Multi-Party Monitoring for the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project

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Grand Mesa Uncompahgre and Gunnison National Forests

Uncompahgre Partnership

March 2026 • CFRI-2610

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The **Colorado Forest Restoration Institute (CFRI)** was established in 2005 as an application-oriented, science-based outreach and engagement organization hosted at Colorado State University (CSU). Along with centers at Northern Arizona University and New Mexico Highlands University, CFRI is one of three institutes that make up the Southwest Ecological Restoration Institutes, which were authorized by Congress through the Southwest Forest Health and Wildfire Prevention Act of 2004. We develop, synthesize, and apply locally relevant, actionable knowledge to inform forest management strategies and achieve wildfire hazard reduction goals in Colorado and the Interior West. We strive to earn trust through being rigorous and objective in integrating currently available scientific information into decision-making through collaborative partnerships involving researchers, land managers, policy makers, interested and affected entities, and communities. CFRI holds itself to high standards of scientific accuracy and aims to promote transparency in the production and communication of science-based information. Always carefully evaluate sources for rigor and appropriateness before applying in your own work.

Land Acknowledgment: Colorado State University acknowledges, with respect, that the land the university is on today is the traditional and ancestral homelands of the Arapaho, Cheyenne, and Ute Nations and peoples. This was also a site of trade, gathering, and healing for numerous other Native tribes. Additionally, the Uncompahgre Plateau and surrounding landscapes are the traditional and ancestral homelands of the Tebeguache (Uncompahgre) Ute people. We recognize the Indigenous peoples as original stewards of this land and all the relatives within it. As these words of acknowledgment are spoken and heard, the ties Nations have to their traditional homelands are renewed and reaffirmed. CSU is founded as a land-grant institution, and we accept that our mission must encompass access to education and inclusion. And, significantly, that our founding came at a dire cost to Native Nations and peoples whose land this University was built upon. This acknowledgment is the education and inclusion we must practice in recognizing our institutional history, responsibility, and commitment.

Acknowledgments: We are grateful to the nearly 40 Forestry Internship Program interns for their hard work, deep learning, and excellent data collection throughout the 10+ years of the program; this report would not be possible without their participation and contribution. We appreciate the help and support of Rusty George and

Colleen Trout for their crew leadership and mentorship of the Forestry Internship Program interns during the first years of data collection. We are immensely grateful to Lyle Motley for his many years of crew leadership; he brought invaluable instruction, safety, data quality, and good humor to the FIP crew for 9 years and this project would not be successful without his invaluable contributions. There are many more staff and interns that supported the monitoring in this report that are too numerous to account for efficiently; we are grateful to all contributors of this document for their monitoring and reporting efforts.

We are grateful to Micah Keralis, Rob Addington, Megan Matonis, and Kristen Pelz for their data contributions and CFRI project management during the beginning years of this project. We are immensely grateful to line officers and staff, both past and present, from the US Forest Service Uncompahgre National Forest for their support of the FIP program and associated monitoring over the years. They include, but are not limited to: Carmine Lockwood, Sherry Hazelhurst, Charlie Richmond, Russ Bacon, Scott Armentrout, Matt Tuten, Tim Garvey, Clay Speas, Tammy Randall Parker, Carly Perovich, Wes Bice, Corey Robinson, Cody Russell, and most especially, Todd Gardiner for his support, passion, knowledge and partnership with this monitoring. We are also grateful to Pam Motley and Leigh Robertson for their facilitation of the UP CFLRP group over the many years, and to Jim Free for his great partnership and contributions to the collaborative. Finally, we are grateful to Hannah O'Reilly for document editing, layout, and formatting.

Funding was provided by the Colorado Forest Restoration Institute through the Southwest Forest Health and Wildfire Prevention Act and by the by the Grand Mesa, Uncompahgre, and Gunnison National Forests. The Colorado Forest Restoration Institute at Colorado State University receives financial support under the Southwest Forest Health and Wildfire Prevention Act provided through the United States Forest Service. In accordance with Federal law and United States Department of Agriculture policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, or disability. To file a complaint of discrimination, write: USDA, Director, Office of Civil Rights Room 326-A, Whitten Building 1400 Independence Avenue, SW Washington, DC, 20250-9410 or call (202) 720-5964 (voice & TDD).

Publication Date: March 2026

Photo Credit: Tony Cheng

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Suggested Citation: Cheng, A., Chambers, M., Binkley, D., Clement, J., Flood, S., Free, J., Gardiner, T., Garvey, T., Motley, P., Robertson, L., Schapira, Z., & Snyder, V. (2026). Multi-Party Monitoring for the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project. Colorado Forest Restoration Institute. CFRI-2610.

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Executive Summary

2024 marked the completion of the final year of 15 years of social, economic and ecological monitoring for the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project (UP-CFLRP). The passing of this milestone provides an opportunity to reflect on lessons and impacts from the monitoring efforts, both for future multi-party monitoring initiatives pertaining to large-scale forest management projects on the Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG) and for the National Collaborative Forest Landscape Restoration Program (CFLRP) writ-large. This summary spans the following topics:

- Background of the multi-party monitoring requirement under the Collaborative Forest Landscape Restoration Program
- Background of multi-party monitoring efforts leading up to the UP-CFLRP
- Multi-party monitoring for the UP-CFLR Project
- After-Action Review: General observations after 15 years of monitoring

Multi-party monitoring under the Collaborative Forest Landscape Restoration Program

The CFLRP was established as a program within the US Forest Service (USFS) pursuant to the Federal Landscape Restoration Act under the Omnibus Public Land Management Act in 2009 (P.L. 111-11). The program allocates USFS funds through a competitive selection process to proposals submitted by National Forest and Grasslands units that are collaboratively developed by a diverse range of interested and invested parties and include details about a landscape-scale restoration strategy that includes at least 50,000 acres. Proposed projects must align with the criteria in the authorizing legislation. Projects are selected for recommended funding by a federal advisory committee composed of individuals reflecting a broad range of expertise, experience, and interests. Selected projects receive 10 years of funding for implementation.

Relevant to this report is a provision in the authorizing law, stating:

> The Secretary [of Agriculture, through the US Forest Service responsible official] shall, in collaboration with the Secretary of the Interior and interested persons, use a ***multiparty monitoring, evaluation, and accountability process*** to assess the positive or negative ecological, social, and economic effects of projects implementing a selected proposal for not less than 15 years after project implementation commences. (Public Law 111-11, Title IV, Sec. 4003 (g)(4))

This is the first time that Congress mandated a multi-party monitoring approach to assess the impacts of a national forest management program. The structures, processes, and practices needed to be created, resourced, and implemented for every CFLRP project. For projects starting in 2010 with funding expired in 2019, like the UP-CFLRP, this meant conducting monitoring through 2024.

