



# Rocky Mountain Research Station

# New Publications

October-December 2015

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# The Rocky Mountain Research Station

The Rocky Mountain Research Station is one of five regional units that make up the U.S. Forest Service Research and Development organization—the most extensive natural resources research organization in the world.



We maintain 14 research locations throughout a 12-state territory encompassing the Great Basin, Southwest, Rocky Mountains, and parts of the Great Plains. The station employs more than 400 permanent full-time employees, including about 100 research scientists.

Scientists conduct research that spans an area containing 52% of the nation’s National Forest System lands (54 national forests and grasslands). In the lower 48 states, our territory also includes 55% of the nation’s Bureau of Land Management lands; 48% of the designated wildernesses; 37% of National Park Service lands; numerous other public and tribal lands; and 41% of the non-urban/rural private lands.

We administer and conduct ecological research on 14 experimental forests, ranges, and watersheds over the long term, even centuries, enabling us to learn how forests change as climate and other factors change over time.

We also oversee activities on several hundred research natural areas, a network of ecosystems set aside to conserve biological diversity. These areas represent a wide variety of habitats and ecosystems from alpine ecosystems to lowlands and from coniferous forests of the Northern Rockies to semiarid deserts of the Southwest and prairie ecosystems of the Great Plains.



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## New RMRS Publication Series

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### Keeping it wild 2: An updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System

Contact Peter Landres,  
[plandres@fs.fed.us](mailto:plandres@fs.fed.us),  
for printed copies

**Keeping it wild 2: An updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System.** Landres, Peter; Barns, Chris; Boutcher, Steve; Devine, Tim; Dratch, Peter; Lindholm, Adrienne; Merigliano, Linda; Roeper, Nancy; Simpson, Emily. 2015. Gen. Tech. Rep. RMRS-GTR-340. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 114 p.

This document updates and replaces Keeping It Wild: An Interagency Strategy for Monitoring Wilderness Character Across the National Wilderness Preservation System (Landres and others 2008), and provides a foundation for agencies to develop a nationally consistent approach to implement this monitoring. This monitoring strategy addresses two questions: How do stewardship activities affect attributes of wilderness character? How are attributes selected as integral to wilderness character changing over time within a wilderness, within an agency, and across the National Wilderness Preservation System? The primary audiences for the information from this monitoring are agency staff who manage wilderness day-to-day, and regional and national staff who develop wilderness policy and assess its effectiveness.

[http://www.fs.fed.us/rm/pubs/rmrs\\_gtr340.html](http://www.fs.fed.us/rm/pubs/rmrs_gtr340.html)

### Impact of biomass harvesting on forest soil productivity in the northern Rocky Mountains

Online only

**Impact of biomass harvesting on forest soil productivity in the northern Rocky Mountains.** Jang, Woongsoon; Keyes, Christopher R.; Page-Dumroese, Deborah. 2015. Gen. Tech. Rep. RMRS-GTR-341. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 35 p.

There is abundant prediction of long-term impacts of intensive biomass removal on forest productivity. In this report, we compare biomass harvesting with natural disturbance regimes or conventional harvesting systems in terms of organic matter redistribution. We review the role of organic matter on forest productivity and compare the organic matter redistribution or removal through biomass harvesting and natural disturbances or conventional harvesting. The summarized findings are: (1) the long-term impacts of intensive biomass harvesting will be mitigated by protection of the belowground organic matter; (2) biomass harvesting could result in the accelerated leaching of nutrients; and (3) immediate understory vegetation recovery can minimize potential negative impacts. Finally, sites sensitive to harvesting impacts (e.g., fine-textured soil and steep slopes) should be approached with caution and prior planning to minimize undesirable responses.

[http://www.fs.fed.us/rm/pubs/rmrs\\_gtr341.html](http://www.fs.fed.us/rm/pubs/rmrs_gtr341.html)

## New RMRS Publication Series

### Ecological Types of the eastern slope of the Wind River Range, Shoshone National Forest, Wyoming

Online only

**Ecological Types of the eastern slope of the Wind River Range, Shoshone National Forest, Wyoming.** Wells, Aaron F.; Boettinger, Janis L.; Houston, Kent E.; Roberts, David W. 2015. Gen. Tech. Rep. RMRS-GTR-345. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 423 p.

