USDA
United States Department of Agriculture

Rocky Mountain Research Station
Grassland, Shrubland, and Desert Ecosystems Program

GSD Update

April 2018

IN THIS ISSUE

Year in Review: Spotlight on 2017 Research by the Grassland, Shrubland and Desert Ecosystems Science Program

In this issue of the GSD Update, we feature selected studies of the RMRS Grassland, Shrubland and Desert Ecosystems Science Program (GSD) that focus on the theme of fire. Significant results of recent research and science delivery by GSD scientists are highlighted. We feature program research that lines up with the strategic priorities and goals of the USDA Forest Service (USFS). These include improving, restoring and sustaining forest and rangeland condition, serving our customers and engaging with partners through co-production of knowledge and actions, and applying and delivering knowledge globally.

In particular, we spotlight accomplishments in GSD fire-related research and technology that address:

- Effects of fire, including in combination with other stressors such as drought, in western ecosystems
- Knowledge discovery, science applications, seeding methods and tools for restoring post-fire ecosystems
- Knowledge and approaches for improving resiliency and resistance of ecosystems impacted by fire and invasive plants
- Approaches for selecting, growing and deploying native plants with the goal of reducing fire risk

Sunset in Reynolds Creek, ID, as the Soda Fire burns in the Owyhee Mountains. Photo: Hugo Sindelar

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Spring recovery of lupine on a post-fire site in southwestern Idaho.

Photo: Francis Kilkenny RMRS Boise

Throughout this annual report, we identify our partners and customers by their short names to conserve space and provide the full list of abbreviations and organization names on the last page of the report. RMRS investigators are identified by author name and collaborators are identified by organization name. To provide customers with additional information and tools, we include hyperlinks to publications, webinars, and project and tool websites. For more information about the GSD program or past GSD Updates and annual reports, visit us at our GSD website.

Manipulating cheatgrass stand failure as a tool for fire risk reduction and sagebrush steppe restoration.

Susan Meyer, RMRS, Provo, UT.

The invasive winter annual cheatgrass (*Bromus tectorum*) is a major cause of wildfire that destroys sagebrush steppe vegetation and results in conversion to annual grass monocultures that re-burn over ever-increasing areas. Cheatgrass stand failure or 'die-off' is a natural phenomenon in which complete short-term cheatgrass control is achieved through natural processes. Die-off areas have greatly reduced fuel loads and also reduced cheatgrass competition. The long-term goals of this National Fire Plan (NFP) project are: to develop the ability to predict cheatgrass stand failure, to quantify stand failure areas in real time as an aid to fuels reduction and restoration planning, and ultimately to manipulate the soil fungal pathogen community to actively create cheatgrass stand failure as part of fuels reduction and restoration activities.

Outcomes and Applications:

- Planned: Completion of landscape analysis studies using remote sensing to extend die-off mapping to a wider geographic area and to examine spatiotemporal relationships on a landscape scale between die-off occurrence and abiotic factors that predispose areas to die-off.
- Planned: Completion of studies on cheatgrass litter dynamics to determine both the effect of key fungal pathogens on litter composition and the effect of litter composition on the probability of epidemic levels of the fungal diseases that cause stand failure.
- Planned: Completion of the quantification of pathogen inoculum loads using qPCR for four key pathogens in die-offs of different ages to examine the extent to which pathogen load limits the ability to trigger die-offs with resource manipulation.
- Planned: Completion of the characterization of the fungal community in die-offs of different ages and in different geographic areas using metagenomic analysis.
- Planned: Completion of field experiments demonstrating the importance of pathogen inoculum load, litter physical characteristics, and litter nutrient status (labile carbon and nitrogen) on cheatgrass stand density.
- Development of remote sensing technology for accurately mapping cheatgrass die-offs over a 30-year time span and also in real time each spring, enabling land managers to identify priority areas for restoration seeding the following year.

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Die-off areas in Skull Valley, UT (top row) showing a typical mosaic pattern of unvegetated areas and areas dominated by cheatgrass monocultures, and in Eden Valley, near Winnemucca, NV (bottom row) showing large contiguous die-off patches. Both types of die-off patterns occur in both regions.

Photo: Owen Baughman, RMRS and UNR

- Establishing that native seeding success can be enhanced by planting into previous-year die-offs due to naturally achieved reduction in cheatgrass competition.
- Identification of the soilborne fungal pathogens that interact to create the die-off scenario and that influence the probability of stand recovery in subsequent years.
- Demonstration that both soil water relations and nutrient dynamics influence the probability of stand failure and subsequent recovery through their effects on interactions among soil microorganisms, including fungal pathogens.

Partners: NFP, UNR, BYU, JFSP, USFS, GBLCC.

Featured Publications:

Arnesen, S.; Coleman, C.E.; Meyer, S.E. 2017. Population genetic structure of *Bromus tectorum* in the mountains of western North America. American Journal of Botany. 104(6): 1-12.

Hawkins, K. K.; Allen, P. S.; Meyer, S. E. 2017. Secondary dormancy induction and release in *Bromus tectorum* seeds: The role of temperature, water potential and hydrothermal time. Seed Science Research. doi: 10.1017/S0960258516000258.

Masi, M.; Meyer, S.; Pescitelli, G.; Cimmino, A.; Clement, S.; Peacock, B.; Evidente, A. 2017. Phytotoxic activity against *Bromus tectorum* for secondary metabolites of a seed-pathogenic Fusarium strain belonging to the F. tricinctum species complex. Natural Product Research. doi: 10.1080/14786419.2017.1297445.

Weisberg, P.J.; Dilts, T.E.; Baughman, O.W.; Meyer, S.E. [and others]. 2017. Development of remote sensing indicators for mapping episodic die-off of an invasive annual grass (*Bromus tectorum*) from the Landsat archive. Ecological Indicators. 79: 173-181.

