity:** dominated by naturally fire-adapted ecosystems interspersed with sensitive infrastructure. In this last class of High Complexity PODs, direct engagement with private land owners and targeted fuel treatments will improve spatial planning and develop new control opportunities. Larger PODs will be partitioned into more spatially explicit units to separate resources likely to benefit from fire from assets likely to be damaged by it. Learn more here: <https://fireadaptednetwork.org/collaborative-spatial-fire-management-getting-ahead-fire-using-potential-operational-delineations/>.

Front Range Roundtable: Fostering Shared Responsibility Through Community Collaboration, Science, and Monitoring

After the 2002 wildfire season—when the Hayman Fire burned 138,000 acres on the Colorado Front Range—managers and scientists recognized the need to respond to the large, severe wildfires threatening ecosystems in historically fire-adapted forests in the West. The Front Range Roundtable (FRR) was established to foster shared responsibility and risk for developing and enacting practical, science-informed solutions to complete forest restoration work on both public and private land on the Front Range. RMRS, in partnership with the Colorado Forest Restoration Institute (CFRI),

provides important technical and monitoring support as the group works to collaboratively set priorities and make science-based decisions. The FRR collaborative has worked together to identify the priority areas for treatment and placed an emphasis on consistent, open communication designed to build trust between land managers, the public, and conservation and monitoring agencies. **The shared stewardship of lands that are influenced by the FRR and informed by RMRS science has had tangible impacts on reducing tree density and improving forest condition.**



photo: E. Kitayama, USFS

**PARTNERS**

USDA USFS (RMRS, Rocky Mountain Region), USFWS, USGS, BLM, NPS, Coalition for the Upper South Platte, University of Colorado, Colorado Department of Health & Environment, Colorado Counties, Inc., Colorado Department of Natural Resources, Colorado Division of Emergency Management, Colorado Geological Survey, County Sheriffs of Colorado, Inc., Colorado Springs Utilities, Colorado Forest Restoration Institute, Colorado State Forest Service, Colorado State Parks, Colorado State University, Denver Water Department, Florissant Fossil Beds National Monument, Grand County Board of Commissioners, Jefferson County Open Space, Jefferson Conservation District, Southern Rockies Conservation Alliance, The Nature Conservancy, The Wilderness Society

Cost of wood utilization is often a limiting factor for performing forest restoration treatments. Collaboration between researchers and practitioners has allowed RMRS scientists to get the word out about creative modifications forest contractors make to their equipment to reduce costs. For example, raising sides of a truck or changing tires to skidder tires improves capacity and mobility.



Improving Woody Biomass Use through Innovative Partnerships

One of the most substantial challenges to completing forest restoration projects is finding a purpose for all of the wood removed. Few readily accessible timber markets for small-diameter timber exist in Colorado, so **restoration treatments are often expensive, with few ways to recoup costs. As a partner in the USDA’s Biomass Research and Development Initiative (BRDI), RMRS is developing new science and technologies to enhance biomass use and make restoration treatments more cost-effective.** One solution is to collect and process woody biomass, and transport it to a facility where it can be converted into fuel, heat, and electricity. For example, Colorado’s first dedicated biomass power plant (Eagle Valley Clean Energy) produces 11.5

megawatts of electricity. But this process can also be expensive. **RMRS found that one barrier to biomass transportation has been the cost of required equipment relative to the value of the material.** Grinders, loaders, trucks, and the other equipment used to get wood out of a forest and on the road to a power plant can cost hundreds of thousands of dollars—far more than the value of the wood product. Forest contractors have reduced costs through innovative modifications to existing equipment and operations. **RMRS scientists work in tandem with practitioners to develop and share information about tangible solutions, like innovative equipment modifications, to improve the efficiency of biomass supply chains.**

Biochar: A Burgeoning Biomass Byproduct that Brings a Boost

Conversion of woody biomass can yield heat and power for manufacturing, power for the grid, and a charcoal product called **biochar**, which is useful for soil restoration, agriculture, and industrial filtration. **Research at RMRS focuses on improving application of biochar and standards for use of the product for restoration.** RMRS scientists respond to manager requests and develop ways to make biochar easier to work with. One approach includes pelletizing biochar so it can be applied using equipment similar to a standard fertilizer spreader. As a soil amendment, it bonds tightly to water and soil nutrients; in dry environments, it can improve water holding capacity by 20 to 30 percent. It can restore and keep nutrients in soil, making it more fertile.