Background of multi-party monitoring leading up to the UP-CFLRP

For the UP-CFLRP, the multi-party monitoring was an extension of collaborative efforts dating back to the early-1990's, starting with the Public Lands Partnership (PLP) and its spin-off initiative, the Uncompahgre Partnership. PLP emerged in 1993 as a collection of individuals from a range of organizations and communities of interests across five counties in Western Colorado committed to working through their differences and finding common ground regarding public lands management in the area via collaborative learning, civil dialogue, and trust-building.

The PLP's organizing principle was to enhance shared understandings about the connections between federal public land management (i.e., Bureau of Land Management public lands, the GMUG National Forest, Black Canyon of the Gunnison, etc.) and local communities' economies and livelihoods. By doing so, public land managers would have more nuanced understandings about the impacts of their decisions, and local communities and community-connected organizations had more nuanced understandings of opportunities and constraints facing public land managers. The Uncompahgre Partnership emerged in the early-2000's as an extension of this collaborative learning, with an emphasis on deepening collaboration across federal, state, and local agencies regarding the technical components of land management and ecological restoration on the Uncompahgre Plateau.

One of the earliest examples of multi-party monitoring was carried out by a working group of the PLP in the mid-1990s to collect more detailed socio-economic information about local communities' economic activity connected to the GMUG National Forest; the data supplemented the US Forest Service's economic impact analyses as part of the GMUG's revision of its Land and Resource Management Plan (or "forest plan"). An early multi-party monitoring effort on the Uncompahgre Plateau was the PLP's monitoring of the Burn Canyon timber salvage carried out by the GMUG. This link provides more information on the project's background and final report.

Multi-party monitoring for forest restoration pre-dated the UP-CFLR project when individuals from a broad range of interests and organizations worked collaboratively with the GMUG National Forest from 2007-2009 to develop the Uncompahgre Mesas Forest Restoration Project. As the project development proceeded, the group defined monitoring questions and measures to gauge progress. As such, the group had a substantial head-start on the multi-party monitoring component when the national CFLRP call for proposals was released in 2009.

Multi-Party Monitoring for the UP-CFLR Project

Who was involved?

The "multi-party" aspect of the UP-CFLR project monitoring was composed of individuals from many different organizations, interests, and perspectives on land use and management on the Uncompahgre Plateau. This included natural resource specialists from federal, state, and local government agencies, academic and federal agency researchers, individuals from nearby communities interested in public lands, private landowners, and individuals from organized interests reflecting motorized and non-motorized vehicle recreation, hunting and angling, forest products, livestock production, wildlife conservation, and environmental protection and conservation, among others.

What was the process?

The approach was informal, voluntary, and had little structure, other than annual meetings in mid-winter and annual field trips in mid-summer. E-mail invitations to participate were sent to GMUG, PLP participation, and Uncompahgre Plateau Partnership (spin-off initiative of PLP) distribution lists; this list included several hundred recipients. The GMUG's distribution list included individuals who signed up for GMUG updates or submitted comments to proposed GMUG plans and projects.

The mid-winter meetings entailed a combination of after-action review of prior year project work, including monitoring results, and next-year treatment and monitoring priorities. The summer field trips were opportunities for interested individuals to see project sites and provide visual, concrete evidence in addition to monitoring data results. These field trips often involved overnight camping during the first five years, allowing participants to interact in more causal setting on the Uncompahgre Plateau itself.

What was monitored?

During the first 2-3 years of the UP-CFLRP, monitoring topics were identified, discussed, refined, and prioritized for UP-CFLR funding. The Uncompahgre Mesas Forest Restoration Project Environmental Assessment (2009) and the Escalante Forest Restoration and Stewardship Project Environmental Assessment (2013) both identified monitoring topics per stated project goals and objectives of each project. Additional topics were identified by collaborative participants during early meetings of the multi-party monitoring planning between in 2011 and 2012. These initial years saw a flurry of activity involving different organizations and program areas, from the GMUG's own program staff conducting field assessments, to academic and agency researchers carrying out research studies, to citizen science activities, as the Audubon Society's bird surveys. This report contains details of these topics, monitoring efforts and results. As the project advanced through the last half of the 10-year implementation schedule (2015-2019), the UP-CFLRP's project funding ratcheted down. This decrease was planned and intentional in the original proposal. As such, the number of monitoring topics receiving funding and attention narrowed. So, too, did the number of active participants decline.

One of the longest running projects was monitoring forest vegetation treatments (i.e., mechanical, silvicultural, and prescribed burning activities) conducted by the Forestry Internship Program co-managed by the Colorado Forest Restoration Institute (CFRI) at Colorado State University and the GMUG National Forest. The driving question was, "How do changes in plant community composition, cover, and diversity resulting from forest treatments (i.e., mechanical and manual tree and brush thinning, prescribed burning) align with project goals?"

Measuring change in plant community components was accomplished through gathering data about forest vegetation pre- and post-treatment. Post-treatment measurements were taken one-year following treatments and, in some project areas, five-years following treatments. The measurement work was carried out by high school students working as paid interns and led by a local high school teacher. Training, oversight, and data compilation and analysis was carried by CFRI Research Associates Micha Keralis (2010-2011), Rob Addington (with Megan Matonis at CSU) (2012-13), Kristen Pelz (2014-15), and Marin Chambers (2016-2024).

Additional intensive monitoring was conducted by CFRI to assess the effects of management treatments in areas dominated by Gambel oak. This work was specially requested by land managers as little is known about how Gambel oak responds to various treatments.

After-Action Review: General observations after 15 years of monitoring

15 years of investment in monitoring was unique

To our knowledge, the 15 years of intensive field monitoring of a national forest management program of work is an unusual length of time to invest in a monitoring effort. The first five years of the project saw heightened interest, attention, and participation by individuals from a range of interests, perspectives, and organizations. GMUG leadership and staff attention and engagement was also high in order to carry out the different components of the UP-CFLRP, including the collaborative engagement, the multi-party monitoring, working agreements with different partner groups, and contracting implementation work on the ground.

Correspondingly, there was a flurry of monitoring and applied research activity from 2011 to 2016. A majority of monitoring activities in this plan were carried out during this period. As the project proceeded into the latter years, a smaller number of monitoring work was being funded and conducted; much of the work was conducted by internal GMUG staff or by partners that had their own ongoing funding to cost-share monitoring projects, such as CFRI, Colorado Parks and Wildlife, and the Uncompahgre Plateau Project. In the latter part of the project period, funding for implementation and monitoring declined per the original proposal. Monitoring projects that had momentum and additional sources of funding were able to continue; others ended when the funding expired. Sustaining funding and energy for monitoring is challenging year-after-year, but several projects did endure for the 15-year monitoring timeframe. This is a testament to the commitment of GMUG leadership and staff, and project partners.