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Resilience to fire and resistance to invasive annual grasses in sagebrush ecosystems - Gaining the necessary longer-term perspective.

Jeanne Chambers, RMRS, Reno, NV.

Jeanne Chambers and her colleagues tested and developed a strategic multi-scale resilience and resistance framework that was pivotal to the development of the Integrated Rangeland Fire Management Strategy, a muti-agency effort to reduce rangeland fire risk and restore fire-damaged western rangelands. To build the framework, Chambers relied on ongoing NFP research showing that (1) ecological resilience to fire and resistance to invasive species increase over elevation gradients and are closely related to soil temperature and moisture regimes and vegetation types and (2) an understanding of these relationships can be used to prioritize areas for conservation and restoration investments and determine the most effective management actions.

Outcomes and Applications:

NFP and collaborative research by Chambers and her colleagues resulted in 18 peer-reviewed publications between 2015 and the present, while collaborative research and management projects resulted in 5 field guides and handbooks and a fact sheet series for managers. Of particular importance for the framework were three RMRS General Technical Reports (GTR-326, 2014; GTR-356, 2016; GTR-360, 2017) that developed a geospatial process for overlaying information on ecosystem resilience and resistance and sage-grouse habitat that is being widely used by state and federal agencies to target areas for management in the western part of the sagebrush biome. A second GTR, Part 2 of the Science Framework on Management Applications will be in press by summer 2018.

The strategic approach was incorporated into the subregional Environmental Impact Statements of both the BLM and USFS, and served as the basis for a Fire and Invasives Team Assessment process to identify focal areas for fire operations, fuels management, post-fire rehabilitation and fire activities in the western part of the range of sage-grouse. The approach has been acknowledged by regional and national agency leaders (FWS, BLM, FS, NRCS) as a key element in preventing listing of sage-grouse in 2015. In 2017, Chambers received the FWS Regional Director's Partnership Award for significant contributions of the framework to regional priorities, specifically, "positively impacting the West-wide collaboration to conserve greater sage-grouse and the hundreds of other native wildlife species that depend on a functional sagebrush ecosystem."

Partners:

RMRS, FS, NFP, BLM, NRCS, Sage Grouse Initiative, USGS, GBLCC, UW, NPS, FWS, WAFWA.

Featured Publications:

Chambers, J.C.; Beck, J.L.; Bradford, J.B. [and others]. 2017. Science framework for conservation and restoration of the sagebrush biome: Linking the Department of the Interior's Integrated Rangeland Fire Management Strategy to long-term strategic conservation actions. Part 1. Science basis and applications. Gen. Tech. Rep. RMRS-GTR-360. Fort Collins, CO: USDA FS Rocky Mountain Research Station. 213 p.

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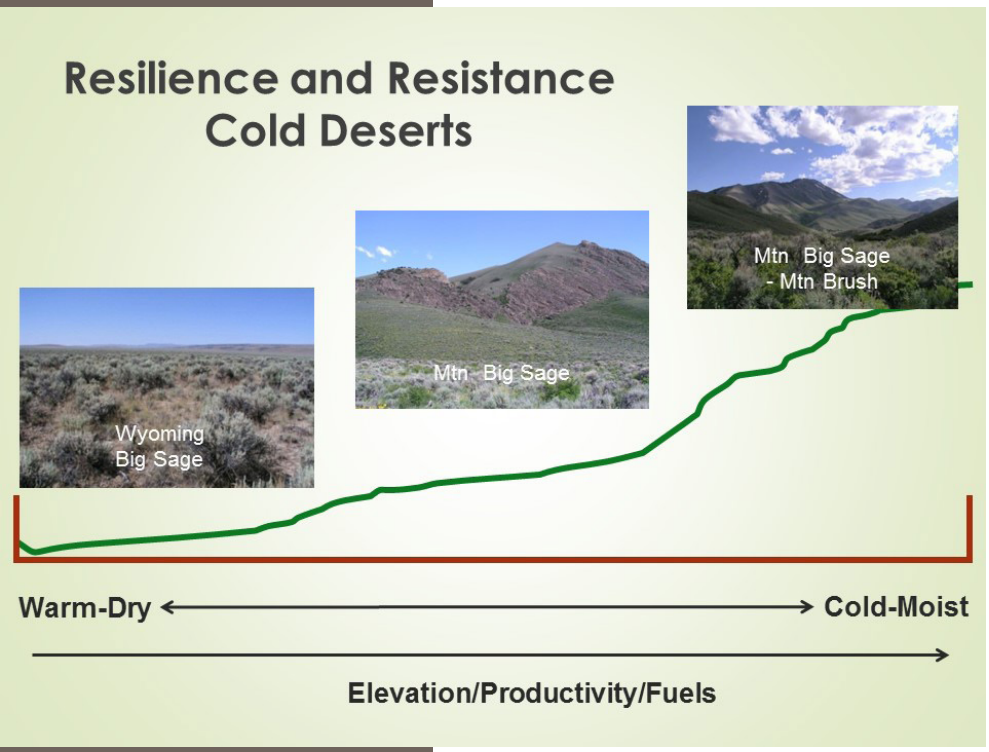
Chambers, J.C.; Maestas, J.D.; Pyke, D.A.; Boyd, C.S.; Pellant, M.; Wuenschel, A. 2017. Using resilience and resistance concepts to manage persistent threats to sagebrush ecosystems and greater sage-grouse. Rangeland Ecology and Management. 70: 149-164.

Chambers, J.C.; Board, D.I.; Roundy, B.A.; Weisberg, P.J. 2017. Removal of perennial herbaceous species affects response of cold desert scrublands to fire. Journal of Vegetation Science. doi: 10.1111/jvs.12548.