This guide presents a classification of the Ecological Types of the eastern slope of the Wind River Range (WRR) on the Shoshone National Forest in west-central Wyoming. Ecological Types integrate vegetation and environmental characteristics, including climate, geology, landform, and soils, into a comprehensive ecosystem classification. The three objectives are: (1) complete field data collection, (2) simultaneously develop soil map unit components and Ecological Types, and (3) publish the ecological type classification such that it is compatible with the National Cooperative Soil Survey spatial and tabular data. Fifty-eight Ecological Types were organized into 3 ecosystems, 3 physiognomic groups, and 12 vegetation series.

[http://www.fs.fed.us/rm/pubs/rmrs\\_gtr345.html](http://www.fs.fed.us/rm/pubs/rmrs_gtr345.html)

## Journals and Other Publications

### Air, water, and aquatic environments

#### **Cold-water fishes and climate change in North America.**

Williams, J.E.; Isaak, D.J.; Imhof, J.; Hendrickson, D.A.; McMillan, J.R. 2015. In: Reference module in earth systems and environmental sciences. Elsevier. doi:10.1016/B978-0-12-409548-9.09505-1. <http://www.treesearch.fs.fed.us/pubs/50140>.

**The dual challenges of generality and specificity when developing environmental DNA markers for species and subspecies of *Oncorhynchus*.** Wilcox, Taylor M.; Carim, Kellie J.; McKelvey, Kevin S.; Young, Michael K.; Schwartz, Michael K. 2015. PLOS ONE. doi:10.1371/journal.pone.0142008. <http://www.treesearch.fs.fed.us/pubs/50103>.

**Ecosystem resistance in the face of climate change: A case study from the freshwater marshes of the Florida Everglades.** Malone, Sparkle L.; Keough, Cynthia; Staudhammer, Christina L.; Ryan, Michael G.; Parton, William J.; Olivas, Paulo; Oberbauer, Steven F.; Schedlbauer, Jessica; Starr, Gregory. 2015. *Ecosphere*. 6(4); Article 57.

**El Niño Southern Oscillation (ENSO) enhances CO<sub>2</sub> exchange rates in freshwater marsh ecosystems in the Florida Everglades.** Malone, Sparkle L.; Staudhammer, Christina L.; Oberbauer, Steven F.; Olivas, Paulop Ryan, Michael G.; Schedlbauer, Jessica L.; Loescher, Henry W.; Starr, Gregory. 2014. *PLoS ONE*. 9(12): e115058. doi:10.1371/journal.pone.0115058.

## Journals and Other Publications

**Global variability in leaf respiration in relation to climate, plant functional types and leaf traits.** Atkin, Owen K.; Bloomfield, Keith J.; . . . Ryan, Michael G.; et al. 2015. *New Phytologist*. 206: 614–636.

**Habitat connectivity as a metric for aquatic microhabitat quality: Application to Chinook salmon spawning habitat.** Carnie, Ryan; Tonina, Daniele; McKean, Jim; Isaak, Daniel. 2015. *Ecohydrology*. doi: 10.1002/eco.1696. <http://www.treesearch.fs.fed.us/pubs/50139>.

**Understanding environmental DNA detection probabilities: A case study using a stream-dwelling char *Salvelinus fontinalis*.** Wilcox, Taylor M.; McKelvey, Kevin S.; Young, Michael K.; Sepulveda, Adam J.; Shepard, Bradley B.; Jane, Stephen F.; Whiteley, Andrew R.; Lowe, Winsor H.; Schwartz, Michael K. 2016. *Biological Conservation*. 194: 209–216. <http://www.treesearch.fs.fed.us/pubs/50105>.