<u>Involving a third-party entity to lead and coordinate multi-party monitoring was essential</u>

CFRI served as a primary entity to lead and coordinate the UP-CFLRP's multi-party monitoring efforts. Through its congressional authorization and appropriated funds, CFRI has a mission, expertise, and capacity to conduct social, economic, and ecological monitoring of forest restoration and wildfire risk mitigation to inform adaptive management – the practice of intentional learning-by-doing in the face of uncertainty. CFRI personnel served as part of a core team to convene, coordinate, and facilitate the UP-CFLRP's stakeholder collaboration process, and leveraged its own funding against UP-CFLRP funds to hire, train, and mentor personnel contributing to the monitoring program.

One benefit of having a dedicated third-party monitoring lead was that it allowed the US Forest Service and other partners to focus on the project planning and implementation components. Even though funds averaging $25,000/year was allocated by the GMUG to CFRI to support the monitoring efforts, the funding agreements afforded CFRI a high degree of independence to develop and implement the details regarding data collection and analysis methods and generate and interpret results. In turn, CFRI delivered oral and poster presentations, and generated written reports, to the stakeholders involved in the UP-CFLRP describing methods and results and facilitating collaborative learning about the results to develop interpretations – the "So what?" part of monitoring. This approach to communication and transparency was essential to fostering trust in the monitoring strategy and results, and in the UP-CFLR project as a whole.

<u>Turnover and shifting attention of participants occurred over time</u>

It's not surprising that, over the course of 15 years, people came and went throughout the life of the project; they took different jobs, relocated for professional or personal reasons, retired, passed away, or simply moved on to new issues they cared about. This turnover had notable impacts. When the original leaders in the GMUG and across the communities of interest who participated in the collaborative engagement portion of the UP-CFLRP eventually moved on, the attention to the UP-CFLRP declined. Perhaps there is natural decay of enthusiasm once a project advances; there is not much new to see and learn, and discussions might have gotten redundant.

Turnover in CFRI staff during the first few years of the monitoring effort resulted in inconsistencies in methodology, training and oversight. As a result, we lost several years and sites of useable data.

On a positive note, independent of the turnover issue, it appeared that the repeated years of monitoring results contributed to both building trust and assuaging concerns among some participants concerned with the potential impacts of the project. One notable example is that some members of the Great Old Broads for Wilderness were satisfied with CFRI monitoring results showing no adverse impacts from forest treatments; their interest waned in subsequent years in hearing about the same monitoring being repeated.

Additionally, a new forest management issue and large-scale project drew a lot of attention and energy in the latter stages of the UP-CFLRP: the Spruce Beetle Epidemic-Aspen Decline Management Response (SBEADMR) project. SBEADMR was initially proposed in 2014 and eventually had its own public engagement process. It was highly controversial and diverted the energy and attention of both GMUG personnel and communities of interest in forest management on the GMUG.

Linking monitoring to adaptive management

Monitoring is a critical component of adaptive management. Monitoring is intended to provide empirical data about the results of implemented actions, so that managers can learn about what worked or didn't work and make adjustments to subsequent implementation activities (Fig. 1).

In reality, linking UP-CFLRP monitoring results to subsequent changes in project goals and management actions proved challenging for several reason.

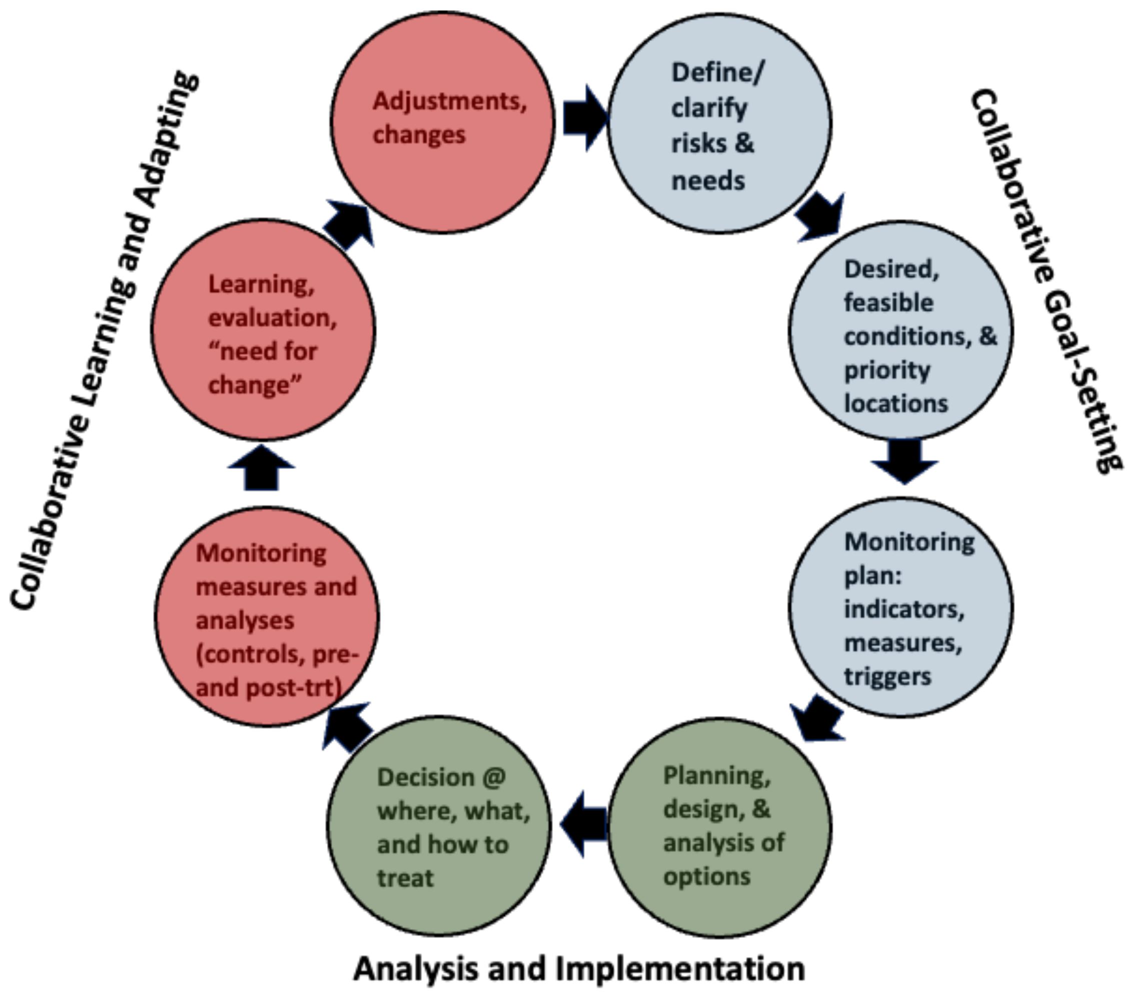


Figure 1. The collaborative adaptive management cycle (adapted from Marcot et al. 2012. "Recent advances in applying decision science to managing national forests". *Forest Ecology and Management* 285:123-132)

One challenge is aligning the timeframes for implementation and monitoring results. UP-CFLRP project implementation occurred through various contracting mechanisms, through different program areas, and on different schedules. For the mechanical and manual forest thinning treatments, contracts ranged in timeframe from one year to 3-4 years, depending on the size and complexity of the project. For prescribed burning projects, implementation occurred when there were appropriate "burn windows" -- an alignment of pre-defined fuel moisture, weather, and atmospheric conditions conducive to a burn achieving its stated objectives. Burn windows also had to align with available wildland fire management resources and capacity – trained wildland fire and fuels management crews, equipment, water resources, logistic support, and partners.