Pyke, D.A.; Chambers, J.C.; Pellant, M.; Miller, R.F [and others]. 2017. Restoration handbook for sagebrush steppe ecosystems with emphasis on greater sage-grouse habitat - Part 3: Site level restoration decisions. https://www.fs.usda.gov/treesearch/pubs/53743. U.S. Geological Survey Circular 1426. Reston, VA: U.S. Geological Survey. 62 p.

In the Cold Deserts, sagebrush ecosystems range from warm and dry Wyoming big sagebrush communities with relatively low resilience to fire and resistance to invasive annual grasses at low elevations, to cold and moist mountain big sagebrush/mountain brush communities with relatively high resilience to fire and resistance to invasive annual grasses at high elevations.

Illustration & Photos: Jeanne Chambers, RMRS Reno



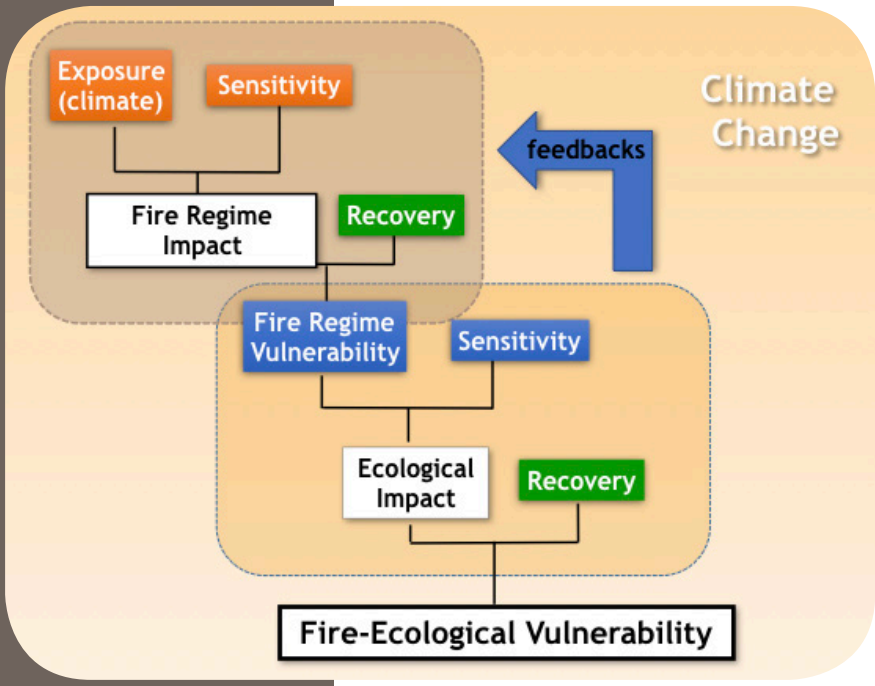
Landscape impacts of fire and climate change in the Southwest: A science-management partnership.

Megan Friggens, RMRS, Albuquerque, NM

Climate change is a pervasive influence on southwestern forested systems, with cascading effects expected throughout the region and across vegetation types. The impacts of warming temperatures and changing hydrology on wildfire are among the most immediate concerns. Management strategies to reduce risk of uncharacteristic wildfire typically focus on restoring natural fire intervals and behavior. However, uncharacteristic disturbance and climate changes may drive forest succession in unanticipated directions and require new strategies that include considerations of alternative disturbance and climate futures. This project is designed to address these needs through a multistage process that includes syntheses, manager-researcher workshops, fire simulation modeling, and the development of a fire-climate vulnerability assessment. Andy Thode, NAU, Flagstaff, AZ is the lead investigator of the project and Co-PI Megan Friggens is leading the development of a framework for assessing the vulnerability of landscape components to changes in fuels and fire regimes that can be used to identify at-risk resources and guide management actions. Numerous additional partners are involved.

Outcomes and Applications:

Along with a framework for assessment vulnerability to fire, this project will identify climate driven changes in individual fire regime components and link specific fire regime shifts to ecosystem impacts. Vulnerability assessments play an important



Conceptual diagram showing the dynamic interactions between climate, wildfire and vegetation in the Southwestern US. To consider feedbacks between fire and climate and fire and vegetation, we have created a nested approach for estimating ecological vulnerability to fire regime change.

Illustration: Megan Friggens, RMRS Albuquerque

role in adaptation planning under climate change and this approach is being used to explore fire-management scenarios under future climates. This project is specifying vulnerability equations to account for the dynamic interactions between climate-fire-forest interactions in order to identify feasible management approaches for reducing undesirable outcomes. The focus is on vegetation communities found in middle and higher elevation habitats within NM and AZ that represent a diverse set of natural fire regimes and unique fire-climate interactions. Using this tool, fire managers will be enabled to compare treatment effectiveness across ecosystems, incorporation climate uncertainties and prioritize areas of concern.

Partners: NAU, JFSP, TNC, NPS, Forest Guild, UA, UCA, FWS, RMRS Fire Lab, USGS, FS R3, USU.

Featured Webpage: SWFireClime

After Fire: Toolkit for the Southwest.

Katelyn Driscoll and Megan Friggens, RMRS, Albuquerque, NM

In the southwestern United States, wildfires are important natural disturbances that alter watershed characteristics, potentially leading to secondary fire effects such as flooding and erosion. These post-fire environments can provide a major challenge for land managers, private landowners, and communities. At workshops conducted with the goal of understanding science and management needs with respect to wildfire, post-fire floods, and extreme precipitation, land managers and urban planners identified a need for an online toolkit for assessing and managing flood impacts associated with wildfire. In response to this vision, we developed an online portal and completed a synthesis report.