### Fire, fuel, and smoke

**Climate and human influences on historical fire regimes (AD 1400–1900) in the eastern Great Basin (USA).** Kitchen, Stanley G. 2015. *The Holocene*. doi: 10.1177/0959683615609751. <http://www.treesearch.fs.fed.us/pubs/50112>.

**Identification of two distinct fire regimes in Southern California: Implications for economic impact and future change.** Jin, Yufang; Goulden, Michael L.; Faivre, Nicolas; Veraverbeke, Sander; Sun, Fengpeng; Hall, Alex; Hand, Michael S.; Hook, Simon; Randerson, James T. 2015. *Environmental Research Letters*. 10: 094005. <http://www.treesearch.fs.fed.us/pubs/50302>.

**Measuring wildland fire leadership: The crewmember perceived leadership scale.** Waldron, Alexis L.; Schar, David P.; Cardinal, Bradley J. 2015. *International Journal of Wildland Fire*. 24: 1168–1175. <http://dx.doi.org/10.1071/WF15077>.

**Modeling fuel treatment impacts on fire suppression cost savings: A review.** Thompson, Matthew P.; Anderson, Nathaniel M. 2015. *California Agriculture*. 69(3): 164–170. <http://www.treesearch.fs.fed.us/pubs/49956>.

**Quantifying social preferences toward woody biomass energy generation in Montana, USA.** Campbell, Robert; Venn, Tyron; Anderson, Nathaniel. 2015. Selected Paper prepared for presentation at the 2015 Agricultural and Applied Economics Association and Western Agricultural Economics Association Annual Meeting; San Francisco, CA; July 26–28. 19 p. <http://www.treesearch.fs.fed.us/pubs/49955>.

**Risk preferences, probability weighting, and strategy tradeoffs in wildfire management.** Hand, Michael S.; Wibbenmeyer, Matthew J.; Calkin, David E.; Thompson, Matthew P. 2015. *Risk Analysis*. 35(10): 1876–1891. <http://www.treesearch.fs.fed.us/pubs/50301>.

**Wildfires: Systemic changes required.** Thompson, Matthew; Dunn, Christopher; Calkin, Dave. 2015. *Science*. 350(6263): 920.

**Wildland fire deficit and surplus in the western United States, 1984–2012.** Parks, Sean A.; Miller, Carol; Parisien, Marc-Andre; Holsinger, Lisa M.; Dobrowski, Solomon Z.; Abatzoglou, John. 2015. *Ecosphere*. 6(12): Article 275. <http://www.treesearch.fs.fed.us/pubs/49942>.

**Wildland fire limits subsequent fire occurrence.** Parks, Sean A.; Miller, Carol; Holsinger, Lisa M.; Baggett, L. Scott; Bird, Benjamin J. 2015. *International Journal of Wildland Fire*. <http://dx.doi.org/10.1071/WF15107>. <http://www.treesearch.fs.fed.us/pubs/49950>.

### Forest and woodland ecosystems

**Burgeoning biomass: Creating efficient and sustainable forest biomass supply chains in the Rockies, Part II.** Miller, Sue; Essen, Maureen; Anderson, Nathaniel; Page-Dumroese, Deborah; McCollum, Dan; Bergman, Rick; Elder, Tom. 2015. *Science You Can Use Bulletin*, Issue 17. Fort Collins,

## Journals and Other Publications

CO: Rocky Mountain Research Station. 10 p. <http://www.treesearch.fs.fed.us/pubs/50111>,

**Carbohydrate regulator of photosynthesis and respiration from branch girdling in four species of wet tropical rain forest trees.** Asao, Shinichi; Ryan, Michael G. 2015. *Tree Physiology*. 35: 608–620.

**Carbon dynamics in central US Rockies lodgepole pine type after mountain pine beetle outbreaks.** Hansen, E. Matthew; Amacher, Michael C.; Van Miegroet, Helga; Long, James N.; Ryan, Michael G. 2015. *Forest Science*. 61(4): 665–679.