Ecological field monitoring, on the other hand, occurred on an annual basis during the summer months when there is an available workforce in the form of high school interns, and when weather and road conditions are favorable for field work. As such, annual monitoring results weren't always aligned with implementation schedules. Furthermore, ecological responses – such as plant community growth and development – can often take five years or more to manifest. In the case of tree establishment, growth, and mortality, changes occur over decades. By the time meaningful ecological changes appeared in the monitoring results, the project implementation was at least half completed, with many other projects already designed and contracted.

Second, it was unclear the extent to which monitoring results were being used by managers to adjust their activities in subsequent years of UP-CFLR. In most cases, monitoring results verified what managers generally already knew through their field observations. The exception has been the effect of treatments in areas with a large component of Gambel oak.

From CFRI's perspective, there are options to address the mismatch in timelines between ecological monitoring and project implementation, and thus we suggest a targeted monitoring and reporting strategy. First, focus on monitoring and reporting on ecological monitoring for attributes of concern with relative short responses, such as propagation of undesirable non-native plants, treatment effects on rare native understory plants, mortality of trees from a prescribed burn, or changes in wildlife use of a project area. These can be measured and reported on in 2-3 year cycles and could inform subsequent project implementation designs and prescription.

Second, a monitoring entity like CFRI, stakeholders, and managers should consider conducting a 5-year review of monitoring results before proceeding with additional projects. This would allow sufficient time from ecological responses to manifest before designing and implementing new projects, and to ensure that results are explicitly and transparently considered in subsequent projects.

Third, plot-level monitoring results need to be aggregated and complemented with landscape-scale change monitoring analysis to assess the ecological effect of forest management at larger geographic scales. Effects could include, but not limited to, changes in fire propagation and intensity, impacts on habitat suitability of wildlife species of interest across their life-cycles and on populations, and alterations in hydrology in watersheds of interest. Such larger and longer scales of monitoring would be useful to adaptations to subsequent forest management project designs and to the GMUG's biennial monitoring and evaluation reports, and future forest plan revisions.

Background on the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project

The Forest Service and partners for the "Uncompahgre Plateau Collaborative Forest Landscape Restoration Project" (Uncompahgre CFLRP) are working to enhance the resiliency, diversity, and productivity of a priority landscape in the Rocky Mountains. The Plateau is located within five counties on the Western Slope of Colorado and includes key watersheds that feed the Colorado River. Cooperative relationships on the Western Slope of Colorado have been developing over the past 15 years, beginning with the formation of the Public Lands Partnership and Uncompahgre Partnership (UP) in the mid-1990s. Strong bonds and trust have been created among community members, public land managers, environmentalists, academia, agency researchers, recreation groups, local governments, energy industry, ranchers, timber companies, and the general public. The Uncompahgre CFLRP builds on this history of landscape-scale collaborative stewardship and applies a science-based ecosystem approach to restore vital forest health to the communities of western Colorado.

The Uncompahgre CFLRP is informed by evolving science, creates jobs while supporting local industry, reduces fuels, and ultimately restores a landscape that will support large-scale beneficial fire. Adaptive management based on locally informed science-based evidence guides our actions, and monitoring is fundamental to improving our work. We aim to eventually reduce forest management expenditures (including wildfire suppression costs); support local industry; and promote new economic opportunities. This project applies active management of forests and rangelands and creates greater resiliency to natural and man-caused disturbances; this progress will be particularly important if future climates shift toward warmer, drier conditions.

The Uncompahgre CFLRP encompasses 160,000 ac of the Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests, which are all managed by the USDA Forest Service from 2010 through 2020. These treated areas will influence fire risks across 555,300 ac of the Plateau (out of a total 1.5 million ac). Treatments will include prescribed burns, mechanical treatments, timber harvesting, invasive species treatments, re- vegetation with native seed, trail and road relocations to reduce sediment, riparian restoration, and improvements for Colorado River cutthroat trout. Multi-party monitoring efforts are proposed for 68,000 ac.

As of 2016, most of the mechanical treatments have been completed in the 17,000 ac Uncompahgre Mesas Forest Restoration Project – the first "NEPA-ready" project (projects that have completed environmental analysis requirements under the National Environmental Policy Act) to be implemented under the Uncompahgre CFLRP. Implementation of treatments in the 130,000 ac Escalante Project are ongoing. There was also a native seed program with many species of grasses and forbs ready to apply to the landscape; an existing and active invasive species eradication program; a Travel Management Plan; and Fire for Resource Benefit Plan in place. The largest remaining forest product company in Montrose Colorado still remains, making this effort economically possible.

Previous National Forest System (NFS) restoration efforts on the Uncompahgre Plateau have been limited and concentrated around private inholdings and infrastructure to provide fuels reduction, WUI protection benefits and mule deer habitat enhancement. In addition, several weed management areas have been intensively treated for invasive species, including spotted knapweed, yellow star thistle, and others. In 2004, the National Environmental Policy Act (NEPA) analysis for Spring Creek/Dry Creek Landscape was completed and fulfilled a variety of on- the-ground restoration and vegetation management treatments. These combined treatments, totaling 20,000 ac on NFS, Bureau of Land Management (BLM), and private lands, represents a major success for active management at ambitious scales. The work supported by the Collaborative Forest Landscape Restoration Program (CFLRP) has built on this success to dramatically enhance the future forests, woodlands, and rangelands of the Uncompahgre Plateau on a landscape scale.

Goals and Objectives for the Uncompahgre Plateau Collaborative Restoration Project

Collaborative efforts dating back to the late 1990s have led to the development of a set of six goals for improving the future landscapes of the Uncompahgre Plateau:

1. Enhance the resiliency, diversity, and productivity of the native ecosystem on the Uncompahgre Plateau using best available science and collaboration.
2. Reintegrate and manage wildfire as a natural landscape-scale ecosystem component that willreduce the risk of unnaturally severe or large crown fires.
3. Restore ecosystem structure, composition, and function to encourage viable populations of all native species in natural patterns of abundance and distribution.
4. Preserve old or large trees while maintaining structural diversity and resilience; the largest and oldest trees (or in some cases the trees with old-growth morphology regardless of size) should be protected when feasible from cutting and crown fires, focusing treatments on excess numbers of small young trees where this condition is inconsistent with Historical Range of Variability (HRV) conditions.
5. Reestablish meadows and open parks and re-establish grasses, forbs, and robust understory communities.
6. Manage herbivory. Grass, forbs, and shrub understories are essential to plant and animal diversity and soil stability. Robust understories are necessary to restore natural fire regimes andto limit excessive tree seedling establishment. Where possible, defer livestock grazing after treatment until the herbaceous layer has established its potential structure, composition, and function. Project partners will work with Colorado Parks and Wildlife to manage big game populations to levels that will contribute to successful restoration treatments.