Biochar can also be used in mining reclamation, as it binds with heavy metals and reduces runoff into streams and groundwater.



RMRS scientists are working to improve biochar (a charcoal byproduct of woody biomass) for use in mine reclamation, agriculture, and restoration.

Innovative Technology Turns Woody Biomass into a Synthetic Gas

As active participants in the Biomass Research and Development Initiative, RMRS and the USDA National Institute of Food and Agriculture partnered with Tucker Engineering Associates to design and build the Tucker Renewable Natural Gas (RNG) System. This system turns wood waste into biochar and a synthetic gas that can be burned like natural gas to produce electricity. **The Tucker RNG System reduces energy costs, processes waste, and produces heat and electricity for customers interested in green energy.** Even more exciting, this technology is scalable and can be sized for mobile units or larger, permanent installations. This project responds directly to manager’s need for wood product utilization.

“This project is the perfect opportunity to grow ongoing research relationships between the forest industry, the U.S. Forest Service and Tucker Engineering Associates. It is a chance to contribute to a technology that has the potential to increase renewable energy production, create jobs and minimize the environmental footprint of producing energy from woody biomass.”

—Nate Anderson, RMRS Research Forester

**PARTNERS**

USDA USFS (RMRS, Southern Research Station, Forest Products Laboratory) and National Institute of Food and Agriculture, Tucker Engineering Associates, University of Montana, University of the Sunshine Coast—Australia, University of Washington

The Tucker RNG System is the result of a collaboration between RMRS scientists, academics, and private industry. The system turns wood waste into biochar and a synthesis gas that can be burned like natural gas to produce electricity.



Crowdsourcing Data to Prioritize Aquatic Conservation

RMRS worked with partners to crowdsource data and use citizen science at an unprecedented scale. [The NorWeST Project](#) compiles stream temperature data collected by hundreds of private citizens, and biologists and hydrologists that work for more than 100 State, Federal, Tribal, and non-governmental organizations.

The NorWeST database produces a publicly available regional stream temperature data archive that may be the largest of its kind in the world, consisting of more 200 million hourly temperature recordings at

more than 20,000 unique stream sites.

The NorWeST database serves as a resource for proactive management of aquatic resources. As streams warm, some salmonid species that live in cold water are at risk. **RMRS analysis of NorWeST project data suggests that many thousands of kilometers of high-elevation streams** will serve as cold-water refugia where native species can be preserved. Over 90 percent of cold-water refugia in the Rocky Mountains are on public lands under municipal, State, Tribal, and Federal ownership. Our predictions of future trends give managers

Temperature sensors help produce a regional stream temperature data archive that can be used for prediction and proactive management of aquatic resources.

vital foresight as they use resources most efficiently to prioritize these areas for conservation, and the scientific data from **the NorWeST project gives managers the opportunity to share stewardship of these streams and build coalitions for conservation.**