**Considerations for restoring temperate forests of tomorrow: Forest restoration, assisted migration, and bioengineering.** Dumroese, R. Kasten; Williams, Mary I.; Stanturf, John; St. Clair, J. Bradley. 2015. *New Forests*. 46: 947–964. <http://www.treesearch.fs.fed.us/pubs/49112>.

**Environmental drivers of deadwood dynamics in woodlands and forests.** Garbarino, M.; Marzano, R.; Shaw, J.D.; Long, J.N. 2015. *Ecosphere*. 6(3): Article 30. <http://www.treesearch.fs.fed.us/pubs/49951>.

**Growing container seedlings: Three considerations.** Dumroese, R. Kasten; Landis, Thomas D. 2015. *Tree Planters' Notes*. 58(2): 58–62. <http://www.treesearch.fs.fed.us/pubs/49947>.

**Non-structural carbohydrates in woody plants compared among laboratories.** Quentin, A.G.; Pinkard, E.A.; Ryan, M.C.; et al. 2015. *Tree Physiology*. 35: 1146–1165.

**Tree mortality: Large trees losing out to drought.** Ryan, Michael G. 2015. *Nature Plants*. 1: Article 15150. doi:10.1038/nplants.2015.150.

### Grasslands, shrublands, and desert ecosystems

**Estimating herbaceous biomass of grassland vegetation using the reference unit method.** Boyda, Eric D.; Butler, Jack L.; Xu, Lan. 2015. *The Prairie Naturalist*. 47: 73–83. <http://www.treesearch.fs.fed.us/pubs/50251>.

**Evolutionary drivers of mast-seeding in a long-lived desert shrub.** Meyer, Susan E.; Pendleton, Burton K. 2015. *American Journal of Botany*. 102(10): 1–10. <http://www.treesearch.fs.fed.us/pubs/50255>.

**Genetic and environmental effects on seed weight in subspecies of big sagebrush: Applications for restoration.** Richardson, Bryce A.; Ortiz, Hector G.; Carlson, Stephanie L.; Jaeger, Deidre M.; Shaw, Nancy L. 2015. *Ecosphere*. 6: Article 201. <http://www.treesearch.fs.fed.us/pubs/49923>.

**Landscape-scale patterns of fire and drought on the High Plains, USA.** Ford, Paulette; Jackson, Charles; Reeves, Matthew; Bird, Benjamin; Turner, Dave. 2015. In: Sustainable use of grassland resources for forage production, biodiversity and environmental protection; proceedings, XXIII International Grassland Congress; 2015 November 20–24; New Delhi, India. <http://www.treesearch.fs.fed.us/pubs/50252>.

**Mechanisms for maintenance of dominance in a non-clonal desert shrub.** Kitchen, Stanley G.; Meyer, Susan E.; Carlson, Stephanie L. 2015. *Ecosphere*. 6(12): Article 252. <http://www.treesearch.fs.fed.us/pubs/50113>.

**Seeding big sagebrush successfully on Intermountain rangelands.** Meyer, Susan E.; Warren, Thomas W. 2015. Great Basin Factsheet Series Number 10. Sage Grouse Initiative. 5 p. <http://www.treesearch.fs.fed.us/pubs/50107>.

### Human dimensions

**Examining alternative fuel management strategies and the relative contribution of National Forest System land**



## Journals and Other Publications

**to wildfire risk to adjacent homes—A pilot assessment on the Sierra National Forest, California, USA.** Scott, Joe H.; Thompson, Matthew P.; Gilbertson-Day, Julie W. 2015. *Forest Ecology and Management*. 362: 29–37.

**Southern Plains assessment of vulnerability and preliminary adaptation and mitigation strategies for farmers, ranchers, and forest land owners.** Steiner, Jean L.; Schneider, Jeanne M.; Pope, Clay; Pope, Sarah; Ford, Paulette; Steele, Rachel F.; Anderson, Terry. 2015. El Reno, OK: U.S. Department of Agriculture, Southern Plains Climate Hub, ARS Grazinglands Research Laboratory. 61 p. <http://www.treesearch.fs.fed.us/pubs/50256>.

