



Rocky Mountain Research Station

New Publications

July-September 2019

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The Rocky Mountain Research Station

The Rocky Mountain Research Station is one of seven regional units that make up the U.S. Forest Service Research and Development organization.



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 percent of the nation's National Forest System lands (54 national forests and grasslands). In the lower 48 States, our territory also includes 55 percent of the nation's Bureau of Land Management lands; 48 percent of the designated wildernesses; 37 percent of National Park Service lands; numerous other public and tribal lands; and 41 percent 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

The Rio Grande National Forest Climate Change Plan Revision Workshop: Designing a science management collaborative process to address 2012 planning rule climate change concerns at the forest plan scale

Online only

The Rio Grande National Forest Climate Change Plan Revision Workshop: Designing a science management collaborative process to address 2012 planning rule climate change concerns at the Forest plan scale. Roske, Molly R.; Joyce, Linda A.; Nagel, Linda M.; Peterson, Lara K.; Peterson, Courtney L.; Matonis, Megan. 2019. Res. Note RMRS-RN-84. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 17 p.

Scientists and managers initiated a collaborative process to assist the Rio Grande National Forest (RGNF) with bringing climate change information into its Forest Planning Process. The first objective of the collaborative, 2-day workshop was to present and discuss in a workshop format the salient climate change science for the RGNF landscape, in terms of projections, impacts, and vulnerabilities. The second objective was to facilitate a planning process that would stimulate ideas regarding aspects of current and proposed management that may need modification in light of stressors related to climate change. We used an adaptation decisionmaking framework to structure the workshop. All parties deemed the workshop a success, leading to lessons learned and minimum conditions for replicating similar efforts to effectively meet the 2012 planning rule criteria.

<https://www.fs.usda.gov/treearch/pubs/58370>

Experiments on wildfire ignition by exploding targets

Print copies available soon

Experiments on wildfire ignition by exploding targets. Finney, Mark A.; Smith, C. Todd; Maynard, Trevor B. 2019. Res. Pap. RMRS-RP-108. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 29 p.

Tests were conducted using 97 exploding targets (ammonium nitrate and aluminum powder) to examine the effects of product formulation, environment, and shooting on wildfire ignition. Tests in 2015 produced no ignitions in cold and humid weather conditions. Ignitions in 2018 under warm and dry conditions were positively related to the aluminum concentration (expressed as a percentage of the ammonium nitrate mass) and the placement of the target on a straw fuel bed rather than on a 6 in (15 cm) high steel pedestal. High speed videography and peak overpressure measured for each explosion suggested that differences in explosive characteristics were also related to other experimentally controlled variables and could help explain how wildfire ignition results from elements of product usage.

<https://www.fs.usda.gov/treearch/pubs/58708>

Journals and Other Publications

Online links are provided if available. For the general public, some links may hit a pay wall. Please accept our apologies for any inconvenience.

Air, water and aquatic environments

Coupling wildfire spread and erosion models to quantify post-fire erosion before and after fuel treatments. Salis, Michele; Del Giudice, Liliana; Robichaud, Peter R.; Ager [et al.] 2019. International Journal of Wildland Fire. doi: 10.1071/WF19034. <https://www.fs.usda.gov/treearch/pubs/58627>

Effectiveness of straw bale check dams at reducing post-fire sediment yields from steep ephemeral channels. Robichaud, Peter R.; Storrar, Keenan A.; Wagenbrenner, Joseph W. 2019. Science of the Total Environment. 676: 721-731. <https://www.fs.usda.gov/treearch/pubs/58626>

Formation of post-fire water repellent layers on *Nothofagus glauca* (Hualo) forests, after the historical “Las Máquinas” wildfire in south-central Chile. Garcia-Chevesich, Pablo A.; Martinez, Eduardo; Garcia, Alejandro; Castillo, Miguel; Garfias, Roberto; Neary, Daniel; Pizarro, Roberto; Valdes, Rodrigo; Gonzalez, Luis; Venegas-Quinones, Hector L.; Magni, Carlos. 2019. American Journal of Environmental Sciences. DOI: 10.3844/ajessp.201. <https://www.fs.usda.gov/treearch/pubs/58222>