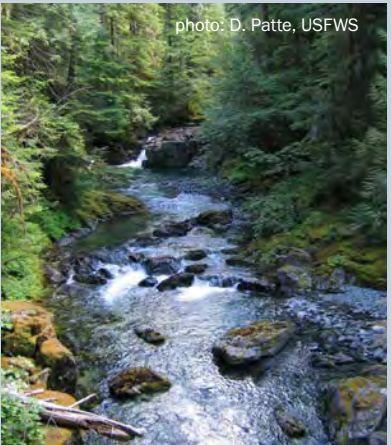


photo: D. Patte, USFWS

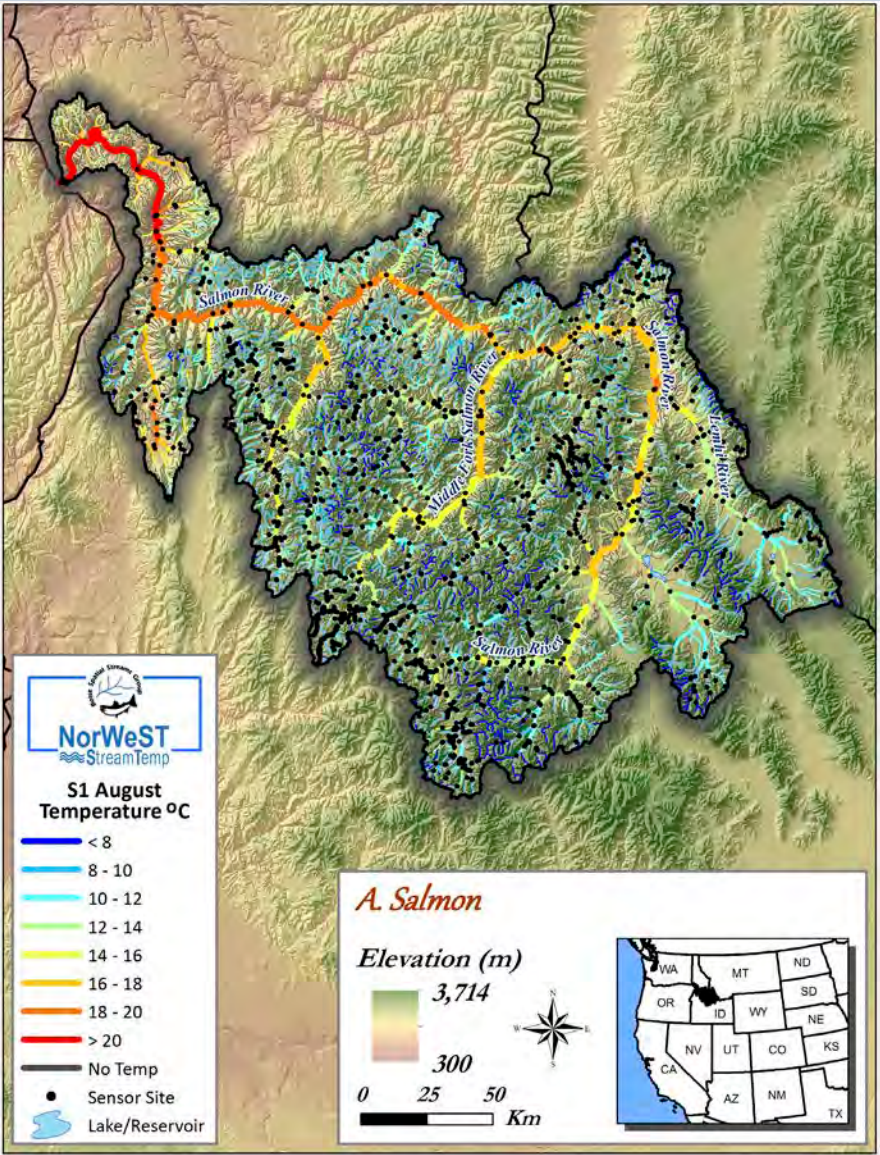


photo: D. Isaak, USFS

“Wise and proactive management decisions in the next decade could substantially affect how many native fish populations there are in Rocky Mountain streams 100 years from now.”

—Dan Isaak, RMRS Research Fisheries Biologist

Through the NorWeST database project, hundreds of hydrologists, biologists, and citizen scientists have installed temperature sensors at more than 20,000 unique stream sites. The data from these sensors is uploaded into an online database that managers can use to prioritize areas for species conservation and identify refugia.



One Cup is Enough: Monitoring and Tracking Species with Environmental DNA (eDNA)

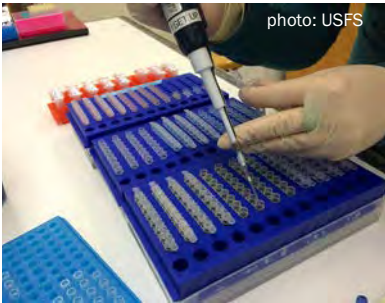
When the right tools don't exist, RMRS creates new ones. **RMRS is improving the efficiency and accuracy of surveys of rare and invasive aquatic species by revolutionizing the use of eDNA for aquatic and terrestrial species monitoring.** eDNA is genetic material released by organisms into the environment. By sampling and testing water for eDNA, scientists can determine which species are present. RMRS developed a publicly

