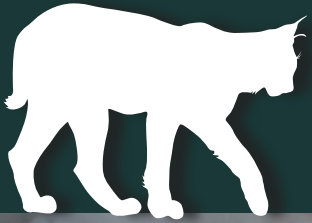




United States Department of Agriculture

RMRS SCIENCE SUPPORTS NATIONAL RESEARCH PRIORITIES



A glimpse at
National Research
Priorities inside the Rocky
Mountain Research Station



USDA Forest Service

Rocky Mountain Research Station

September 2020



Message from the Station Director

Our science improves lives and landscapes. RMRS invests in research aligned with the Forest Service Research and Development Priority Areas and supports the needs of the Forest Service and our regional and national partners. The projects highlighted here are a small sample of the exemplary research occurring at RMRS. For over a century, Forest Service R&D has been delivering high-quality science with broad applications, and I am proud of RMRS' contribution to this long legacy of Forest Service research.

–Monica Lear, PhD, RMRS Station Director

Introduction

The Rocky Mountain Research Station (RMRS) develops and delivers innovative science and technology to improve lives and landscapes. RMRS conducts research focused on the issues of today, applying knowledge gained from decades of prior research to contemporary problems. Scientists at RMRS also continue long-term research that provides a lens from the past into the future to inform the sustainable management of diverse ecosystems.

This document showcases a selection of innovative, impactful research aligned with the 2020 Research & Development Priority Areas. These selections demonstrate how RMRS research is improving the condition of America's forests and grasslands, how we are improving inventory and analysis techniques and technology, our world-renowned investments in enhancing the wildland fire system, and our efforts to improve the utilization of wood products. In addition to the science showcased here, RMRS also conducts extensive research on water and watersheds, wildlife and fish, rangeland and forest health, insects and diseases, wilderness, human interactions with natural resources, and much more. We invest in this research because it can help us address the priorities of today and tomorrow. This full suite of research — our ability to respond to the issues of today and prepare for the issues of tomorrow — is why Forest Service Research and Development is a world leader in natural resource sciences.

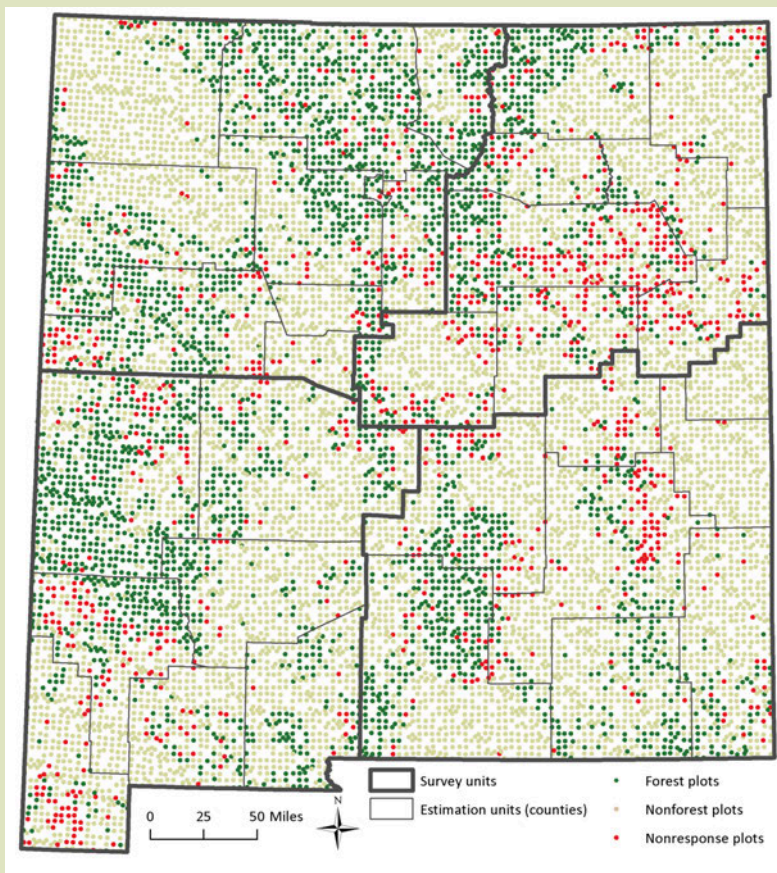


APPLIED SCIENCE TO SUPPORT SHARED STEWARDSHIP AND IMPROVE FOREST CONDITIONS

RMRS leverages our research and relationships to achieve meaningful outcomes for the management of our nation's forests and grasslands.

RMRS science supports Shared Stewardship with innovative approaches and data-driven analysis 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 ecosystems and science disciplines.