### Inventory and monitoring

**Estimating FIA plot characteristics using NAIP imagery, function modeling, and the RMRS Raster Utility coding library.** Hogland, John S.; Anderson, Nathaniel M. 2015. In: Stanton, Sharon M.; Christensen, Glenn A., eds. *Pushing boundaries: New directions in inventory techniques and applications: Forest Inventory and Analysis (FIA) symposium 2015*. Gen. Tech. Rep. PNW-GTR-931. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 340–344. <http://www.treesearch.fs.fed.us/pubs/50147>.

**Representative regional models of post-disturbance forest carbon accumulation: Integrating inventory data and a growth and yield model.** Raymond, Crystal L.; Healey, Sean P.; Peduzzi, Alicia; Patterson, Paul L. 2015. *Forest Ecology and Management*. 336: 21–34. <http://www.treesearch.fs.fed.us/pubs/50110>.

### Science application and integration

**Evolution of marginal populations of an invasive vine increases the likelihood of future spread.** Kilkenny, Francis F.; Galloway, Laura F. 2015. *New Phytologist*. doi: 10.1111/nph.13702. <http://www.treesearch.fs.fed.us/pubs/50146>.

**Global view of remote sensing of rangelands: Evolution, applications, future pathways [Chapter 10].** Reeves, Matthew C.; Washington-Allen, Robert A.; Angerer, Jay; Hunt, E. Raymond, Jr.; Kulawardhana, Ranjani Wasantha; Kumar, Lalit; Loboda, Tatiana; Loveland, Thomas; Metternicht, Graciela; Ramsey, R. Douglas. 2015. In: *Land resources monitoring, modeling, and mapping with remote sensing*. Boca Raton, FL: CRC Press/Taylor and Francis Group: 237–276.

**Impact of surface coal mining on soil hydraulic properties.** Liu, X.; Wu, J.Q.; Conrad, P.W.; Dun, S.; Todd, C.S.; McNearny, R.L.; Elliot, W.J.; Rhee, H.; Clark, P. 2015. In: *Society for Mining, Metallurgy & Exploration*. 338: Paper TP-12-036.

**LiDAR based prediction of forest biomass using hierarchical models with spatially varying coefficients.** Babcock, Chad; Finley, Andrew O.; Bradford, John B.; Kolka, Randall; Birdsey, Richard; Ryan, Michael G. 2015. *Remote Sensing of Environment*. 169: 113–127. <http://www.treesearch.fs.fed.us/pubs/49754>.

**Predicting relative species composition within mixed conifer forest pixels using zero-inflated models and Landsat imagery.** Savage, Shannon L.; Lawrence, Rick L.; Squires, John R. 2015. *Remote Sensing of Environment*. 171: 326–336. <http://www.treesearch.fs.fed.us/pubs/49953>.

**Remote sensing of rangeland biodiversity [Chapter 11].** Hunt, E. Raymond, Jr.; Wang, Cuizhen; Booth, D. Terrance; Cox, Samuel E.; Kumar, Lalit; Reeves, Matthew C. 2015. In: *Land resources monitoring, modeling, and mapping with remote sensing*. Boca Raton, FL: CRC Press/Taylor and Francis Group: 277–308.

**Response of conifer species from three latitudinal populations of light spectra generated by light-emitting diodes and high-pressure sodium lamps.** Apostol, Kent G.; Dumroes, R. Kasten; Pinto, Jeremiah R.; Davis, Anthony S. 2015. *Canadian Journal of Forest Research*. 45: 1711–1719. <http://www.treesearch.fs.fed.us/pubs/49946>.

## Journals and Other Publications

**The role of remote sensing in process-scaling studies of managed forest ecosystems.** Masek, Jeffrey G.; Hayes, Daniel J.; Hughes, M. Joseph; Healey, Sean P.; Turner, David P. 2015. *Forest Ecology and Management*. 355: 109–123. <http://www.treesearch.fs.fed.us/pubs/50109>.