Temperature sensitivity of microbial Fe(III) reduction kinetics in subalpine wetland soils. Schilling, Kathrin; Borch, Thomas; Rhoades, Charles C.; Pallud, Celine E. 2019. Biogeochemistry. 142: 19-35. <https://www.fs.usda.gov/treearch/pubs/58607>

Unmanned aerial vehicle-based rangeland monitoring: Examining a century of vegetation changes. Sankey, Temuulen Ts.; Leonard, Jackson M.; Moore, Margaret M. 2019. Rangeland Ecology and Management. 72: 858-863. <https://www.fs.usda.gov/treearch/pubs/58556>

Wildfires alter forest watersheds and threaten drinking water quality. Hohner, Amanda K.; Rhoades, Charles C.; Wilkerson, Paul; Rosario-Ortiz, Fernando L. 2019. Accounts of Chemical Research. 52: 1234-1244. <https://www.fs.usda.gov/treearch/pubs/58606>

Fire, fuel and smoke

***Artemisia tridentata* subsp. *wyomingensis*.** Innes, Robin J. 2019. Wyoming big sagebrush. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky

Mountain Research Station, Missoula Fire Sciences Laboratory (Producer). Available: <https://www.fs.usda.gov/treearch/pubs/58809>

Climate, environment, and disturbance history govern resilience of Western North American forests. Hessburg, Paul F.; Miller, Carol L.; Parks, Sean A.; Povak, Nicholas A.; Taylor, Alan A.; Battaglia, Mike A. [et al.] 2019. Frontiers in Ecology and Evolution. 7: 11770. <https://doi.org/10.3389/fevo.2019.00239> <https://www.fs.usda.gov/treearch/pubs/58415>

Social vulnerability to large wildfires in the western USA. Palaiologou, Palaiologos; Ager, Alan A.; Nielsen-Pincus, Max; Evers, Cody R.; Day, Michelle A. 2019. Landscape and Urban Planning. 189: 99-116. <https://www.fs.usda.gov/treearch/pubs/58283>

Forest and woodland ecosystems

The 21st Century silviculturist. Jain, Theresa Beneavidez. 2019. The 21st Century silviculturist. Journal of Forestry. 2019: 417-424. <https://www.fs.usda.gov/treearch/pubs/58281>

An approach for modeling and quantifying traffic-induced processes and changes in forest road aggregate particle-size distributions. Rhee, Hakjun; Fridley, James; Chung, Woodam; Page-Dumroese, Deborah. 2019. Forests. 10: 769. <https://www.fs.usda.gov/treearch/pubs/58624>

A column canopy-air turbulent diffusion method for different canopy structures. Chen, Xuelong; Massman, William J.; Su, Zhongbo. 2019. Journal of Geophysical Research: Atmospheres. 124: 488-506. <https://www.fs.usda.gov/treearch/pubs/58631>

Biological aspects of mountain pine beetle in lodgepole pine stands of different densities in Colorado, USA. Negron, Jose F. 2019. Forests. 10: 18. <https://www.fs.usda.gov/treearch/pubs/58633>

Bayesian analyses of 17 winters of water vapor fluxes show bark beetles reduce sublimation. Frank, John M.; Massman, William J.; Ewers, Brent E.; Williams, David G. 2019. Bayesian analyses of 17 winters of water vapor fluxes show bark beetles reduce sublimation. Water Resources Research. 55: 1598-1623. <https://www.fs.usda.gov/treearch/pubs/58238>

Bedding of wetland soil: Effects of bed height and termite activity on wood decomposition. Jurgensen, Martin F.; Miller, Chris A.;

Journals and Other Publications

Online links are provided if available. For the general public, some links may hit a pay wall. Please accept our apologies for any inconvenience.