RMRS partnered with the State of New Mexico to collect FIA data on all New Mexico lands, including private, Tribal, State, and Department of Defense lands. As a result, New Mexico was able to develop true, cross-boundary priority maps and plans. This multi-jurisdictional, shared stewardship approach that highly leverages FIA data has led to a true baseline dataset that managers and scientists can use to easily track change over time and prioritize forest management across the state.



Approximate locations of FIA survey plots in New Mexico.



eDNA

When the right tools don't exist, RMRS creates new ones. **We are improving the efficiency and accuracy of surveys of rare and invasive aquatic species by revolutionizing the use of [environmental DNA \(eDNA\)](#).** eDNA sampling serves as an efficient and relatively inexpensive monitoring tool that can increase the efficacy of treatments, reduce labor and costs, and improve allocation of conservation funds. For example, we are working with Montana Fish, Wildlife, and Parks managers, the Kalispell Tribe, and the Washington Department of Fish and Wildlife to use eDNA sampling to inform brook trout (*Salvelinus fontinalis*) eradication efforts in small streams. RMRS scientists at the [National Genomics Center for Fish and Wildlife Conservation](#) partner with organizations across the world to deploy this technology and support monitoring efforts.



When the Forest Service began a restoration project in habitat of the bull trout, a threatened species under the U.S. Endangered Species Act, managers were able to use eDNA to confirm that the species was not present in the area (photo: R. Hargrave, Oregon Department of Fish & Wildlife).

“Analysis of eDNA is only one of three major focus areas at the Genomics Center, but its use has been booming over the past few years. It’s one of the most cost-effective and defensible sampling approaches for detecting endangered species and invasive aquatic species, and more and more people are approaching us who are interested in using the technique.”

–Mike Schwartz, RMRS Wildlife Science Program Manager and Director of the National Genomics Center for Fish and Wildlife Conservation

Environmental DNA (eDNA) sample collection is simple, and analysis can be more sensitive and less expensive than traditional sampling for aquatic species.



Great Basin Native Plant Project

The [Great Basin Native Plant Project \(GBNPP\)](#) is a multistate collaborative research project led by RMRS scientists and the BLM Plant Conservation Program. **The GBNPP focuses on developing sound management and successful restoration practices in the face of threats from invasive species, shifting fire regimes, and climate change.** For example, we studied sites in Tintic Valley, Utah and demonstrated that the seed mix used for postfire seeding can have a strong influence on the resulting plant community composition decades later. In this location we found that native seed mixes performed as well as conventional seed mixes and resulted in a more diverse and dynamic native plant community in the long term. We continue to partner with over 30 collaborators on postfire restoration to develop seed mixes that discourage cheatgrass and other non-native grass invasion.



After 16 years, little cheatgrass can be seen in both the conventional and the native seed mixes. In the conventional mix, crested/Siberian wheatgrass remains dominant, while in the native mix native shrubs have colonized, suggesting that successional processes are moving in a desired direction (photos: Utah Division of Wildlife Resources Range Trend Crew).

Forest Restoration

RMRS scientists responded to the concerns of Rocky Mountain Region and Colorado Front Range forest managers who needed locally relevant science to guide forest restoration. Our scientists worked with specialists in the Rocky Mountain Region, the Natural Resources Conservation Service, the Nature Conservancy, the Wilderness Society, Colorado State University and others to co-develop a framework for restoration of ponderosa pine and dry mixed-conifer forests based on best available science, such as a robust historical forest reconstruction study. This framework, presented in [RMRS-GTR-373](#), provides 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. Across the Colorado Front Range, this framework is being used for on the ground forest restoration projects.



Mastication

Mastication is a useful treatment for preparing a site for planting, releasing sapling-sized trees, or reducing surface fuels in fire-prone forest ecosystems. However, not all mastication treatments are the same. In [RMRS-GTR-381](#), **our scientists provide information that is useful for a land manager to evaluate whether mastication is**

appropriate for their project. The GTR includes information about equipment selection, why operator experience should be considered when designing a treatment, and the economic costs of mastication. The GTR also includes three decision trees to further assist land managers in determining the type of treatment best suited to the project area and management objectives.



Insect and Disease Mortality and Resilience

RMRS scientists are conducting research to understand impacts of insect and disease mortality events on western forests and developing strategies to manage forest health before, during, and after these disturbances. Our scientists, in collaboration with other researchers and forest managers, have developed the [regeneration for resilience](#) (R4R) framework to guide management decisions to support sustainable pine populations in the presence of white pine blister rust. We are also part of a team researching [emerging pest management approaches](#) for mountain pine beetle, finding that mountain pine beetle is highly sensitive to gene silencing through RNA interference. We are also examining the [effect to ecosystem services, like water](#), as a result of mountain pine beetle epidemics. Our research leads to informed management in the face of insects and disease and healthier western forests.