**Using LiDAR to evaluate forest landscape and health factors and their relationship to habitat of the endangered Mount Graham red squirrel on the Coronado National Forest, Pinaleno Mountains, Arizona.** Anhold, John; Mitchell, Brent; Wilcox, Craig; Mellin, Tom; Merrick, Melissa; Lynch, Ann; Waltermann, Mike; Falk, Donald; Koprowski, John; Laes, Denise; Evans, Don; Fisk, Haans; 2015. In: Potter, K.M.; Conkling, B.L., eds. *Forest health monitoring: National status, trends, and analysis 2014*. Gen. Tech. Rep. SRS-209. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 133–142. <http://www.treesearch.fs.fed.us/pubs/49266>.

### Wildlife and terrestrial habitats

**Conserving and restoring habitat for Greater Sage-Grouse and other sagebrush-obligate wildlife: The crucial link of forbs and sagebrush diversity.** Dumroese, Kas; Luna, Tara; Richardson, Bryce A.; Kilkenny, Francis F.; Runyon, Justin B. 2015. *Native Plants Journal*. 16(3): 276–299. <http://www.treesearch.fs.fed.us/pubs/50143>.

**Elk resource selection at parturition sites, Black Hills, South Dakota.** Lehman, Chadwick P.; Rumble, Mark A.; Rota, Christopher T.; Bird, Benjamin J.; Fogarty, Dillon T.; Millsbaugh, Joshua J. 2015. *Journal of Wildlife Management*. doi: 10.1002/jwmg.1017. <http://www.treesearch.fs.fed.us/pubs/50254>.

**Implications of climate change for bird conservation in the southwestern U.S.** Friggens, Megan M.; Finch, Deborah M. 2015. *PLoS ONE*. 10(12): e0144089. <http://www.treesearch.fs.fed.us/pubs/50101>.

**Microhabitat selection of brood-rearing sites by greater sage-grouse in Carbon County, Wyoming.** Schreiber, Leslie A.; Hansen, Christopher P.; Rumble, Mark A.; Millsbaugh, Joshua J.; Gamo, R. Scott; Kehmeier, Jon W.; Wojcik, Nate. 2015. *Western North American Naturalist*. 75(3): 348–363. <http://www.treesearch.fs.fed.us/pubs/50108>.

**A multi-scale assessment of population connectivity in African lions (*Panthera leo*) in response to landscape change.** Cushman, Samuel A.; Elliot, Nicholas B.; Macdonald, David W.; Loveridge, Andrew J. 2015. *Landscape Ecology*. doi: 10.1007/s10980-015-0292-3. <http://www.treesearch.fs.fed.us/pubs/49732>.

**An eDNA assay for river otter detection: A tool for surveying a semi-aquatic mammal.** Padgett-Stewart, Ticha M.; Wilcox, Taylor M.; Carim, Kellie J.; McKelvey, Kevin S.; Young, Michael K.; Schwartz, Michael K. 2015. *Conservation Genetics Resources*. doi: 10.1007/s12686-015-0511-x. <http://www.treesearch.fs.fed.us/pubs/50102>.

**Nesting pair density and abundance of ferruginous hawks (*Buteo regalis*) and golden eagles (*Aquila chrysaetos*) from aerial surveys in Wyoming.** Olson, Lucretia E.; Oakleaf, Robert J.; Squires, John R.; Wallace, Zachary P.; Kennedy, Patricia L. 2015. *Journal of Raptor Research*. 49(4): 400–412. <http://www.treesearch.fs.fed.us/pubs/49952>.

**Woodpecker forage availability in habitat disturbances of the Black Hills.** Dickerson, Brian E.; Ambourn, Angie K.; Rumble, Mark A.; Allen, Kurt K.; Lehman, Chad P. 2015. *The Prairie Naturalist*. 47: 110–114. <http://www.treesearch.fs.fed.us/pubs/50299>.



## Science Program Areas

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### Air, Water and Aquatic Environments

Air quality, water availability, water quality, and aquatic habitats are critical issues within the rapidly changing Western United States. The Air, Water and Aquatic Environments program is committed to the development of knowledge and science applications related to air and water quality, as well as the habitat quality, distribution, diversity, and persistence of fish and other aquatic species. Website: [http://www.fs.fed.us/rm/boise/awae\\_home.shtml](http://www.fs.fed.us/rm/boise/awae_home.shtml). Contact Frank McCormick, Program Manager, for more information: 208-373-4351.