- Trettin, Carl T.; Page-Dumroese, Deborah S. 2019. Soil Science Society of America Journal. 83(s1) S218-S227. <https://www.fs.usda.gov/treearch/pubs/58395>
- Correction to: A case study comparison of LANDFIRE fuel loading and emissions generation on a mixed conifer forest in Northern Idaho, USA.** Hyde, Josh; Strand, Eva K.; Hudak, Andrew T.; Hamilton, Dale. 2019. Fire Ecology. 15: 23. <https://www.fs.usda.gov/treearch/pubs/58620>
- Does burn severity affect plant community diversity and composition in mixed conifer forests of the United States Intermountain West one decade post fire?** Strand, Eva K.; Satterberg, Kevin L.; Hudak, Andrew T.; Byrne, John; Khalyani, Azad Henareh; Smith, Alistair M. S. 2019. Fire Ecology. 15: 25. <https://www.fs.usda.gov/treearch/pubs/58622>
- Growth and needle properties of young *Pinus koraiensis* Sieb. et Zucc. trees across an elevational gradient.** Fan, Ying; Moser, W. Keith; Cheng, Yanxia. 2019. Forests. 10: 54. <https://www.fs.usda.gov/treearch/pubs/58634>
- Initiating climate adaptation in a western larch forest.** Crotteau, Justin S.; Sutherland, Elaine Kennedy; Jain, Theresa B; Wright, David K; Jenkins, Melissa M; Keyes, Christopher R; Nagel, Linda M. 2019. Forest Science. 65(4): 528-536. <https://www.fs.usda.gov/treearch/pubs/58632>
- Insects visiting drippy blight diseased red oak leaves are contaminated with the pathogenic bacterium *Lonsdalea quercina*.** Sitz, Rachael A.; Aquino, M. Vincent; Tisserat, A. Ned; Cranshaw, S. Whitney; Stewart, Jane E. 2019. Plant Disease. doi: 10.1094/PDIS-12-18-2248-RE. <https://www.fs.usda.gov/treearch/pubs/58286>
- Interspecific effects between overstorey and regeneration in small-scale mixtures of three late-successional species in the Western Carpathians (southern Poland).** Paluch, J.; Bartkowiec, L.; Moser, W. Keith. 2019 European Journal of Forest Research. doi: 10.1007/s10342-019-01209-y. <https://www.fs.usda.gov/treearch/pubs/58635>
- Long-term vegetation response following post-fire straw mulching.** Bontrager, Jonathan D.; Morgan, Penelope; Hudak, Andrew T.; Robichaud, Peter R. 2019. Fire Ecology. 15: 22. <https://www.fs.usda.gov/treearch/pubs/58619>
- Tracing the footprints of a moving hybrid zone under a demographic history of speciation with gene flow.** Menon, Mitra; Landguth, Erin; Leal-Saenz, Alejandro; Bagley, Justin C.; Schoettle, Anna W.; Wehenkel, Christian; Flores-Renteria, Lluvia; Cushman, Samuel A.; Waring, Kristen M.; Eckert, Andrew J. 2019. Evolutionary Application. 2019: 1-15. <https://www.fs.usda.gov/treearch/pubs/58628>
- Restoration thinning impacts surface and belowground wood decomposition.** Wang, Weiwei; Page-Dumroese, Deborah; Jurgensen, Martin; Miller, Chris; Walitalo, Joanna; Chen, Xiao; Liu, Yong. 2019. Forest Ecology and Management. 449: 117451. <https://www.fs.usda.gov/treearch/pubs/58625>
- Grasslands, shrublands and desert ecosystems**
- Aerobiology and passive restoration of biological soil crusts.** Warren, Steven D.; St. Clair, Larry L.; Leavitt, Steven D. 2019. Aerobiologia. 35(1): 45-56. <https://www.fs.usda.gov/treearch/pubs/57423>
- Application of UAV-based methodology for census of an endangered plant species in a fragile habitat.** Rominger, Kody; Meyer, Susan E. 2019. Remote Sensing. 11: 719. <https://www.fs.usda.gov/treearch/pubs/58137>
- Defining the historical northeastern forested boundary of the Great Plains Grasslands in the United States.** Hanberry, Brice B. 2019. The Professional Geographer. doi: 10.1080/00330124.2019.1611460. <https://www.fs.usda.gov/treearch/pubs/58630>
- Does white-tailed deer density affect tree stocking in forests of the eastern United States?** Hanberry, Brice B.; Abrams, Marc D. 2019. Ecological Processes. 8: 30. <https://www.fs.usda.gov/treearch/pubs/58417>
- The ecology and significance of below-ground bud banks in plants.** Ott, Jacqueline P.; Klimesova, Jitka; Hartnett, David C. 2019. Annals of Botany. 123: 1099-1118. <https://www.fs.usda.gov/treearch/pubs/58240>
- Field demonstration of a semiochemical treatment that enhances *Diorhabda carinulata* biological control of *Tamarix* spp.** Gaffke, Alexander M.; Sing, Sharlene E.; Dudley, Tom L.; Bean, Daniel W.; Rusak, Justin A.; Mafra-Neto, Agenor; Peterson, Robert K. D.; Weaver, David K. 2019. Scientific Reports. 9: 13051. <https://www.fs.usda.gov/treearch/pubs/58603>
- Freezing resistance, safety margins, and survival vary among big sagebrush populations across the western United States.** Lazarus, Brynne E.; Germino, Matthew J.; Richardson, Bryce A. 2019. American Journal of Botany. 106(7): 922-934. <https://www.fs.usda.gov/treearch/pubs/58610>