Our scientists found that post bark beetle outbreak snagfall dynamics create a multiple-decade legacy that will persist longer in high-elevation compared to lower-elevation forests.



White pine blister rust.



FOREST INVENTORY AND TREND ANALYSIS

RMRS scientists develop technologies and tools to monitor forest resources and their condition—on the ground, from the air, and from space.

RMRS houses flagship inventory, monitoring, and assessment programs. Our scientists and partners develop technologies and tools to monitor resources and their condition—on the ground, from the air, and from space. Whether the issues are site-specific or global, our scientists conduct robust analysis to better understand resource issues and develop state-of-the-art monitoring solutions.

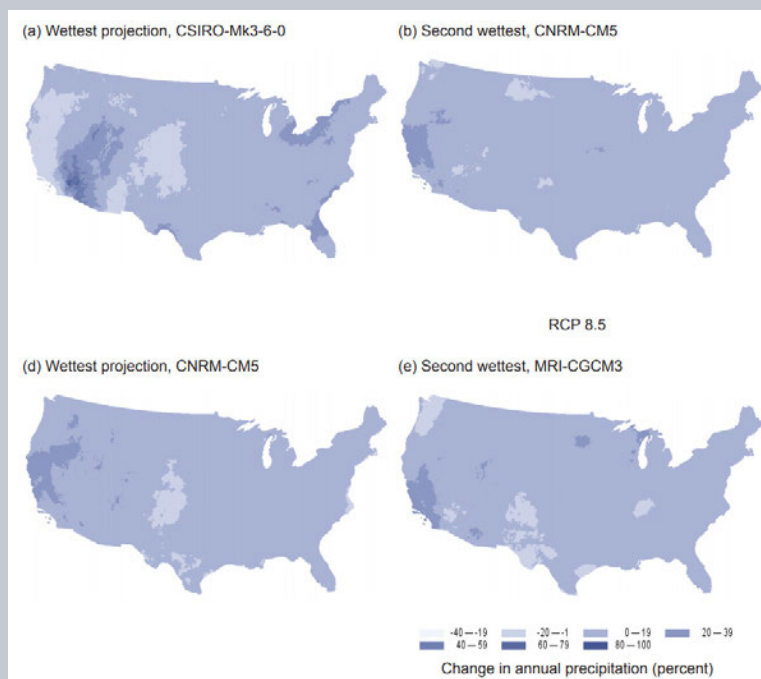
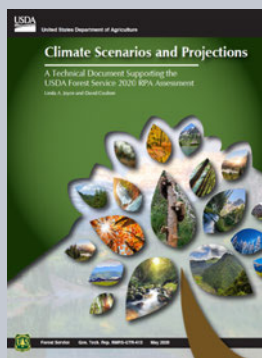
RMRS scientists led statistical estimation and uncertainty assessment for biomass information products produced by NASA's [Global Ecosystem Dynamics Investigation \(GEDI\)](#) mission. The GEDI mission, led by the University of Maryland, is quantifying the distribution, change, and potential of above-ground forest carbon at fine spatial resolution. These measurements are collected through a full-waveform LIDAR attached to the International Space Station. This mission will provide the first global, high-resolution observations of forest vertical structure, supplying land managers with important and reliable data.



GEDI was carried from Earth to the International Space Station atop a SpaceX Falcon 9 rocket. GEDI was then extracted from the Dragon capsule's trunk by the space station's robotic arms and passed along the length of the space station to the Japanese Experiment Module – Exposed Facility, where it was attached (photos: NASA).

Resources Planning Act Assessments

RMRS has consistently advanced the science in [Resources Planning Act \(RPA\) Assessments](#). Our scientists have served as water, range, and wildlife specialists for RPA Assessments, and RMRS has published many supporting GTRs. We led development of the climate scenario and climate projection work for the 2020 RPA Assessment cycle. **Our scientists selected the scenarios, climate models, and climate projections that will be used to project and evaluate the future of the Nation's renewable natural resources through 2070 and described the process in [RMRS-GTR-413](#).**