Specific treatment objectives for the major vegetative communities within the project area, as well as examples of proposed types of projects, include (acreages are from 2017):

Sagebrush. Restoration treatments are needed to improve the understory, increasing available forage for both wildlife and domestic livestock. The GMUG will work closely with the Colorado Parks & Wildlife (CPW) to target key Gunnison sage-grouse habitat areas as well as take advantage of biomass potential of pinyon-juniper in reestablishing key openings. Nearly 2400 ac of sagebrush treatments, mostly with mechanical treatments, have been completed by 2016; additional treatments will continue in the future.

Pinyon-Juniper (PJ). The PJ cover type is currently the largest cover type on the Plateau. A comparison between 1937 and 1994 showed that PJ expanded into areas formerly dominated by shrublands and grasslands, and the density of PJ stands has increased. These changes have decreased the amount of available forage for both wildlife and domestic livestock and have degraded habitat for Gunnison sage-grouse. The landscape restoration project has reduced fuels and enhanced the patchy mosaic of vegetation types (and ages) by masticating trees on approximately 5000 ac. The treatment units have also been designed to reduce invasion into other cover types. Additional treatments will continue in the future.

Mountain Shrub (MS) (Oak/service berry/mountain mahogany). Mastication projects with some follow-up prescribed burning have been completed on over 12,600 ac to mimic natural fire disturbances and have resulted in a patch mosaic with 10% to 15% of MS in the early seral stage; work on an additional 1500 ac is planned for the future. The resulting mosaic will improve forage and grazing and limit the size of large crown fires when they occur.

Ponderosa Pine (PP). Restoration in the PP cover type will reduce tree density by cutting large numbers of small-diameter trees relative to larger trees; improve spatial heterogeneity; protect old-growth ponderosa pine; increase long-term structural diversity (within stands and across landscapes); and create fuel conditionsthat reduce the likelihood of uncharacteristically severe fires, by reestablishing the high-frequency, low- intensity historic fire regime. Both commercial and noncommercial treatments will be accomplished with mechanized equipment. Post-harvest prescribed fire will be used as part of our strategy to reintroduce fire as an active part of the landscape. We will design treatments to reduce surface and ladder fuels, create conditions favorable to the growth of grasses, forbs, and shrubs, and then continue to use wildfire as a management tool to maintain these ecosystems. More than 15,200 ac are completed, and more treatments are planned for the future.

Mixed Conifer (MC) (ponderosa pine/aspen/Douglas-fir/blue spruce/Engelmann spruce/sub-alpine fir). Restoration treatments in the MC cover types will reduce tree density and develop more open conditions characterized by multi-age structure and multi-species tree composition. Treatments will increase diversity of forest structures within stands, including variety in spatial arrangement of residual trees and developmentof small (0.1 to 0.5 ac) meadows. Because the future is expected to be hotter and drier, treatments will create conditions favorable to Douglas-fir, ponderosa pine, and aspen regeneration over blue spruce. Prescriptions will generally favor the perpetuation of aspen on the landscape by encouraging regeneration. Both commercial and noncommercial treatments will be accomplished with mechanized equipment. Most areas will receive follow-up broadcast burning. The fire regime in the cooler, moister mixed-conifer forest was undoubtedly a less-frequent mixed-severity regime; fire in places would creep through mixed conifer forest, consuming little fuels and killing only small trees, while in other areas torching and killing groups or patches of large trees. The reduction in surface, ladder, and canopy fuels will result in a lower risk of stand- replacing fire and will create the conditions necessary to reinitiate the historically safer, mixed-severity fire regime. Over 5000 ac of restoration projects have been completed by 2016, including the Unc Mesas Projectand treatments along Western Area Power lines; over 6,000 ac of MC treatments are planned for the future.

Aspen. There is an urgent need to treat aspen stands. Only one-quarter of the stands are younger than 80 yr which are predominantly 80 to 120 yr old and therefore less resilient to Sudden Aspen Decline (SAD). SAD is a relatively recent phenomenon, not described by regional insect and disease experts until 2007. Foresters estimate that approximately 37% of the aspen cover type on the Plateau is impacted by SAD; about one-fourth of the standing aspen trees on the Plateau are dead. Mortality is having the greatest impact on medium-size trees (3-9” DBH); this combined with the dramatically low rates of establishment of new aspen trees creates a high risk of major reductions in aspen on the Plateau. Young aspen trees are rare across thePlateau, as are young stands of aspen. SAD stands on the Plateau continue to decline, but SAD stands are notcurrently increasing, and healthy aspen regeneration is occurring across the landscape. Approximately 7700 ac of NFS aspen projects have been implemented, and an additional 3300 ac are planned. Restoration treatments in other vegetation types will also favor aspen.

Spruce-fir (SF) (Engelmann spruce and subalpine fir). The Plateau has very few young spruce-fir forests; historically we expect young (<75 years) stands to have comprised 20 to 70% of the spruce-fir forests of the Plateau (varying in response to majorfires across decades). Although any single acre of spruce-fir forest on the Plateau may not be outside the historical range of variation that would have been common for spruce-fir forest, the overall landscape of the Plateau is probably well outside historical conditions. The near-absence of young spruce-fir forests results in a low diversity in age, size, and seral conditions, with large implications for wildfire spread and insect/pathogen outbreaks. The potential for biomass utilization and stewardship contracting is excellent, providing both anopportunity to restore a missing part of the forest landscape and funds (from commercial harvests) to help offset the cost of restoration work in the ponderosa pine and mixed-conifer. More than 2600 ac of SF treatments have been implemented, and an additional ~1400 are planned.

Monitoring Projects

Applied Silvicultural Evaluation for Spruce Patch-Cuts

Leadership people:
Seth Ex (Colorado State University), Todd Gardiner (GMUG)

Overall goals and objectives:
This monitoring work will yield insights into tree seedling establishment and future composition of the forest following group selection treatments in the wet mixed conifer stands that cover a considerable portion of the Uncompahgre Plateau. This work has two main objectives: 1) determine appropriate opening sizes and slash treatments for group selection regeneration treatments on the Uncompahgre Plateau to foster natural regeneration of Engelmann spruce from seed, 2) evaluate how the same factors affect survival of planted seedlings. To meet these objectives, we planted seedlings and sowed seed in sets of plots with various levels of slash retention arrayed at increasing distances from the edge of openings within the Columbine timber sale using a replicated, randomized, complete block design. We also distributed a set of temperature sensors across the set of locations and levels of slash retention to determine whether these factors alter microsite temperatures in a way that is meaningfully related to seedling establishment.