Journals and Other Publications

Online links are provided if available. For the general public, some links may hit a pay wall. Please accept our apologies for any inconvenience.

- Landscape and organismal factors affecting sagebrush-seedling transplant survival after megafire restoration.** Davidson, Bill E.; Germino, J. Matthew; Richardson, Bryce; Barnard, David M. 2019. *Restoration Ecology*. doi: 10.1111/rec.12940. <https://www.fs.usda.gov/treearch/pubs/58285>
- Nondestructive age estimation of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) using morphological characteristics.** Landeen, Melissa L.; Kitchen, Stanley G.; Allphin, Loreen; Petersen, Steven L. 2019. *Rangeland Ecology and Management*. 72: 515-522. <https://www.fs.usda.gov/treearch/pubs/58609>
- Operationalizing ecological resilience concepts for managing species and ecosystems at risk.** Chambers, Jeanne C.; Allen, Craig R.; Cushman, Samuel A. 2019. *Frontiers in Ecology and Evolution*. 7: 241. <https://www.fs.usda.gov/treearch/pubs/58418>
- Plasticity in native perennial grass populations: Implications for restoration.** Espeland, Erin K.; Johnson, Richard C.; Horning, Matthew E. 2018. *Implications for restoration. Evolutionary Applications*. 11: 340-349. <https://www.fs.usda.gov/treearch/pubs/58623>
- Random forests for classification in ecology.** Cutler, D. Richard; Edwards, Thomas C.; Beard, Karin H.; Cutler, Adele; Hess, Kyle T.; Gibson, Jacob; Lawler, Joshua J. 2007. *Ecology*. 88(11): 2783-2792. <https://www.fs.usda.gov/treearch/pubs/58548>
- Recent shifts in shade tolerance and disturbance traits in forests of the eastern United States.** Hanberry, Brice B. 2019. *Ecological Processes*. 8: 32. <https://www.fs.usda.gov/treearch/pubs/58416>
- Seasonal flooding affects habitat and landscape dynamics of a gravel-bed river floodplain.** Driscoll, Katelyn P.; Hauer, F. Richard. 2019. *Freshwater Science*. 38(3). <https://www.fs.usda.gov/treearch/pubs/58629>
- Shrub facilitation of tree establishment varies with ontogenetic stage across environmental gradients.** Urza, Alexandra K.; Weisberg, Peter J.; Chambers, Jeanne C.; Sullivan, Benjamin W. 2019. *New Phytologist*. 223: 1795-1808. <https://www.fs.usda.gov/treearch/pubs/58280>
- Simulating groundcover community assembly in a frequently burned ecosystem using a simple neutral model.** Loudermilk, E. Louise; Dyer, Lee; Pokswinski, Scott; Hudak, Andrew T.; Hornsby, Benjamin; Richards, Lora; Dell, Jane; Goodrick, Scott L.; Hiers, J. Kevin; O'Brien, Joseph J. 2019. *Frontiers in Plant Science*. 10: 1107. <https://www.fs.usda.gov/treearch/pubs/58621>
- Using invaded-range species distribution modeling to estimate the potential distribution of *Linaria* species and their hybrids in the U.S. northern Rockies.** McCartney, Kevin R.; Kumar, Sunil; Sing, Sharlene E.; Ward, Sarah M. 2019. *Invasive Plant Science and Management*. 12: 97-111. <https://www.fs.usda.gov/treearch/pubs/58612>
- Use of native and nonnative nest plants by riparian-nesting birds along two streams in New Mexico.** Smith, D. M.; Finch, D. M. 2014. *River Research and Applications*. 30: 1134-1145. <https://www.fs.usda.gov/treearch/pubs/58284>
- Validation of the unit stream power erosion and deposition (USPED) model at Yakima Training Center, Washington.** Warren, Steven D.; Ruzycki, Thomas S.; Vaughan, Robert; Nissen, Peter E. 2019. *Northwest Science*. 92(5): 338-345. <https://www.fs.usda.gov/treearch/pubs/58614>