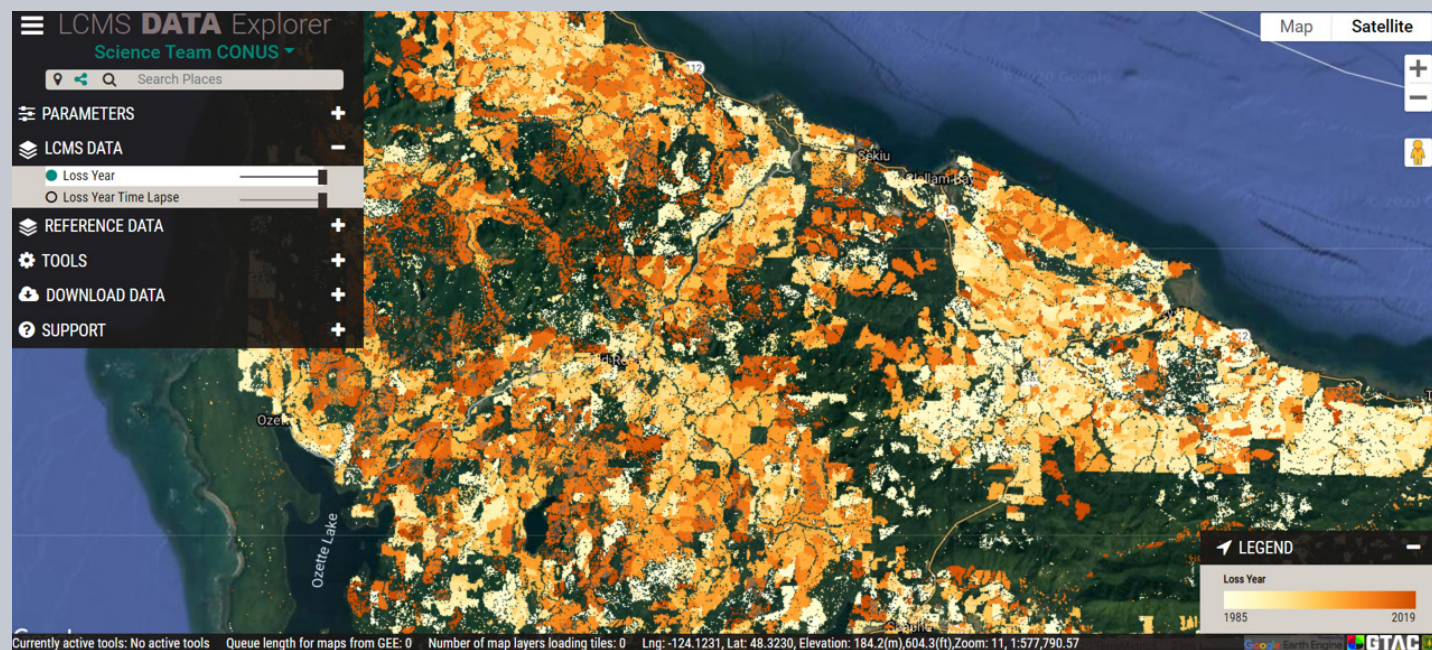


The 2020 RPA Assessment will include climate change as a driver of change affecting natural resources on all forests and rangelands in the United States.

Landscape Change Monitoring

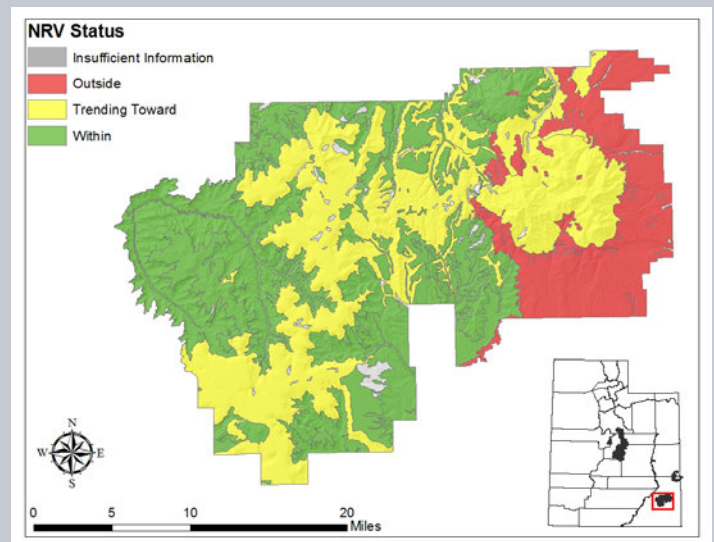
The **Landscape Change Monitoring System (LCMS)** uses remote sensing to produce annual maps depicting changes in vegetation, land cover, and land use, from 1985 to the present. RMRS led the production of these maps, which can be used in a wide range of land management applications such as creating habitat maps and updating carbon assessments. The Forest Service Geospatial Technology Applications Center (GTAC) has completed LCMS pilot projects with several national forests and the entire Intermountain Region. The Pacific Northwest Forest Plan Effectiveness Monitoring Program is using the LCMS data to regularly update habitat and old growth maps.

The publicly available LCMS data explorer shows disturbances (which include harvests, fires, and insects) occurring on the Olympic Peninsula (WA) between 1985 and 2019.



Riparian and Groundwater-Dependent Ecosystem Assessment

Our scientists, together with Intermountain Region forest managers, are developing **forest-wide comprehensive assessments** of riparian and groundwater-dependent ecosystems. These assessments serve as key citable references for forest plans, monitoring, and locally specific project planning. We have published general technical reports, which provide a synthesis of best available science and identify drivers and stressors of these systems, for the Ashley, Manti-La Sal, Salmon-Challis, and Bridger-Teton National Forests to use in the forest plan revision process.