Key questions to be examined:
This study is designed to yield immediate insights into how opening size and slash treatment affect natural and artificial regeneration of trees in openings on the Uncompahgre Plateau. It will continue to yield insights over time as we re-visit plots in subsequent years and monitor multi-year seedling survival and growth.

Objectives for [2015] monitoring (multi-year monitoring project):
Objectives in year 1 of this project were to establish permanent plots, plant seedlings and sow seeds, monitor seed germination and survival over the first growing season, and evaluate planted seedling survival and height growth at the end of the first growing season. We met all these objectives.

Objectives for [2016] monitoring (multi-year monitoring project):
Objectives in year 2 of this project were to re-measure plots at the beginning and end of the growing season, and to collect over-winter and second growing season temperature data from sensors. We met these objectives.

Objectives for [2017] monitoring (multi-year monitoring project):
Objectives in year 3 of this project were to re-measure plots as in years 1 and 2 as well as re-monument permanent plots. The next steps for this project in year 3 were to relocate temperature sensors to smaller openings within the Smokehouse timber sale to collect temperatures over the growing season, and to install seed traps in the same openings to quantify seed pressure. We should also consider fall cone collection to support a second paired sowing / planting trial of Engelmann spruce, Douglas-fir, and ponderosa pine in Smokehouse openings.

Objectives for [2018] monitoring (multi-year monitoring project):
Our objectives in year 4 were to re-measure the original set of plots within the Columbine timber sale as

before, collect temperature data, and collect samples from seed traps. If we move forward with a second, multi-species paired sowing/planting trial in openings within the Smokehouse timber sale we could establish that study in year 4.

Protocol:

Spatial scale of the area under consideration:

The spatial scale of this study is confined to the Columbine (2015-present) and Smokehouse (planned 2017 onward) timber sales.

General approach:

Repeated measurement of permanent plots within a randomized, replicated experiment.

Locations to be assessed:

Openings within timber sales in mesic spruce-dominated stands on the Uncompahgre Plateau.

Measurements to be taken at each location:

Repeated measurement of seedling number and height (for planted seedlings), download of temperature data from sensors. Collection of samples from seed traps from 2017 onwards.

People engaged in measuring (agency, volunteers, etc.):

Numerous graduate and undergraduate students at CSU. Ryan Davy installed the permanent plots in the Columbine openings as part of his thesis work.

Data management plans:

Data are in spreadsheets that are stored on redundant hard drives in the Silviculture Lab at CSU. Analysis of the first 2 years of data are complete and a manuscript is in preparation.

Data archiving plans:

Data will be archived at CFRI.

Plan for communicating findings to collaborators, line officers:

Findings have been presented at several CFLRP and SBEADMR stakeholder meetings and field trips. We will continue to use these venues to update collaborators and line officers. We will circulate a summary of second year results in spring 2017 ahead of their anticipated publication.

Aspen Browsing

Leadership people:
Dan Binkley (CSU), Bill Romme (CSU), Tim Garvey (GMUG)

Overall goals and objectives:
1. Determine how substantial the effects of browsing on aspen regeneration (to tree-size recruitment).
2. Determine to what extent browsing impacts result from cattle versus deer and elk?
3. Determine the pattern of browsing impact across the Plateau and are there any apparent explanations for the pattern (elk populations within local areas; season of use by elk or cattle; basic site factors (such as elevation, forest type, conifer basal area).
4. Determine how recent patterns of aspen regeneration differ over the course of the past 200 yr? Does aspen regeneration improve in the future, both inside and outside exclosures?

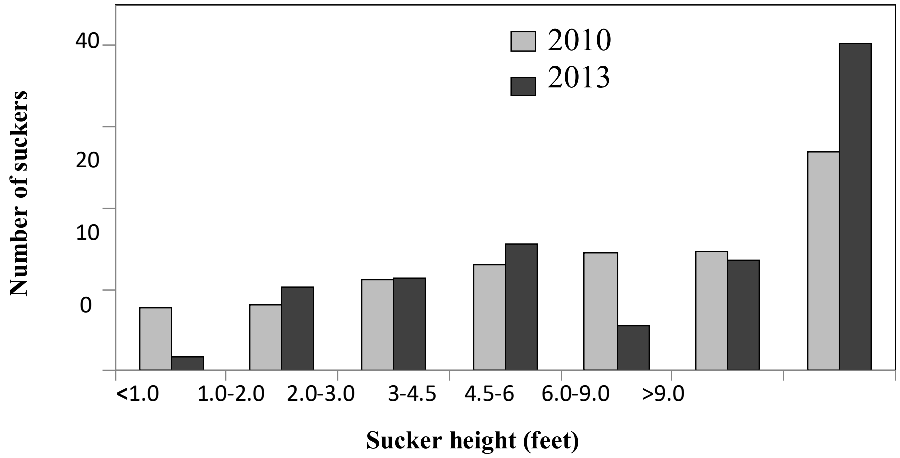
Objectives for 2013 monitoring:
Follow-up monitoring of aspen regeneration in exclosures set up in 2010.

Key questions to be examined:
See #1-4 under goals and objectives.

2013 Findings:
The heights of aspen suckers inside the fenced exclosures did not differ very much between 2010 and 2013 (with 4 growing seasons), even for the locations where browsing on aspen suckers appeared moderate or heavy outside the exclosures (see figure). At this point, our conclusion is that browsing does not appear to hold back height growth on aspen suckers over most of the Plateau.

Objectives for 2014 monitoring:
Perform a thorough assessment of plots inside and outside the exclosures, as well as the transect plots through the forest.

2014 Findings:
- Browsing intensity varies greatly across the plateau, from almost none to almost 100%.
- Browsing is preventing growth into tree-sized aspen in a few places on the plateau, but not very many places.
- Across the plateau, most aspen stems are increasing in height very slowly or not at all—regardless of whether they are being browsed or not, or whether they are inside exclosures or not. The only places where growth is relatively rapid is in recent burned areas and clearcuts.
- In recent clearcuts, aspen is somewhat denser and are growing somewhat faster inside exclosures than outside exclosures—but even outside the exclosures, aspen density and growth are adequate to re-stock the stands.
- Overall, browsing by elk, deer, and cattle is not a threat to aspen regeneration, except in a few select locations. We may need more fire and/or more harvesting if we want to regenerate more aspen on the UP.