available protocol so simple that anyone can follow it to collect samples. These samples go through rigorous testing at the National Genomics Center for Wildlife and Fish Conservation. This information is then uploaded to the RMRS-hosted online [eDNAtlas](#), which provides interactive maps showing where any species of fish, amphibian, or mussel occurs in streams, lakes, and ponds. The Atlas maintains a comprehensive database

which ultimately saves time and money as managers make decisions about freshwater ecosystems. RMRS collaborates with numerous partners to add data to the Atlas, making it robust, far-reaching, and relevant to landscape-scale management questions. There are currently 10,000 sites and 37 species represented in the Atlas. In response to manager questions about sensitive and invasive species in streams, RMRS continues to train State agencies and others in eDNA collection.

eDNA efforts at RMRS helped address the shared needs of the USFS, USFWS,

RMRS revolutionized the use of eDNA (genetic material released by organisms into their environment) as a sampling method for aquatic species, and has increased efficiency of species surveys and land managers need to plan management for invasive, rare, or threatened aquatic species.



and States through the Rangewide Bull Trout eDNA project. Bull trout occur over public lands subject to a wide variety of jurisdictions. They are listed as threatened under the Endangered Species Act, so their presence has an important influence on land and water management and planning. However, there was uncertainty on the part of land managers about where these fish could be

**PARTNERS**

USDA USFS (RMRS, NRS, PNW, SRS), BLM, USBR, NPS, National Fish and Wildlife Foundation, NOAA, USFWS, USGS, State Fish, Wildlife, and Game Departments (Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming), Confederated Tribes of the Chehalis, Colville, Umatilla, and Warm Springs Reservations, Cow Creek Band of Umpqua Tribe, Kalispel Tribe of Indians, Nez Perce Tribe, Shoshone-Bannock Tribes, City of Portland Environmental Services, Idaho Department of Environmental Quality, Idaho Power Company, Seattle City Light, Colorado State University, Montana State University, Oregon State University, Rutgers University, University of Montana, University of Washington, Utah State University, Clark Fork Coalition, Conservation Northwest GeoEngineers, GeoSense LLC, Kalispell Middle School, Mid-Columbia Fisheries Enhancement Group, MPG Ranch, Partnership for Umpqua Rivers, Sentinel High School, Santec, Trout Unlimited, Turner Enterprises, Whitefish Lake Institute, Wild Fish Conservancy

found, and therefore, how to plan for them. Through eDNA, project collaborators quickly resolved questions about the distribution of bull trout. **New populations of bull trout have been discovered,** and populations not detected in recent decades were rediscovered. Additionally, some areas were confirmed to have no bull trout, **and freed from the administrative requirements associated with local project planning and regulatory compliance.**

eDNA served as an important tool for the USFS and USFWS to share stewardship of the broad landscapes that serve as habitat for this species.

The eDNAtlas “is becoming an invaluable repository of biodiversity information we can use to evaluate the status of species now and in the future.”

—Mike Young, RMRS Research Fisheries Biologist

Our Nation’s Forest Census: Forest Inventory and Analysis (FIA)

The [FIA program](#) is the census of the Nation’s forests. The first inventories started in 1930. This long-term data set allows RMRS scientists to project how forests are likely to appear in 10 to 50 years.

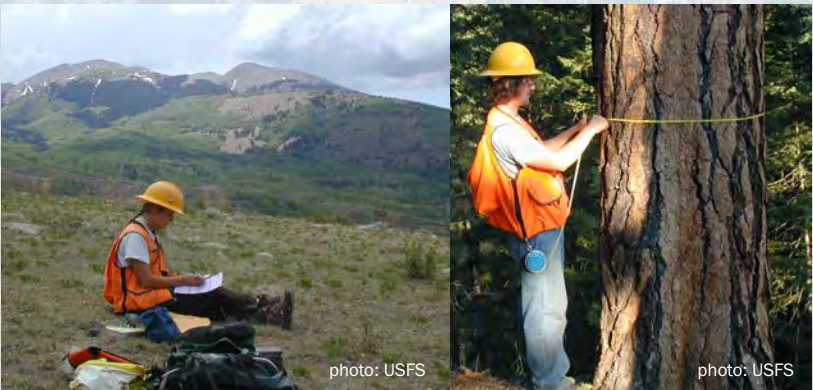
FIA now uses remote sensing in the form of satellite imagery and aerial photos to determine forest characteristics in each State. On a subset of plots each year, field crews collect more extensive data about tree size and condition, lichens, soils, and other conditions.