Human dimensions

- Clustering and ensembling approaches to support surrogatebased species management.** Sofaer, Helen R.; Flather, Curtis H.; Skagen, Susan K.; Steen, Valerie A.; Noon, Barry R. 2019. *Diversity and Distributions*. 25: 1246-1258. <https://www.fs.usda.gov/treearch/pubs/58451>
- Future changes in fire weather, spring droughts, and false springs across U.S. National Forests and Grasslands.** Martinuzzi, Sebastian; Allstadt, Andrew J.; Pidgeon, Anna M.; Flather, Curtis H.; Jolly, William M.; Radeloff, Volker C. 2019. *Ecological Applications*. 29(5): e01904. <https://www.fs.usda.gov/treearch/pubs/58450>
- Harvesting forest biomass in the US southern Rocky Mountains: Cost and production rates of five ground-based forest operations.** Townsend, Lucas; Dodson, Elizabeth; Anderson, Nathaniel; Worley-Hood, Graham; Goodburn, John. 2019. *International Journal of Forest Engineering* 30(2): 163-172. <https://www.fs.usda.gov/treearch/pubs/58608>
- Phone-call reminders narrow the intention-action gap by increasing follow-through for a residential tree giveaway program.** Hand, Michael S.; Roman, Lara A.; Locke, Dexter Henry; Fich-

Journals and Other Publications

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man, Erica Smith. 2019. Urban Forestry and Urban Greening. 44: 126425. <https://www.fs.usda.gov/treearch/pubs/58453>

Predicting understory vegetation structure in selected western forests of the United States using FIA inventory data. Krebs, Michael A.; Reeves, Matthew C.; Baggett, L. Scott. 2019. Forest Ecology and Management. 448: 509-527. <https://www.fs.usda.gov/treearch/pubs/58282>

Rethinking resilience to wildfire. McWethy, David B.; Schoennagel, Tania; Higuera, Philip E.; Krawchuk, Meg; Harvey, Brian J.; Metcalf, Elizabeth C.; Schultz, Courtney; Miller, Carol; [et al.] 2019. Nature Sustainability. doi: 10.1038/s41893-019-0353-8. <https://www.fs.usda.gov/treearch/pubs/58436>

Spatial and temporal assessment of responder exposure to snag hazards in post-fire environments. Dunn, Christopher J.; O'Connor, Christopher D.; Reilly, Matthew J.; Calkin, Dave E.; Thompson, Matthew P. 2019. Spatial and temporal assessment of responder exposure to snag hazards in post-fire environments. Forest Ecology and Management. 44: 202-214. <https://www.fs.usda.gov/treearch/pubs/58032>

Using forest inventory data with Landsat 8 imagery to map long-leaf pine forest characteristics in Georgia, USA. Hogland, John; Anderson, Nathaniel; Affleck, David; St. Peter, Joseph. 2019. Remote Sensing. 11: 1803. <https://www.fs.usda.gov/treearch/pubs/58414>

Inventory and Monitoring

Generalized hierarchical model-based estimation for aboveground biomass assessment using GEDI and Landsat data. Saarela, Svetlana; Holm, Soren; Healey, Sean P.; Andersen, Hans-Erik; Petersson, Hans; Prentius, Wilmer; Patterson, Paul L.; Næset, Erik; Gregoire, Timothy G.; Stahl, Goran. 2018. Remote Sensing. 10: 1832. <https://www.fs.usda.gov/treearch/pubs/58615>

The stability of mean wood specific gravity across stand age in US forests despite species turnover. Healey, Sean P.; Menlove, James. 2019. Forests. 10: 114. <https://www.fs.usda.gov/treearch/pubs/58616>

Benefits of the free and open Landsat data policy. Zhu, Zhe; Wulder, Michael A.; Roy, David P.; Woodcock, Curtis E.; Hansen, Matthew C.; Radeloff, Volker C.; Healey, Sean P.; [et al.] 2019. 224: 382-385. <https://www.fs.usda.gov/treearch/pubs/58618>