Pattern in height change 2010-2014:	Forest Type	% Browsed in 2012	Other Events
Inside increased, outside decreased	***Pure aspen***	***43***	***n/a***
Inside increased, outside decreased	***Pure aspen***	***43***	***n/a***
Inside increased, outside decreased	***Pure aspen***	***31***	***n/a***
Inside increased, outside decreased	***Pure aspen***	***31***	***n/a***
Inside no change, outside decreased	Pure aspen	58	n/a
Inside increased, outside no change	Pure aspen	86	n/a
Inside increased, outside no change	Aspen - pine	90	n/a
Inside increased, outside increased	***Aspen mixed conifer***	***21***	***Mechanical thinning***
Inside increased, outside increased	***Aspen mixed conifer***	***30***	***Canopy mortality***
Inside increased, outside increased	***Aspen mixed conifer***	***25***	***n/a***
Inside no change, outside no change	***Aspen - pine***	***15***	***n/a***
Inside no change, outside no change	***Pure aspen***	***19***	***n/a***

Protocol:

Spatial scale of the area under consideration:

Entire Plateau where aspen trees occur.

General approach:

Multiple approaches:

1. Plateau-wide survey with prism cruises (in 9 plots/ triangle location) to determine aspen size and age structure.
2. Plateau-wide survey to quantify aspen regeneration (vertex plots of prism triangles).
3. Various exclosures to determine ability of aspen suckers to develop into tree-size classes, in intact stands (pure aspen, aspen-conifer) and SAD-affected stands (pure aspen, aspen-conifer).
4. Exclosures established in the past in clearcuts will be measured to demonstrate the impacts of browsing on aspen regeneration.

Locations assessed:

1. Over 60 triangle plots were chosen randomly across the Plateau for aspen size/age/regeneration quantification; report completed in 2011.
2. Twelve exclosure sites, chosen to represent pure aspen and aspen/conifer types, with and without substantial recent death of overstory aspen.

Measurements to be taken at each location:

1. Triangle plots: aspen basal area and stem DBH (both living and dead); qualitative aspen regeneration for 9 points of each triangle; measurement of aspen sucker numbers by height class in 3 fixed-area plots in each triangle location.
2. 12 exclosures: measure number of aspen suckers by height classes inside and outside, early and late in the growing season; measure aspen suckers by height class in 6 plots along a transect extending from each exclosure to document browsing impacts (and if possible, time of browsing).

People engaged in measuring (agency, volunteers, etc.):
Summer 2013: Bill Romme, Dan Binkley

Data management plans:
Data entered and analyzed in Excel spreadsheets; synthesized and reported by Dan and Bill.

Data archiving plans:
Copies of master data sets will be stored with Dan, with Bill, with the Ouray District, and with CFRI. Copies of photos from each exclosure will be stored in the same locations.

Plan for communicating findings to collaborators, line officers:

1. Presentations at annual UP collaborative meeting (2016).
2. Scientific journal article in 201.

Citizen Scientist Webpage

Leadership people:
Greg Newman, CSU and Natural Resource Ecology Laboratory (NREL).

Additional People:
Russell Scarpino, CSU and NREL.

Overall goals and objectives:
Develop a website in support of community-based monitoring activities among a wide array of value holders across the Uncompahgre Plateau. The goals are to: (1) support high school student weed mapping and monitoring activities as desired by the team and that may include Montrose High School (Rusty George, teacher), (2) support community-based citizen science monitoring activities for forest health monitoring as desired by value holders, and (3) ensure that all monitoring data are entered into the web portal, can easily be visualized and updated as new data are submitted, and that the data can easily be downloaded in a variety of formats and in such a way to facilitate vetting of data and eventual submittal to USFS data management systems (e.g., NRIS, Terra Grid, etc.).

Objectives for 2013 monitoring:
Ensure basic weed mapping data entry forms are in place for spring 2014 monitoring activities.

Objectives for 2014-2017:

1. Improve Project Profile performance.
2. Develop a My Profile page so that individual monitor can see statistics about their contributions.
3. Automate data export for common fire prediction software formats.

2013 findings and progress:

- Current website / project page (a project within the citsci.org system) can be seen here: http://www.citsci.org/cwis438/Browse/Project/Project_Info.php?ProjectID=331
- We have developed the ability for Leigh Robertson and/or high school teachers (e.g., Rusty George) to create weed monitoring data entry sheets. At this time, it is up to project managers to define which species they would like students to map and monitor and create their own data sheets as needed for such monitoring.
- We added the ability for project managers to be able to define "pre-defined monitoring locations" so that project members/participants can easily pick a location they monitored from a drop-down of pre-defined locations defined by the project manager.
- We added the ability for project managers to invite project members by entering in the email address of trained members; the system automatically registers the new user, creates a password for them that they may change, adds them as an approved data contributor for the specified project, and sends them an email with their login and assigned password (this works much like an eVite system).
- We improved the performance of the project profile map of all project data to support an unlimited number of observations and display them all quickly. Our approach was to draw clustered points when total number of observations exceeds 10,000 and make it so that one clustered point becomes many points when the user zooms in on the map. We are finishing the design of a customizable data analysis and visualization tool that we hope to be available May 2014 that will enable project managers to create custom analyses/visualizations by selecting from the data measurements they

have identified for their volunteers to measure and then selecting as dependent and independent variables for graphs.

2014-2017findings and progress:

- New project page (a project within the citsci.org system) can be seen here: http://www.citsci.org/cwis438/Browse/Project/Project_Info.php?ProjectID=331 and has been optimized for improved performance.
- We developed a new My Profile page that provides real-time statistics for volunteer forest health monitors to instantly be able to see the total number of observations, locations they monitor, and number of measurements they have made and submitted to CitSci.org. The page also lists the projects of which they are a member of and offers a variety of privacy andother related options.
- Automated export of data in useful formats for common fire modeling software is not yetcomplete and requires additional funding.

Key questions to be examined:
Can trained community members collect and submit quality forest health monitoring data?

Protocol:

Spatial scale of the area under consideration:
The Uncompahgre Plateau.

General approach:
Agile website development approach.

Locations to be assessed:
1. Weed monitoring plots (TBD).
2. Forest health monitoring locations (TBD)
.

Measurements to be taken at each location:
1. Presence/absence of noxious weeds and percent ocular cover.
2. Forest health monitoring data, including fuels, biomass, DBH, etc.

People engaged in measuring (agency, volunteers, etc.):
Volunteers and high school students.

Data management plans:
Available upon request.

Data archiving plans:
Available upon request.

Plan for communicating findings to collaborators, line officers:
Online approaches (transparent and freely open).

Delta High School Internship Program

Leadership people:
Matthew Dare (USFS GMUG), Luke Holguin (USFS Norwood and OurayRanger District)

Overall goals and objectives:
Continue the successful internship program at Delta High School. Each year we "employ" a student to participate in a 6-week program during which they learn about careers in public lands management and conduct independent scientific investigations.

Key questions to be examined:
Questions change from year to year based on agency needs andstudent interests.

Objectives for [2016] monitoring (multi-year monitoring):
Two students from Delta High Schoolparticipated in the program in 2016.

Objectives for [2017] monitoring (multi-year monitoring):
TBD; however, we intend to includeNorwood High School in the 2017 program.
Objectives for [2018] monitoring (multi-year monitoring):
TBD

Protocol:

Spatial scale of the area under consideration:
The Uncompahgre Plateau.