A natural range of variation status map created by RMRS classifies Manti-La Sal National Forest areas as within, moderately altered, or outside the natural range of variation for water fluctuation in surface water systems (image: USDA Forest Service).

“Our approach is extremely collaborative, we start with at least one site visit with the Forest Plan revision team and riparian experts on the Forest—mostly hydrologists and fish biologists but also recreation and range conservation managers. We find that face-to-face meetings are critical to our effort and outcomes are better when we have that kind of relationship.”

—Katey Driscoll, RMRS Research Ecologist





ENHANCING THE WILDLAND FIRE SYSTEM

RMRS has been a global leader in fire research for over 60 years, developing strategies to manage wildland fire before, during, and after fire events.

Our scientists and collaborators build an understanding of the fundamentals of fire science, create tools that make firefighters and communities safer, and develop strategies to manage wildland fire before, during, and after fire events.

2020 Fire Season Response

RMRS scientists are contributing to agency wildfire response in the 2020 season in an unprecedented way. Our researchers are providing risk management analysis on large fire incidents in real-time to improve situational awareness and firefighter and community safety. We are also working closely with leadership and on the ground fire managers to understand this season's unique safety challenges in light of COVID-19 and [provide research-based approaches](#) for risk assessment and mitigation, rapid on-the-ground sensemaking, and tactical adjustments.

Fire Weather Alert System

The RMRS-developed [Fire Weather Alert System \(FWAS\)](#) that warns on the ground firefighters of real time dangerous weather conditions. The FWAS monitors weather forecasts and alerts firefighters via email or text message of dangerous weather such as high winds, low relative humidity, thunderstorms, and Red Flag Warnings. This user-friendly custom weather delivery system increases situational awareness and firefighter safety and informs decision making on wildland fire incidents.

Our researchers provide risk management analysis on large fire incidents in real-time to improve situational awareness and firefighter and community safety.



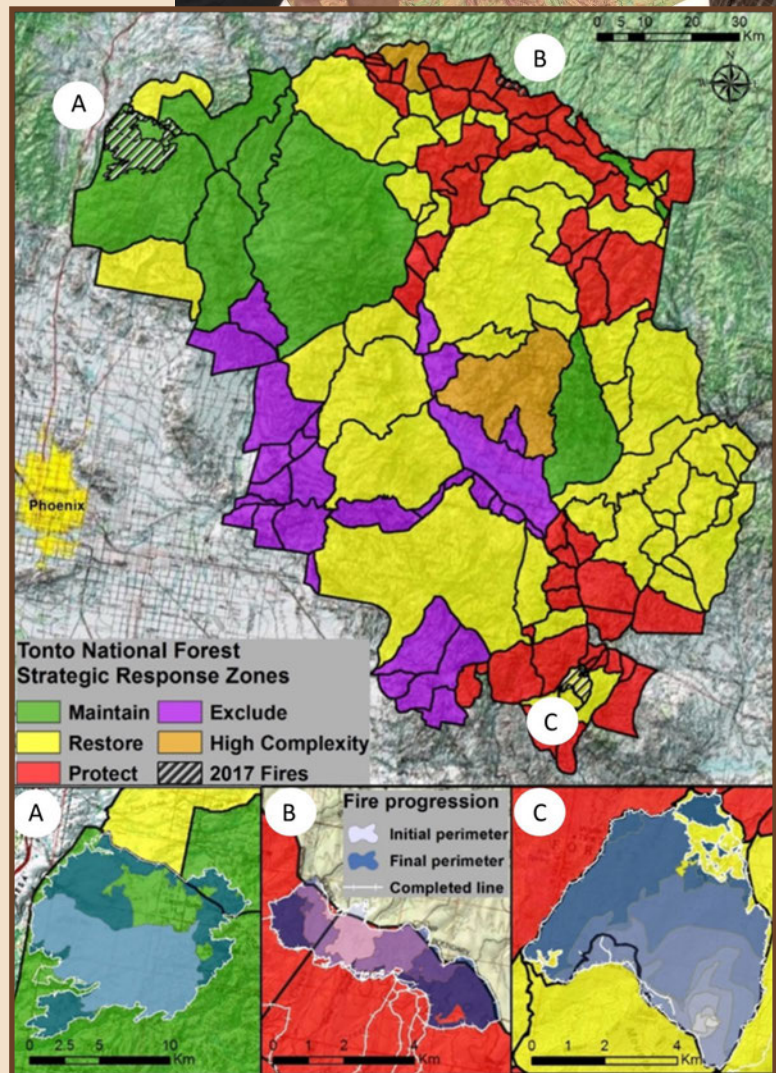
“We provide state of the art decision support models to visualize the control opportunities across large landscapes.”