Quality control and assessment of interpreter consistency of annual land cover reference data in an operational national monitoring program. Pengra, Bruce W.; Stehman, Stephen V.; Horton, Josephine A.; Dockter, Daryn J.; Schroeder, Todd A.; Yang, Zhiqiang; Cohen, Warren B.; Healey, Sean P.; Loveland, Thomas R. 2019. Remote Sensing of Environment. doi: 10.1016/j.rse.2019.111261. <https://www.fs.usda.gov/treearch/pubs/58617>

Stable or seral? Fire-driven alternative states in aspen forests of western North America. Morris, Jesse L.; DeRose, R. Justin; Brussel, Thomas; Brewer, Simon; Brunelle, Andrea; Long, James N. 2019. Stable or seral? Biology Letters. 15(6): 20190011. <https://www.fs.usda.gov/treearch/pubs/58422>

Wilderness research

Climate change likely to reshape vegetation in North America's largest protected areas. Holsinger, Lisa; Parks, Sean A.; Parisien, Marc-Andre; Miller, Carol; Batllori, Enric; Moritz, Max A. 2019. Conservation Science and Practice. doi: 10.1111/csp2.5F0. <https://www.fs.usda.gov/treearch/pubs/58044>

Mitigating the impact of field and image registration errors through spatial aggregation. Hogland, John; Affleck, David L. R. 2019. Remote Sensing. 11: 222. <https://www.fs.usda.gov/treearch/pubs/57922>

Wildlife and terrestrial habitats

Distant neighbors: Recent wildfire patterns of the Madran Sky Islands of southwestern United States and northwestern Mexico. Villarreal, Miguel L.; Haire, Sandra L.; Iniguez, Jose M.; Montano, Citlali Cortes; Poitras, Travis B. 2019. Fire Ecology. 15: 2. <https://www.fs.usda.gov/treearch/pubs/58421>

Factors affecting lifetime reproduction, long-term territory-specific reproduction, and estimation of habitat quality in northern goshawks. Reynolds, Richard T.; Lambert, Jeffrey S.; Kay, Shannon L.; Sanderlin, Jamie S.; Bird, Benjamin J. 2019. PLoS ONE. 14(5): e0215841. <https://www.fs.usda.gov/treearch/pubs/58059>

Journals and Other Publications

Online links are provided if available. For the general public, some links may hit a pay wall. Please accept our apologies for any inconvenience.

Increasing trends in high-severity fire in the southwestern USA from 1984 to 2015. Singleton, Megan P.; Thode, Andrea E.; Meador, Andrew J. Sanchez; Iniguez, Jose M. 2019. Increasing trends in high-severity fire in the southwestern USA from 1984 to 2015. *Forest Ecology and Management*. 433: 709-719
F <https://www.fs.usda.gov/treesearch/pubs/58420>

Tree and opening spatial patterns vary by tree density in two old-growth remnant ponderosa pine forests in Northern Arizona, USA. Iniguez, Jose M.; Fowler, James F.; Moser, W. Keith; Sieg, Carolyn H.; Baggett, L. Scott; Shin, Patrick. 2019. *Forest Ecology and Management*. 450: 117502. <https://www.fs.usda.gov/treesearch/pubs/58419>

Science Program Areas

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/air-water-and-aquatic-environments>. Contact Frank McCormick, Program Manager, for more information: 970-498-1175.

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/aldo-leopold-wilderness-research-institute>. Contact Beth Hahn, Program Director, for more information: 406-542-3244.

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/fire-fuel-and-smoke>. Contact Colin Hardy, Program Manager, for more information: 406-329-4978.

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/forest-and-woodland-ecosystems>. 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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/grassland-shrubland-and-desert-ecosystems>. 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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/human-dimensions>. Contact Lincoln Bramwell, Program Manager, for more information: 970-498-1170.

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/inventory-and-monitoring>. Contact Michael Wilson, Program Manager, for more information: 801-625-5407.

Science Application and Communication

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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/science-application-and-communication>. Contact Jennifer Hayes, 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. Webpage: <https://www.fs.fed.us/rmrs/science-program-areas/wildlife-and-terrestrial-ecosystems>. Contact Michael Schwartz, Program Manager, for more information: 406-542-4161.

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