Outcomes and Applications:

- An online portal housing information and resources for land managers, private landowners, and communities. The site, After Fire: Toolkit for the Southwest, includes information on the effects of wildfire, tools for assessing risk, treatments for burned landscapes, and potential funding sources for restoring watersheds.
- A library of over 150 publications related to effects of wildfire on the landscape and secondary fire events. The articles are hosted on the website and have been entered into a JournalMap so users can find literature specific to their location.

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A watershed on the Lincoln National Forest, New Mexico after the Little Bear Fire in 2012. Slopes were treated with seeded mulch to reduce erosion and flooding risks. These types of treatments are described in the online toolkit.

Photo: Anna Jaramillo-Scott, USFS

- A synthesis report describing fire effects on hydrology, erosion, water quality, ecology, wildlife, and infrastructure. The report also includes reviews of resources for federal and non-federal lands, as well as tools available for assessment and risk mitigation. Finally, we identified web resources for different user groups and research needs.

- The online toolkit and report have been shared on the USDA Southwest Climate Hub (SWCH) website and were profiled in the Fire Learning Network Networker. We presented it at the National Burned Area Emergency Response meeting and in a webinar for the First Friday All Climate Change Talks hosted by the Climate Hubs and USFS.

Partners: RMRS, USFS Region 3, SWCH, UA, TNC

Featured Webinar: Friggens, M.M.; Driscoll, K.P. 2018. After Fire: Toolkit for the Southwest

Featured Website: After Fire: Toolkit for the Southwest (https://postfiresw.info/)

Testing the efficacy of bluebunch wheatgrass seed transfer zones in post-fire rangeland restoration.

Francis Kilkenny, RMRS, Boise, ID.

Data from 15 common garden studies conducted from FY15-FY17 using 80 bluebunch seed sources are being analyzed to determine the degree of local adaptation in populations of the Intermountain West and the efficacy of previously determined seed transfer zones in post-fire restoration. Early analyses of morphological, phenological, physiological and genetic traits indicate that bluebunch wheatgrass has a high degree of local adaptation to site environmental conditions and that seed transfer zones are relatively effective predictors of restoration success. Common gardens will be monitored again in FY18 and at 2-5 year intervals for as long as funding and site MOUs and NEPA can be maintained. No study of this scope has ever been attempted for plant species other than forest trees.

Outcomes and Applications:

The expected outcome of this study will be an in-depth understanding of bluebunch adaptive and biogeographic genetics that will lead to breakthroughs in both the basic science of local adaptation and applied restoration genetics. A minimum of five journal publications are expected from already-collected data. This is the first study to test the efficacy of species-specific seed transfer zones for a keystone restoration species in a non-forest system. Information from this study will directly inform the use of seed transfer zones in restoration of rangelands in western North America, and will be used as a gold-standard example of

Top: RMRS and PNW crews installing bluebunch wheatgrass for a seed transfer study at the Steens Mountain common garden site in Oregon after a controlled burn in 2013.

Bottom: RMRS technician installing a weather data logger at the Richfield common garden in Idaho in 2016. The Richfield common garden site was installed in 2013 on the 2012 Flat Top fire.

Photo: Francis Kilkenny, RMRS Boise

how to develop and test seed transfer zones worldwide. Underlying data collected in this study will inform the advancement of seed transfer models using novel statistical techniques. These new models will support web-based app technology allowing managers, specifically FS BAER teams and BLM ES&R teams, to make seeding decisions in the field and "on-the-fly." Lastly, 7 seed zone based polycrosses have been certified and are being increased for release to the restoration seed production market.

Partners: RMRS Boise, Moscow and Provo Labs, PNW, NWCH, GBNPP, BLM, USGS, ARS, OSU.

Featured Publication:

Massatti, R.; Prendeville, H.R.; Larson, S.; Richardson, B.A.; Waldron, B.; Kilkenny, F.F. 2018. Population history provides foundational knowledge for utilizing and developing native plant restoration materials. I*n review*. Evolutionary Applications.

Long-term successional processes in native and nonnative seed mixes used in post-fire rangeland restoration.

Francis Kilkenny and Jeffrey Ott, RMRS, Boise, ID.

This is the only study in the Great Basin that has compared the effects of these types of seed mixes over the long-term in an experimental context. Preliminary findings indicate that (1) restoration seedings have a significant effect on post-fire plant community successional dynamics in rangelands, (2) successional outcomes of seeding are not always predictable by early monitoring, (3) native-only seed mixes can be nearly as effective at suppressing exotic annual species, such as cheatgrass, as mixes that include introduced species, and (4) seedings using seed from introduced bunchgrasses, particularly crested wheatgrass, may interfere with long-term shrub recovery.

Outcomes and Applications:

The expected outcome of this study will be an increased understanding of the long-term impacts of using native-only seed mixes vs. mixed native/introduced combined seed mixes in post-fire rangeland restoration seedings. This study has significant practical applications. (1) It suggests that the current three-year monitoring window for post-fire seedings may not be adequate for determining restoration success in the long-term. (2) It indicates that native-only mixes can suppress cheatgrass nearly as well as the mixes that included a nonnative species, contrary to commonly held beliefs. (3) Non-native bunchgrasses may hold back successional processes, particularly shrub recovery, that are critical for wildlife

Plant communities in various seed-mix treatments in 2015, fifteen years after seeding. This study was installed on the 1999 Railroad fire in the Tintic Valley of Utah.

Top: unseeded control showing invasion by annual exotics and forbs and some shrub recovery.

Middle: BLM conventional mix showing establishment and dominance of introduced perennial grasses and exclusion of shrubs and annual exotics.

Bottom: Native high diversity mix showing native perennial grasses mixed with significant shrub recovery.