The data from FIA is useful for managers during landscape level planning and to scientists as they examine change over time.

FIA data has been used to assess the health of whitebark pine populations in the western United States, perform detailed State-level analyses of forests, and to assess forest carbon pools and sequestration rates.

“[FIA data] is one of the things we all take for granted, but it’s very important... we’re making management decisions every day based on FIA data.”

-Mary Stuever, Chama District Forester, New Mexico State Forestry



The Forest Inventory and Analysis (FIA) program uses remote sensing, satellite imagery, and aerial photos in addition to on the ground data collection to complete a census of the nation’s forests to assist managers in landscape level planning and provide data to scientists.

photo: R. Peterson, USFS

Spotlight on Intermountain West FIA

The State of New Mexico knows how valuable FIA data is. As part of its 2010 Forest Action Plan, New Mexico identified a need to fill a decade-long gap in their FIA data. Since 2000, the State’s forests suffered from beetle outbreaks, drought, and wildfires, and the iconic pinyon pine had been decimated. Managers did not know the extent of the damage because of a lack of FIA data.

In partnership with RMRS, the State of New Mexico has been aggressively filling in FIA data on all lands, not just Forest Service lands. They have included private, Tribal, State, and Department of Defense lands in the inventory, and as a result the State developed true, cross-boundary priority maps and plans. **The multi-jurisdictional approach to FIA data collection has allowed for unprecedented collaboration in the State of New Mexico** as well as

depth of data to develop new Landsat and Landfire models. **As a result of the partnership with RMRS to fill data gaps, New Mexico now has a true baseline dataset that managers can use to track rapid change over time.** This gives scientists and managers the ability to predict trajectories for what ecosystems are going to look like in the future.



photo: K. Greer, USFS

Mapping Social Networks in Support of Shared Stewardship

The CoMFRT vision: Wildfire is no longer seen as disastrous or catastrophic for communities, but becomes more like rain— normal and expected, but sometimes problematic in its intensity.

In addition to engaging in shared stewardship as a regular part of the way we do business, RMRS actively studies how shared stewardship, collaboration, and communication can be more effective.

agencies can best interact and make decisions that affect fire and risk. **Social science done at RMRS builds relevant, usable knowledge of how communities can better live with wildfire through**

research on human behavior, institutions and governance, community dynamics, and social networks.

The CoMFRT Partnership studies what makes people

One RMRS project, CoMFRT (Co-management of Fire Risk Transmission), provides solutions for improving public and private collaboration to increase ecological and social resilience and to reduce risk to communities from wildfire.



High-severity fire crosses jurisdictional and ownership boundaries and can threaten communities and homes in the wildland-urban interface. The financial costs of fighting fire in the WUI are enormous. The CoMFRT project improves public and private collaboration to increase ecological and social resilience to create more fire-adapted communities and reduce risk and costs.

Fire cannot be managed by any one actor; instead, we need to understand how homeowners, communities, non-profit organizations, and local, State and federal

“From a practitioner’s perspective, the CoMFRT Project is taking a holistic look at how policy, governance, learning networks and programs are affecting our ability to effectively get work done on the ground. Understanding the complexities within these systems is critical to creating more fire-adapted communities in our region.”

—Patrick Haggerty, Project Coordinator, Cascadia Conservation District

and institutions work successfully together across scales and circumstances to best mitigate fire risk. Learning how social networks around fire function allows managers to make shared stewardship more effective over the long term. As of 2018, the CoMFRT research team has conducted over 1,000 interviews and surveys with stakeholders. The data provide an informative snapshot about the state of fire management in a specific at-risk location in the Wenatchee, Washington area. There are 500 people,

100 organizations, and 1,200 professional relationships working in wildfire prevention and mitigation in the area. Despite this, there are some key populations and issues around complex ownership patterns that are not being addressed. Further, interviewees thought that USFS engagement with the community was not adequate. **With data about these shortcomings, agencies engaging in shared stewardship have the opportunity to address these concerns.**