- Jessica Haas,
RMRS Ecologist



PODs

RMRS' Wildfire Risk Management Science (WRMS) Team developed Potential Wildfire Operational Delineations (PODs) to pre-plan for fire using a risk management approach. PODs combine local fire knowledge with advanced spatial analysis to help managers weigh values, current conditions, and most likely fire outcomes to determine fire management objectives. The PODs pre-planning framework has been applied on over 40 national forests and counting. Already this fire season, PODs work from previous years has been leveraged to make well thought out, risk-based plans for responding to fire. For example, on the Bush Fire on the Tonto National Forest this year, fire operations were adjusted to very rapidly identify suppression opportunities by making small refinements to prior years' work.



Fire managers gather around a Potential Control Location map to discuss and define the best boundaries for the PODs. In this picture, the black marker lines are the POD boundaries that they identified together (photo: M. Caggiano, Colorado Forest Restoration Institute). The color coded map below the photo shows PODs for the Tonto National Forest.

“We get fuel planners, fire managing officers, and fire staff along with their collaborators—local volunteer fire departments, state fire departments, the people who are actually out responding when a fire occurs—into the room.”

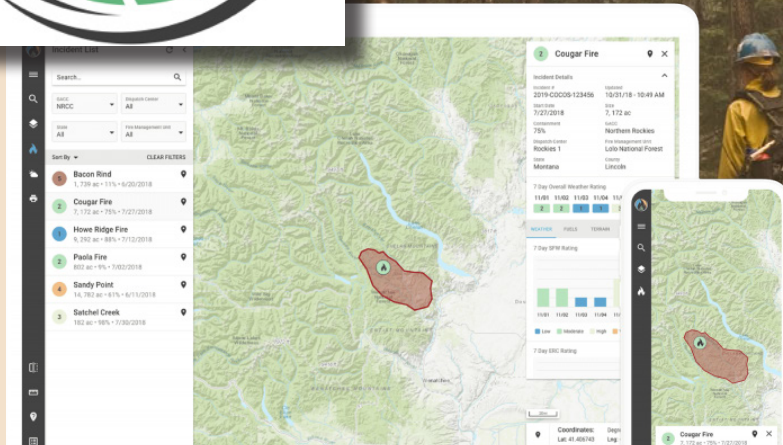
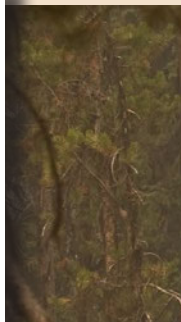
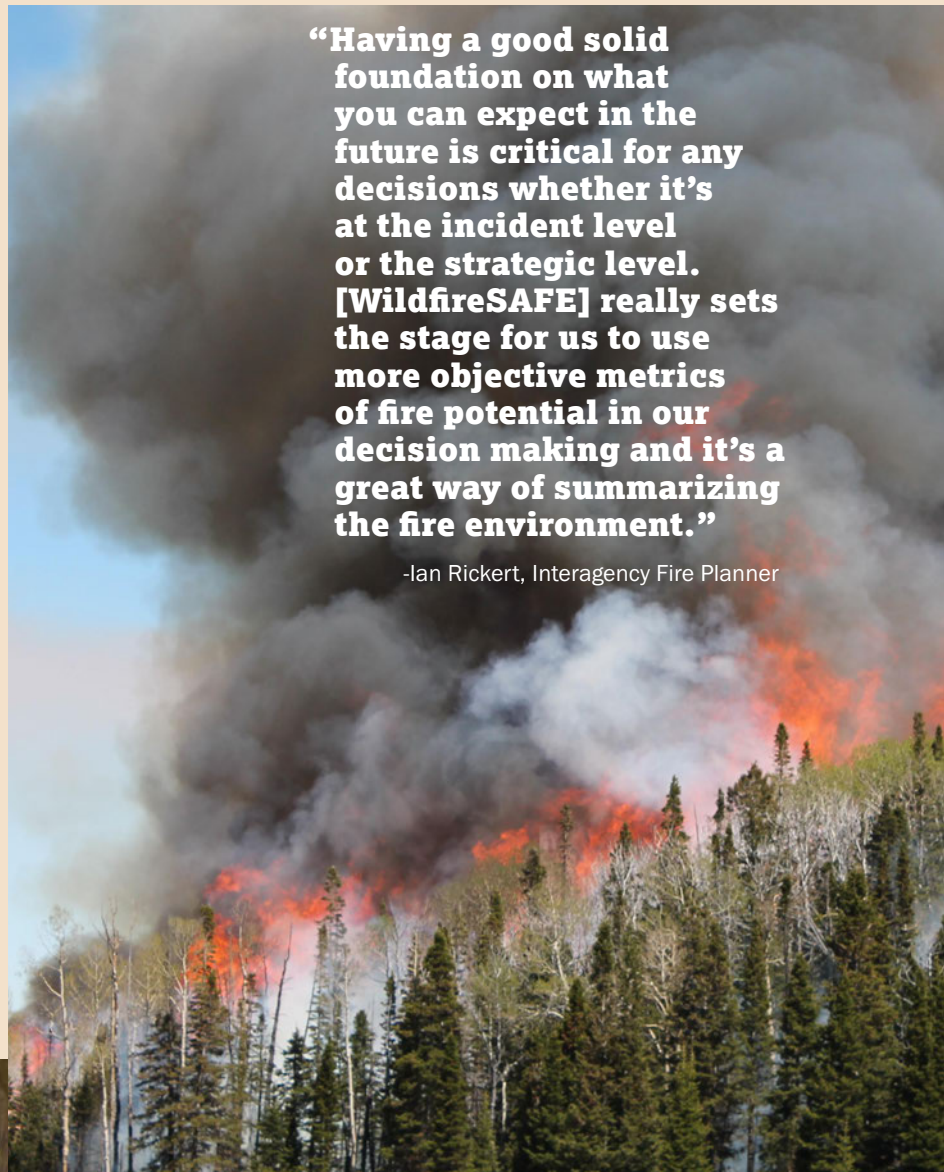
– Jessica Haas,
RMRS Ecologist