### Aldo Leopold Wilderness Research Institute

The Aldo Leopold Wilderness Research Institute aims to provide scientific leadership by bringing diverse groups of scientists and managers together to develop and use the knowledge needed to assure wilderness ecosystems and values endure for generations to come. Website: <http://leopold.wilderness.net>. Contact Susan Fox, Program Director, for more information: 406-542-4193.

### Fire, Fuel and Smoke

The Fire, Fuel and Smoke program works to improve the safety and effectiveness of fire management through the creation and dissemination of basic fire science knowledge. The program investigates the impacts of fires on the environment by means of fundamental and applied research for understanding and predicting fire behavior, its effects on ecosystems, and its emissions into the atmosphere. Website: <http://www.firelab.org>. Contact Bret Butler, Acting Program Manager, for more information: 406-329-4801.

### Forest and Woodland Ecosystems

Forests and woodlands are increasingly being impacted by large scale urbanization and human developments, uncharacteristically large and severe wildfires, insect and disease outbreaks, exotic species invasions, and drought, and interactions of multiple stressors at local, landscape, and regional scales. The Forest and Woodland Ecosystems program acquires, develops, and delivers the scientific knowledge for sustaining and restoring forests and woodlands landscape health, biodiversity, productivity, and ecosystem processes. Website: <http://www.fs.fed.us/rmrs/research/programs/forest-woodlands-ecosystem/>. Contact Alison Hill, Program Manager, for more information: 928-556-2105.

### Grassland, Shrubland and Desert Ecosystems

Disruptions by large-scale clearing for agriculture, water diversions, extensive grazing, changes in the native fauna, the advent of alien weeds, altered fire regimes, and

increases in human-caused insect and disease epidemics have contributed to produce areas that are in unsuitable condition. The Grassland, Shrubland and Desert Ecosystems program addresses the biology, use, management, and restoration of these grass and shrublands. Website: <http://www.fs.fed.us/rmrs/research/programs/grassland-shrubland-desert/>. Contact Debbie Finch, Program Manager, for more information: 505-724-3671.

### Human Dimensions

The Human Dimensions program provides social and economic science based innovation to human societies as they develop a sustainable relationship with their environment. Major issues confronting societies across the globe such as global climate change, energy, fire, water, and ecosystem services all have important social-economic dimensions that will be explored and addressed by this program. Website: <http://www.fs.fed.us/rmrs/research/programs/social-economics-decision/>. Contact David Chapman, Program Manager, for more information: 970-498-1378.

### Inventory, Monitoring and Analysis

The Inventory, Monitoring and Analysis program provides the resource data, analysis, and tools needed to effectively identify current status and trends, management options and impacts, and threats and impacts of fire, insects, disease, and other natural processes. Website: <http://www.fs.fed.us/rm/ogden/>. Contact Michael Wilson, Program Manager, for more information: 801-625-5407.

### Science Application and Integration

The Science Application and Integration program is a knowledge transfer unit that provides leadership for the integration and use of scientific information in natural resource planning and management across the Interior West. Website: <http://www.fs.fed.us/rm/science-application-integration/>. Contact Jan Engert, Assistant Station Director, for more information: 970-498-1377.

### Wildlife and Terrestrial Ecosystems

The Wildlife and Terrestrial Ecosystems program is engaged in sustaining species and ecosystems of concern through studies of ecological interactions within and between plant, aquatic, and terrestrial animal communities; understanding public use effects through studies elucidating social and economic values associated with consumptive and non-consumptive uses of fish and wildlife; managing terrestrial and aquatic habitats; and evaluating outcomes of land and water uses and natural disturbances. Website: <http://www.rmrs.nau.edu/wildlife/>. Contact William Block, Program Manager, for more information: 928-556-2161.

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