Photo: Jeffrey Ott, RMRS Boise

habitat. All together there are trade-offs to using any given seed-mix that should be considered based on the goals of the particular management action.

Partners: UDWR, BYU, BLM, GBNPP.

Featured Publication:

Ott, J.E.; Kilkenny, F.F.; Summers, D.D.; Thompson, T.W. 2018. Long-term vegetation recovery and invasive annual suppression in native and introduced post-fire seeding treatments. In review. Rangeland Ecology and Management.

Featured Website: The Great Basin Native Plant Project

Fire effects on herbaceous regeneration across an invasion gradient in grasslands and shrublands.

Jacqueline Ott, RMRS, Rapid City, SD.

Fire effects on the regeneration potential of the native herbaceous plant community in northern mixed-grass prairie and eastern sagebrush steppe are poorly understood but critical for appropriate management and the conservation of biodiversity and ecosystem function. The primary objectives of this project are to: 1) determine the regeneration potential of important forbs and grasses from belowground buds following fire, 2) determine how pre-fire community composition affects post-fire regeneration, 3) investigate the effect of fuel loading on the regeneration resiliency of grasslands and shrublands, and 4) determine the response of big sagebrush (*Artemisia tridentata*) to low intensity fire. Regeneration responses will be compared across a range of fuel loadings that produce fire intensity and severity levels representative of these fuel types.

Outcomes and Applications:

Expected outcomes will provide basic and applied understanding of plant responses to fire that can be used to make management decisions regarding the role of prescribed fire to maintain adequate forage for livestock and appropriate habitat for Greater Sage-grouse while also preventing invasion by non-native plant species in the northern Great Plains. This research will provide needed rehabilitation and restoration information on the post-fire regenerative ability of key forb species and their genera that are important for wildlife, especially pollinators and the Greater Sage-grouse. We will determine the feasibility of maintaining big sagebrush stands after low intensity fire. We will also deliver needed results on how annual brome invasion impacts the resiliency and regeneration of grasslands and shrublands in the northern Great Plains before brome invasion reaches levels comparable to those of the intermountain west.

Partners: ARS, USGS, CSU, UW, RMRS-Fire Science Lab, Buffalo Gap and Thunder Basin National Grasslands, Thunder Basin Grassland Prairie Ecosystem Association.

Featured Publication:

Ott, J.P.; Butler, J.L.; Rong, Y.; Xu, L. 2017. Greater bud outgrowth of *Bromus inermis* than *Pascopyrum smithii* under multiple environmental conditions. Journal of Plant Ecology. 10: 518-527.

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Jacqueline Ott, Research Ecologist in Rapid City, SD, uses fire tables to mimic fire behavior at the lab and burn off cores at different fuel loads. Cores are located near the end of the table and were taken from the National Grasslands with a target species in the center. Cores will be transported to a greenhouse to see how target species (plant species important to pollinators and the Greater sage-grouse) regenerate following fire.

Photo: Brian Dickerson, RMRS Rapid City

Developing and testing native plants for use in ecosystem restoration and rehabilitation.

Jeremiah Pinto and Kasten Dumroese, RMRS, Moscow, ID.

Restoring and rehabilitating ecosystem function after disturbances, especially fire, requires a supply of genetically-adapted, healthy, and hardy plant material that can be appropriately deployed with success (achieving high survival and subsequent growth). This project works through the National Center for Reforestation, Nurseries, and Genetic Resources (RNGR) and the Western Center for Native Plants (WCNP) to develop and distribute science-based pragmatic information to the Nation's 1400 native plant nurseries that annually produce about 1 billion seedlings toward improving availability (species and numbers) and quality of native plant materials.

Outcomes and Applications:

The annual effort includes two regional conferences, a national conference for tribes, scientist research leveraged through universities resulting in 10-30 publications per year, support of an on-line database with plant production protocols and relevant information, on-site and virtual consultations, and, in FY18, working with ranchers, tribes, and FWS, informed decision-makers and native plant suppliers to develop a robust chain in support of sagebrush steppe restoration in Oregon via FWS' Candidate Conservation Agreements with Assurances program.

Partners: FS S&PF, NFS, and R&D, RNGR, WCNP, BLM, WFCA, FWS; Federal, State, and Tribal nurseries; Universities of Georgia, Hawaii, Idaho, and Montana.

Featured Websites:

Western Center for Native Plant Conservation and Restoration, Reforestation, Nurseries and Genetics Resources

Featured Publications:

Williams, M.I.; Dumroese, R.K. 2016. Planning the future's forests with assisted migration [Chapter 8]. In: Sample, V.A.; Bixler, R.P.; Miller, C., eds. Forest Conservation in the Anthropocene: Science, Policy, and Practice. Boulder, CO: University of Colorado Press: 113-123. https://www.fs.usda.gov/treesearch/pubs/54514

Pinto, J.R.; Marshall, J.D.; Dumroese, R. K.; Davis, A.S.; Cobos, D.R. 2016. Seedling establishment and physiological responses to temporal and spatial soil moisture changes. New Forests. 47(2): 223-241. https://www.fs.usda.gov/treesearch/pubs/50485

Jimenez, M. N.; Pinto, J. R.; Ripoll, M. A.; Sanchez-Miranda, A.; Navarro, F. B. 2017. Impact of straw and rock-fragment mulches on soil moisture and early growth of holm oaks in a semiarid area. Catena. 152: 198-206. https://www.fs.usda.gov/treesearch/pubs/53835

Hubbel, K.; Barkley, Y.; Pinto, J.R.; Dumroese, R.K.; Deristin, S.; Joseph, R.; Brooks, R.; Davis, A.S. 2016. Tree planting in Haiti: How to plant and care for your nursery grown seedlings. Bulletin 103. Moscow, ID: University of Idaho, Forest Wildlife and Range Experiment Station. 2 p. Includes Creole (*Plante Pyebwa an Ayiti*) and French (*Plantation d'arbres en Haïti*) translations. https://www.fs.usda.gov/treesearch/pubs/54513

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Controlled burn at the Sevilleta Long-Term Ecological Research site, New Mexico.