**PARTNERS**

USDA USFS (RMRS, State and Private Forestry, Fire and Aviation Management), Colorado State Forest Service, Portland State University, University of Colorado, Washington State University, University of Montana, University of Idaho, Florida State University, Utah State University, Oregon State University



The Science Partner Program Enhances Collaboration Between Scientists and Land Managers

RMRS is committed to co-producing knowledge with our land management partners. While grassroots and informal partnerships are a critical element of the Station’s long history of collaboration with land management agencies and always will be, the [Science Partner Program](#) provides a mechanism for formalized relationships. The Program launched in 2016 to enhance collaboration opportunities between RMRS researchers and National Forest System managers in the Intermountain West. **Scientists and managers are purposefully paired**

to develop science-based solutions that have direct on-the-ground implications. Collaboration effectiveness is improved with travel funds to incentivize regular, in-person communication. As managers revise land and resource management plans for forests and grasslands and work on project-level planning, **RMRS researchers provide technical support to create better strategies and practices for land managers and focus on developing outcomes for specific resource management challenges.**



photo: C. Rhoades, USFS

The Science Partner Program pairs land managers and researchers to develop science-based solutions to on-the-ground problems. Current projects include:

- Landscape-scale forest restoration on the Boise Basin Experimental Forest and Boise National Forest
- Leveraging range monitoring data
- Prioritizing conservation of groundwater dependent ecosystems
- Detecting boreal toads using eDNA
- Developing mesocarnivore models across multiple regions
- Increasing site resilience and biodiversity on the Curlew National Grassland
- Integrating climate change research into the Manti-La Sal National Forest Plan revision process
- Public socioeconomic workshops on the Salmon-Challis National Forest



photo: USFS



photo: USFS



photo: USFS

Science Leaders at the Landscape Scale

The [RMRS Center for Landscape Science \(CLS\)](#) promotes communication, coordination and co-creation among RMRS scientists and natural resource managers to facilitate development and implementation of leading edge science in landscape ecology and its applications to adaptive management and shared stewardship.

As part of Idaho’s Multi-species Baseline Initiative (MBI), CLS is part of a coalition of 18 partner groups representing Federal, State, Tribal, university, and non-governmental organizations, and private corporations. MBI used a single survey to determine the species occurrence of multiple species and gathered data about microclimates. The species occurrence data changed our understanding of species distribution and abundance for multiple species. Combining data about species occurrence with microclimate data allowed CLS to identify species that may prefer cool air and pinpoint areas which could be used as cool-air conservation reserves. **This inventory of multiple target species means that management actions developed for them will be based on data, rather than assumptions.**

photo: H. McLean, USFS

The Rocky Mountain Research Station is one of seven units within Forest Service Research and Development. This booklet focuses on RMRS commitment to co-developing knowledge with partners to produce solutions for our Nation’s forests and grasslands. Other Research Stations across our organization are also providing science in support of shared stewardship, here are a few examples:

- Southern Research Station scientists are teaming up with the Francis Marion National Forest and the South Carolina Forestry Commission to restore native longleaf pine. The team will conduct a timber sale through a Good Neighbor Authority agreement. Following the harvest, they will plant longleaf seedlings, monitor broad-scale changes in water yield, and work with the Longleaf Alliance and NRCS-South Carolina to share technical assistance about longleaf pine forests on private lands.
- The Pacific Southwest Research Station is working with the FS Pacific Southwest Region, The Nature Conservancy, California state agencies, and other partners to provide the scientific foundation and tools to assess fire risk, drought vulnerability, biodiversity and wood supply to support planning and permitting projects on three national forests in the Tahoe-Central Sierra region.

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The Rocky Mountain Research Station produces independent, credible science that informs today's decisions and asks tomorrow's questions. We endeavor to continuously improve upon the stewardship and conservation of all lands. We are ready to propel these efforts forward into a changing future by co-producing knowledge and solutions at the scale of the problem with and for our land management partners. We stand ready to work with states and regions to provide the best available science in support of shared stewardship.



photo: P. Keres, USDA

To learn more about Rocky Mountain Research Station visit us on the web: <https://www.fs.fed.us/rmrs>

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