WildfireSAFE

WildfireSAFE is a mobile application and web-based tool that provides real-time, incident specific intelligence about the wildland fire environment. WildfireSAFE supports the greater interagency fire community in incident-level analysis during the planning, response, and recovery phases of wildfire management. WildfireSAFE integrates information from Wildland Fire Assessment System (WFAS) to provide targeted resources for fire incidents. The application allows users to view weather analysis for any active incident, compare active incidents within an area of interest, and capture observations about fire behavior. WildfireSAFE is designed to be used by the Forest Service, private industry, local and state firefighting organizations, and the general public.

“Having a good solid foundation on what you can expect in the future is critical for any decisions whether it’s at the incident level or the strategic level. [WildfireSAFE] really sets the stage for us to use more objective metrics of fire potential in our decision making and it’s a great way of summarizing the fire environment.”

-Ian Rickert, Interagency Fire Planner



WOOD PRODUCTS AND MARKET INNOVATION

RMRS scientists develop wood products and market innovations with direct application to management and industry.

RMRS scientists are actively developing wood product and market innovations that advance the wood products industry and have direct applications for forest management. New wood products and market innovations enhance the cost-effectiveness of forest health treatments, improve rural economies, and strengthen both local ecosystems and neighboring communities. RMRS works with practitioners to develop tangible solutions and advance understanding of the social, environmental, and economic impacts of using [forest biomass](#).



RMRS research supports decision making around salvage logging with implications for forest managers, the timber industry, and local and regional economies. Following a disturbance, management decisions such as whether and where to allow salvage logging are time sensitive. We have developed the [First Order Fire Effects Model \(FOFEM\)](#), a **free modeling software managers can use to estimate postfire tree mortality for both prescribed burns and wildfires.** [FIRE-BIRD](#), an RMRS-created tool for ArcGIS, informs forest management planning by identifying areas that can be targeted for woodpecker conservation, thereby **facilitating science-based compatibility of salvage logging and woodpecker habitat needs.** To inform salvage logging in bark beetle impacted landscapes, we developed [predictive maps of Canada lynx-use](#) that allow managers to **identify areas preferred by Canada lynx from areas of lesser conservation value.**

“We expect increases in wildfire and bark beetle outbreaks, which will allow more opportunities for salvage logging,” says Saab. “The FIRE-BIRD tool is intended to help managers make the best decisions for maintaining habitat of key wildlife species, while still allowing economic benefits to local communities.”

–Vicki Saab
RMRS Research Wildlife Biologist



RMRS scientists are studying how to balance salvage logging with the management of ecosystems and species such as the Canada lynx.

Harvest System Decision Model

As new timber harvest systems are developed, how can forest managers determine the best system to use? **A decision support model developed by RMRS scientists helps forest managers implement the best harvest systems based on topography and stand characteristics identified with lidar data.** RMRS scientists used this model on the Nez Perce-Clearwater National Forests to determine that shovel harvester-based options previously uncommon in the region were feasible in the study area. The model allows managers to evaluate alternative harvest systems and encourages the use of innovative machinery.