Photo: FWS

Identifying optimal season and frequency of fire in southern Great Plains and Chihuahuan Desert grasslands.

Paulette Ford, RMRS, Albuquerque, NM and Matt Reeves, RMRS, Missoula, MT.

This long-term project initiated in 1997 identifies optimal season and frequency of fire to achieve desired management goals. It addresses the NFP Key Focus Area of Rehabilitation and Restoration. This project consists of ongoing long-term experimental research on the effects of season and frequency of fire in shortgrass steppe in the southern Great Plains, with additional experimental research on fire seasonality and climate variability in the Chihuahuan Desert grassland of central New Mexico.

Outcomes and Applications:

- A decision support system based on ecological models for predicting the impact of climate on fuelbed properties on Great Plains grasslands was developed. This new decision support system (DSS) enables managers to determine the most appropriate strategies for reducing fuel loads and fostering ecological resilience.
- DSS is based on: The Rangeland Vegetation Simulator: A system for quantifying production, succession, disturbance and fuels in non-forest environments, and A Prototype Application of State and Transition Simulation Modelling in Support of Grassland Management.
- Fire season and frequency of experimental results are used to plan prescribed burns on national grasslands and wildlife refuges in the Southwest and in NEPA analyses and plan revisions.
- Results are used in decision support for restoring wildlife habitat for featured species such as black-tailed prairie dog and its associates.
- Results help to discriminate between the effects of fire specific management actions versus long-term effects of drought. Drought overrode fire effects in both Great Plains shortgrass prairie and Chihuahuan Desert, resulting in similar findings and patterns. During long-term drought, managers should carefully consider whether to use prescribed fire based on their management objectives. When such grassland types are not experiencing drought, more frequent use of prescribed fire may meet management objectives.

Partners:

RMRS, APEX Resource Management Solutions, Cove NDR LLC, ARS, SWCH, JFSP, FS Cibola National Forest and Kiowa National Grassland, FWS, Sevilleta National Wildlife Refuge, Sevilleta LTER, UNM, WWETAC.

Featured Publication:

Ford, P.L., Reeves, M.C. and Frid, L. 2018. The rangeland vegetation simulator: A decision support tool for monitoring and projecting grassland conditions. In Press. Proceedings of the Fourth Biennial America's Grasslands Conference, Fort Worth, Texas, November 14-16, 2017.

Featured Webinar:

Characterizing the Future Range of Variability of Rangelands in Region 3 of the USFS National Forest System

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Field crew members examine evidence of multiple surface fires recorded in the annual growth rings of a ponderosa pine stump surrounded by aspen-dominated forest, Fishlake National Forest, Utah. Using dendrochronological techniques, seven fires were dated to a period from the mid-1600s to the early 1800s.

Photo: Andrew Orlemann

Multi-century, tree-ring-based fire histories for southwest Utah aspen forests: Local and regional perspectives.

Stanley Kitchen, RMRS, Provo, UT.

Periodic disturbance promotes resilience in quaking aspen forests by reducing competition from associated conifers and promoting emergence of young, stress-resistant age classes and stand heterogeneity across spatial scales. Knowledge is lacking about historical fire regime range of variability that supported thriving aspen-conifer mosaics in past centuries.

Outcomes and applications:

Outcomes will include multi-scale, multi-century fire regime reconstructions for aspen-conifer forests of southern Utah. Results will be presented in a workshop for private and public land managers with emphasis on uses of disturbance in the rehabilitation and restoration of aspen. Findings will also be communicated through non-technical newsletter publication, brief syntheses prepared to inform project analysis, presentations at professional meeting and peer-reviewed publication in a scientific journal.

Partners: USU Cedar Mountain Initiative Research Program, FS R4, Dixie NF, Fishlake NF.

Post-fire succession of mountain big sagebrush in the Great Basin and Colorado Plateau.

Stanley Kitchen, RMRS, Provo, UT

Large severe wildfires in the Interior West are a serious threat to the sagebrush-steppe ecosystem and dependent wildlife species. Resilience to fire for these shrub-dominated systems (capacity to recover after disturbance) varies with environmental factors (e.g. precipitation and temperature) and biotic condition. Knowledge of drivers of variability in post-fire succession is lacking.

Outcomes: Project outcomes include projections for post-fire recovery for mountain big sagebrush-steppe communities across a wide range of environmental conditions.

Application: Results are being used to model mountain big sagebrush recovery in response to variability in climate. Managers will be able to use modeled results to develop plans for ecosystem rehabilitation and restoration, and will improve allocation of limited resources after disturbance. Findings will also be communicated through workshops, presentations at professional meetings and peer-reviewed publications.

Partners: BYU, UDWR, BLM, Ashley NF, Fishlake NF, Uinta-Wasatch-Cache NF.

Featured Publication:

Landeen, M.L.; Allphin, L.; Kitchen, S.G.; Petersen, S.L. 2017. Seed production estimation for mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*). Rangeland Ecology and Management. 70(5): 633-637.

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Great Basin bristlecone pine historical fire regimes and wildfire vulnerability assessment.

Stanley Kitchen,
RMRS, Provo, UT.

Above: Forest succession with Great Basin bristlecone pine, Douglas fir, and quaking aspen trees 70 years after a stand replacing fire on Frisco Peak, Millard County, Utah.

Photo: Stan Kitchen, RMRS Provo

Large severe wildfires in the Interior West are a potential threat to many forest communities. Great Basin bristlecone pine (GBBP) is an iconic long-lived species that is found from dry woodlands to subalpine tree-line. Long-term fire regime variability and post-fire succession for GBBP forests is poorly understood, subsequently, the knowledge to assess vulnerability to evolving fire regimes is currently inadequate.

Outcomes: Project outcomes will include assessment of stand variability (composition and structure), multi-century fire regime reconstructions and post-fire tree succession after stand replacing fire.

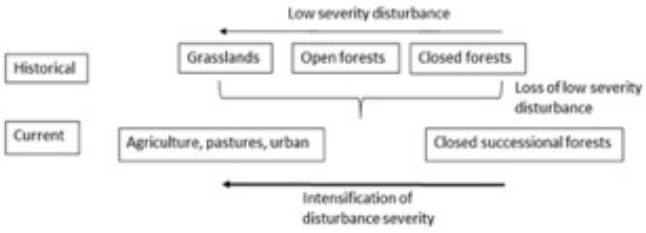
Application: Results will inform rehabilitation and restoration plans and enable strategic use of limited conservation resources to manage hazardous fuels reductions in a diversity of forest types, including GBBP, across multiple federal and state agency lands. Findings will also be communicated through workshops, presentations at professional meetings and peer-reviewed publications.

Partners: WWETAC, BYU, BLM, NPS, Humboldt-Toiyabe NF, Ashley NF, Dixie NF, Fishlake NF.

Recognizing loss of open forest ecosystems by tree densification and land use intensification in the Midwestern United States.

Brice Hanberry, RMRS, Rapid City, SD

Forests and grasslands have changed during the past 200 years in the eastern United States and it is now possible to quantify loss and conversion of vegetation cover at regional scales. We quantified historical (ca. 1786 – 1908) and current land cover and determined long-term ecosystem change to either land use or closed forests in eight states of the Great Lakes and Midwest. Variation in fire frequency produces open forest ecosystems of savannas, open woodlands, and closed woodlands, which fill a wide gradient of tree density and canopy cover between grasslands and closed forests. Historically, the region was 35% grasslands (31 million ha), 38% open forests of savannas and woodlands (33 million ha), and 25% closed forests (22 million ha). Currently the region is about 85% land use (76 million ha), primarily agriculture, and 15% closed forests (12 million ha). Land use intensification removed 75% of open forests, while 25% of open forests



Right: A conceptualized model of changes in state from historical grasslands, open forests, and closed old growth forests to current dense forests and land use classes of land cover. Low severity disturbance typically involves fire in grasslands and open forests.

Illustration: Carter Kinkead

have densified to closed forests without low severity disturbance to remove understory trees. Historical forest ecosystems included a gradient of oak savannas and woodlands with open midstories (50 to 250 trees/ha), along with closed old growth forests. Open forests

Forest Service
Rocky Mountain Research Station

Example of a forest with an open midstory and grassland understory (left panel) and closed forest with woody vegetation that has replaced herbaceous vegetation.

Photos: Carter Kinkead

have become dense (200 to 375 trees/ha) and are cut frequently, resulting in the extremes of closed canopy forests and clearcut openings across forested landscapes.

Outcomes and Applications:

We demonstrated that forests have transitioned from a historically wide gradient in canopy closure to either dense young closed forests with clearcut openings or to various land uses (agriculture, grazing, residential and commercial land development). The historical abundance of open forest ecosystems, comprised of both forest and grassland layers, often is not recognized and thus, these forests are undervalued for conservation and management.

Partners: Penn State University

Featured Publication:

Hanberry, B. B.; Abrams, M.D. 2018. Recognizing loss of open forest ecosystems by tree densification and land use intensification in the Midwestern USA. Regional Environmental Change. 1-10.

Black-backed woodpecker field crew poses for picture with fire killed ponderosa pine (Myrtle Fire) in the background during initial training on recognizing birds and orientation with the Black Hills.

Photo: Brian Dickerson, Rapid City.

Black-backed woodpecker abundance in the Black Hills of South Dakota and Wyoming.

Brian Dickerson and Mark Rumble (retired), Rapid City, SD

Black-backed woodpecker point count transect surveys were conducted over two years to estimate the number of breeding pairs in the Black Hills of South Dakota and Wyoming and associate the vegetation communities with the occurrence or density of woodpeckers.

Outcomes and Applications:

The expected outcome of this study is to provide an estimate of abundance that would inform management decisions regarding a species that was petitioned to be listed as threatened or endangered as a Distinct Population Segment under the Endangered Species Act. As a species with special management status in both states in which this study will be conducted, the information will provide a benchmark for management decisions. In addition to an estimate of abundance, the information provided will also describe associations with the vegetation communities in which the birds were occurring. These data will also be useful when land managers create management plans for timber resources in the Black Hills to ensure

the viability of the Black-backed woodpecker population.

Partners: NRS, UM, MU.

Featured Publication:

Matseur, E. A.; Thompson III, F.R.; Dickerson, B.E.; Rumble, M.A.; Millspaugh, J.J. 2018. Black-backed woodpecker abundance in the Black Hills. Journal of Wildlife Management. DOI: 10.1002/jwmg.21450

Assisting tribes to produce native plants in response to climate change-induced drought.

Jeremiah Pinto and Kasten Dumroese, Moscow, ID; Francis Kilkenny, Boise, ID; and Holly Prendeville, PNW, Corvallis, OR.