Restoration Harvest Systems

High-grade logging, forest grazing practices, and fire suppression have altered once park-like ponderosa pine-dominated ecosystems into dense forests containing an abundance of low-value, small-diameter wood products in need of restoration. Few readily accessible markets for small-diameter timber exist in Colorado, so forest restoration treatments are often expensive. **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.** RMRS scientists [evaluated restoration harvest practices in the southern Rocky Mountains](#) in terms of equipment used, production rates, and costs under both observed and modeled site and stand conditions across the region. This provides forest contractors with a reference to compare logging systems they may use in the future and can benchmark their operations using these results.



RMRS scientists work with practitioners to develop tangible solutions and advance our understanding of the impacts of using forest biomass.

Biochar

RMRS scientists have responded to managers' needs to develop new uses for biochar. As a product developed from otherwise non-merchantable wood, biochar provides opportunities for new revenue streams for the wood products industry.

- RMRS scientists demonstrated several **low-tech methods of making biochar on-site, including the use of efficient slash piles and portable air curtain burners.** These techniques prevent soil damage, and the biochar produced can be a revenue stream for timber purchasers.
- Scientists at RMRS demonstrated that biochar, when applied to **abandoned mine sites, is inexpensive and effective at increasing soil cover and plant growth.** Building soil organic matter on these sites will enable the soil to better support trees in the future.
- Biochar has applications in plant and tree nurseries. **RMRS scientists found that it can be a suitable replacement for sphagnum peat** in nursery production of ponderosa pine seedlings. It is also an **effective amendment in soilless nursery media** for propagation of three northern Rocky Mountain native species used in restoration plantings.

RMRS scientists developed and tested a high capacity biochar spreader to reduce the cost and facilitate the application of biochar as a soil amendment. The spreader can be mounted on a log forwarder and used on skid trails and log landings to distribute either pelleted or bulk biochar.



Mulched biochar treatments developed by RMRS scientists have the potential to enhance soil nitrogen, improve soil water holding capacity, and support plant recovery following severe wildfire.

Delivering Science to Land Managers

RMRS delivers scientific information to those making and influencing land management decisions. Through the [Science You Can Use](#) series, [land manager-focused science webinars](#), [interactive websites](#) and maps, podcasts and [webcasts](#), and other innovative communication tools, we seek to ensure land managers can easily access scientific information in support of decision making.

Priority Area 1: Applied Science to Support Shared Stewardship and Improve Forest Conditions

[The Big Picture: New Perspectives On Restoring Landscapes](#)

[Everyone In: A Road Map for Science-Based, Collaborative Restoration of Western Quaking Aspen](#)

[Sage Advice for Managers: A New, Collaborative Science Framework for Conservation and Restoration of The Sagebrush Biome](#)

[Building Resilience in Colorado Front Range Forests for The Future](#)

[Back to The Future: Building Resilience in Colorado Front Range Forests Using Research Findings and A New Guide for Restoration of Ponderosa and Dry-Mixed Conifer Landscapes](#)

[A Public Engagement Protocol: Social Science in Support of Planning Efforts](#)

Priority Area 2: Forest Inventory and Trend Analysis

[Vulnerable, Valuable, Variable: Science-Based Assessments of Riparian and Groundwater-Dependent Ecosystems](#)

[Making Sense of Big Data: Putting Forest Inventory and Analysis to Work in Forest Planning](#)

[One Year After Launch, eDNAAtlas Proves Its Worth](#)

[Morphology Is Better Than Size for Revealing A Tree's Age on Colorado's Front Range](#)

[Black and White and Shed All Over: How Edna Analysis Can Help to Answer Your Species Questions](#)

[No Fish Left Behind: Best Practices for Using Environmental DNA Sampling to Inform Fish Eradication Efforts](#)

[Riparian and Groundwater-Dependent Ecosystem Assessments](#)

Priority Area 3: Enhancing the Wildland Fire System

[A Double Whammy: Climate Change and Stand-Replacing Wildfires](#)

[Consequences of An Endless Summer: Untangling the Link Between Summer Precipitation and Western Wildfires](#)

[A World in Pixels: How New Research Is Helping to Predict Probability of High-Severity Fire](#)

[A West-Wide Rangeland Fuel Assessment: Reading the Tea Leaves](#)

[Wildfiresafe: A Tool to Provide Rapid, Actionable Intelligence to Inform Risk-Based Decision Making for Wildland Fire Operations](#)

[The West-Wide Fuelcasting System](#)

Priority Area 4: Wood Product and Market Innovations

[A Go-To Guide for Your Mastication Questions](#)

[Of Woodpeckers and Harvests: Finding Compatibility Between Habitat and Salvage Logging](#)

[Is That Tree Dead? Quantifying Fire-Killed Trees to Inform Salvage and Forest Management](#)

[FIRE-BIRD Wildlife Habitat Tool](#)

About the Rocky Mountain Research Station

The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. Learn more about RMRS by following us on Twitter [@usfs_rmrs](#) or visit our [website](#).