The production of native plant materials is a vital step for accelerating the recovery trajectory of restoration projects following disturbance. In the face of changing climate, it is critical that native plant materials not only meet management objectives, such as soil stabilization after disturbance, but that they also create more resilient landscapes under current and future climates. Equally, it is important that resources and management activities be leveraged so that multiple restoration goals can be accomplished through one set of tasks. This project, funded by the USDA Northwest Climate Hub (NWCH), aims to improve knowledge and production of native plant materials for sagebrush steppe restoration while addressing changing climate issues around drought and multiple species management. The project focus emphasizes climate-adapted plant production (using genetic knowledge and nursery cultural practices) for habitat recovery of sage-grouse, pollinators, and monarch butterflies and potentially other sagebrush obligate species. Existing knowledge, tools (e.g. Seedlot Selection Tool), and protocols will be synthesized into a usable format (e.g. technical document) for managers as well as a training workshop. In addition to collaboration with Jeff Everett, FWS, Portland, OR, participation is anticipated from tribes, other federal agencies, soil and water conservation districts, and private land owners.

Outcomes and Applications:

The first task is to generate plant species lists that satisfy mutual needs among sage-grouse, pollinators, and monarch butterflies and potentially other sagebrush-steppe obligate species. Secondly, we will examine and overlay the existing knowledge (e.g., WWETAC Seed Zone GIS Mapping) and tools (e.g., Seedlot Selection Tool [SST]) surrounding the transfer guidelines for these species considering a variable climate. Our third task is to compile plant propagation protocols for the same species of interest. The above three items will be synthesized into a practical technical guide. This guide will address the time- and budget-limited quandaries faced by managers when looking for science-based information to justify their practices. Both tribal and non-tribal nursery personnel will use it as their reference, and it will also serve as a guide for natural resource managers who wish to replicate this science delivery model to other landscapes in need of restoration. A training workshop (targeting the same audience) will use the guide for instruction as well as demonstrate how the Seedlot Selection Tool works so that current and future climate information can be incorporated in restoration decisions. We also know that research by RMRS Geneticist

Nursery stock from this project is being used on this private ranch in southeast Oregon, to restore sagebrush habitat and help in greater sage-grouse reintroduction.

Photo: Jeremiah Pinto RMRS Moscow

Bryce Richardson and others will be adding capacity to the SST, and could potentially be used in our training workshop.

Partners: FS S&PF, NFS, and R&D, NWCH, WCNP, RNGR, WFCA, FWS; Federal and Tribal nurseries.

Featured Publication:

Dumroese, R. K.; Luna, T.; Pinto, J.R.; Landis, T.D. 2016. Forbs: Foundation for restoration of monarch butterflies, other pollinators, and greater sage-grouse in the western United States. Natural Areas Journal. 36(4): 499-511.

Featured Website: USDA Northwest Climate Hub

Strategies towards the production of woody plants and forbs by tribal nurseries for Great Basin sagebrush ecosystem restoration.

Jeremiah Pinto, Moscow, ID.

In an effort to address degraded sage-grouse habitat—due to fire, grazing, and invasive species—this work seeks to leverage the capability of tribal nurseries to produce native plant materials for habitat restoration. This project works through the US Fish & Wildlife's Candidate Conservation Agreement with Assurances (CCAA) program with private land owners. Currently, in Oregon alone, about 5 million acres of land are impacted by this program, with several hundred private land owners signed up to participate. Partners include Jeff Everett, FWS, Portland, OR; Gail Redberg, Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Pendleton, OR; and a private ranch in southeast OR. The first demonstration project with the ranch is working towards restoring and rehabilitating critical sage-grouse habitat with genetically-adapted, high quality nursery plant material. The project aims to develop and implement science-based information related to the deployment of native plants for structure, function, and diet of greater sage-grouse.

Outcomes and Applications: As CCAAs gain more traction, tribal nurseries will be well-suited to provide the necessary plant materials for restoration. Private land owners will gain access to locally-adapted nursery stock and helpful guidelines on how to maximize restoration trajectory on their sites.

Partners: FS R&D, FWS, WCNP, RNGR, Tribal nurseries, private land owners.

Featured Website: FWS Candidate Conservation Agreement with Assurances Program

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LIST of ABBREVIATIONS

ARS – Agricultural Research Service

BAER – Burned Area Emergency Response

BLM – Bureau of Land Management

BYU – Brigham Young University

CSU – Colorado State University

ES&R – Emergency Stabilization and Restoration

FS – USDA Forest Service

GBLCC – Great Basin Landscape Conservation Cooperative

GBNPP – Great Basin Native Plant Project

GSD – USDA FS Grassland, Shrubland and Desert Ecosystems Science Program

LTER – Long-Term Ecological Research

JFSP – Joint Fire Sciences Program

MOU – Memorandum of Understanding

MU – University of Missouri

NAU – Northern Arizona University

NEPA – National Environmental Policy Act

NFS – National Forest System

NFP – National Fire Plan

NIFC – National Interagency Fire Center

NPS – National Park Service

NRCS – USDA Natural Resources Conservation Service

NRS – USDA Forest Service Northern Research Station

OSU – Oregon State University

NWCH – USDA (ARS) Northwest Climate Hub

PNW – USDA Forest Service Pacific Northwest Research Station

qPCR – Quantitative polymerase chain reaction

R&D – Research and Development

RMRS – USDA Forest Service Rocky Mountain Research Station

SWCH – USDA (ARS) Southwest Climate Hub

S&PF – USDA Forest Service State and Private Forestry

TNC – The Nature Conservancy

UA – University of Arizona

UCA – University of Central Arkansas

UNM – University of New Mexico

UDWR – Utah Division of Wildlife Resources

UNR – University of Nevada, Reno

USFS – U.S. Forest Service

FWS – U.S. Fish and Wildlife Service

UM – University of Montana

USGS – U.S. Geological Survey

USDA – United States Department of Agriculture

USU – Utah State University

UW – University of Wyoming

WCNP - Western Center for Native Plants

WFCA – Western Forestry and Conservation Association

WWETAC – Western Wildland Environmental Threat Assessment Center