General approach:
Approximately 3 weeks of job shadowing with USFS personnel followed byapproximately 3 weeks of guided research. Guided research projects are coordinated and supervised by USFS personnel and a High School Science teacher.

Locations to be assessed:
Various locations on the Uncompahgre Plateau.

Measurements to be taken at each location:
TBD

People engaged in measuring (agency, volunteers, etc.):
Agency personnel participate in job shadowing experiences each year. We have coordinated involvement of ColoradoParks and Wildlife personnel in the past. We will continue to involve CPW personnel based on their availability. Each high school selects two students to participate in the program. Additionally, the school district identifies a teacher-mentor to participate in the program and mentor the students. In 2016, the Delta program was lucky to have Kevin Dunbar participate asthe teacher mentor. Mr. Dunbar is a science teacher at Cedaredge High School, and he has expressed interest in returning to serve as the teacher-mentor in 2017.

Data management plans:
All data are stored on server drives and uploaded to the appropriatecorporate databases.

Data archiving plans:
All data are stored on server drives and uploaded to the appropriate corporate databases.

Plan for communicating findings to collaborators, line officers:
Students present their findings to USFS personnel and CFLRP stakeholders at the conclusion of each year's internship (July).

Dominguez Creek Stream Temperature Monitoring

Leadership people:
Matthew Dare (USFS GMUG)

Overall goals and objectives:
The GMUG began an intensive stream-monitoring campaign in 2011, and the project is ongoing. Data from across the forest were integral to the completion of predictive stream temperature models developed by the Forest Service's Rocky Mountain Research Station (RMRS). Big Dominguez Creek was one of more than 40 streams included in the sampling array. Within the larger stream temperature sampling project, we deployed several temperature sensors in Big Dominguez Creek to evaluate changes in stream temperature.

Key questions to be examined:
How does maximum summer stream temperature change as water flows downstream in Big Dominguez Creek?

Objectives for annual monitoring (multi-year monitoring project):
Annual monitoring includes one permanent stream temperature sensor deployed in Big Dominguez Creek. The sensor is visited, and data are uploaded every other year. Data will be periodically sent to RMRS, who plan to recalibrate the stream temperature models every 5 years.

Protocol:

Spatial scale of the area under consideration:
The entire GMUG National Forest. Predictive models recently completed by the Rocky Mountain Research Station apply to all perennial streams in Colorado. More information on the models, including the spatial data, can be found at:
https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html (accessed February 6, 2017).

General approach:
We maintain an array of stream temperature sensors at 40-50 locations across the GMUG National Forest. The sensors measure stream temperature every 30 minutes and store the data. We visit each sensor every 1-2 yr and upload data and replace the sensor if necessary. Sensors are glued to large boulders. Sensors can be deployed seasonally using a wooden anchor and PVC housing.

Locations to be assessed:
All perennial streams on the GMUG, including Big Dominguez Creek.

Measurements to be taken at each location:
Stream temperature measured every 30 minutes.

People engaged in measuring (agency, volunteers, etc.):
GMUG staff. In 2014 a student from Delta High School studied stream temperature in Big Dominguez Creek.

Data management plans:
All temperature data are archived in corporate databases as well as server drives. Data are periodically

transmitted to RMRS for model calibration.

Data archiving plans:
All data are stored on server drives and corporate databases.

Plan for communicating findings to collaborators, line officers:
Completed stream temperaturemodels are applicable to all perennial streams in Colorado. The data will be integral to several phases of the Forest Plan revision process. Additionally, stream temperature data have been used to evaluate streams on the Uncompahgre Plateau for suitability for native Cutthroat Trout introduction and management.

Economic Monitoring of Restoration Projects

Leadership people:
Tony Cheng, Kathy Mattor, Torston Lund Snee, and Hannah Bergemann (CFRI/CSU)

Overall goals and objectives:
Job creation, biomass utilization, and meaningful collaboration were identified as primary goals of the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project. The socioeconomic monitoring of the UP-CFLRP will be conducted as a project-level assessment of task orders completed in calendar year 2012 and will identify the economic contributions and summarize wood utilization, community attitudes, and collaborative outcomes that resulted. Outreach mechanisms relevant to forest management and wildfire preparedness and mitigation will be identified and recommendations will be made based on their effectiveness.

Objectives for monitoring:
The UP-CFRLP socioeconomic monitoring will:

1. Quantify economic contributions to local communities that result from UP-CFLRP task orders in calendar year 2012 and identify the extent to which economic goals of the UP-CFLRP were met.
2. Measure the types and amounts of wood utilization that resulted from these task orders.
3. Measure public attitudes toward forest management practices, particularly toward mechanical treatments and prescribed fire.
4. Describe collaborative outcomes for the development and implementation of the UP-CFLR project.
5. Provide recommendations for future monitoring efforts.

2013 Findings:
This excerpt from the Uncompahgre CFLRP 2013 Socio-economic Monitoring Report summarizes key findings:

Table 2. Economic Contributions of UP CFLR Task Orders in 2013

	2013
Employment (Full and part time jobs)	1.16
Labor Income	$46,275
Value Added (GDP)	$100,021

In 2013, 328 acres were implemented by private contractors. One hundred percent of the wood material harvested was utilized by local wood production facilities.

Key questions to be examined:
What impact have the restoration activities on the UP had on the economies of surrounding communities?

Protocol:

Spatial scale of the area under consideration:
The entire Uncompahgre Plateau.

Locations to be assessed:
All restoration treatment areas implemented as USDA Forest Service contracts to privateenterprises.

Measurements to be taken at each location:
Collection and analysis of monitoring data will include:

- Economic contribution and wood utilization surveys
- Use of the relevant literature and interviews of community members and collaborativestakeholders to assess community attitudes and collaborative outcomes
- Input-output analysis of survey results to determine the economic and employment impactsof UP-CFLR task orders

People engaged in measuring (agency, volunteers, etc.):
Tony Cheng, Kathy Mattor, Torston Lund Snee, and Hannah Bergemann

Data management plans:
Data files and models kept on secure, password-protected network drive at Colorado StateUniversity.

Data archiving plans:
Copies of the study results will be stored on the CFRI websites.

Plan for communicating findings to collaborators, line officers
Results will be communicated at collaborator meetings, and in CFRI reports. Agency colleagueswill be routinely brought up to date through frequent conversations as well.

Forest Structure on Unroaded Mesas

Leadership people:
Steve Hasstedt (CSU and USAF), Dan Binkley (CSU)

Overall goals and objectives:
To determine the current and historical structure of forests on three unlogged mesas (Free, Motley, Goodtimes), including the importance of soil depth in determining fire impacts and the presence of large "legacy" conifers.

Objectives for 2013 monitoring:
Determine ages of trees across the mesas and develop insights about historical fire timing and severity.

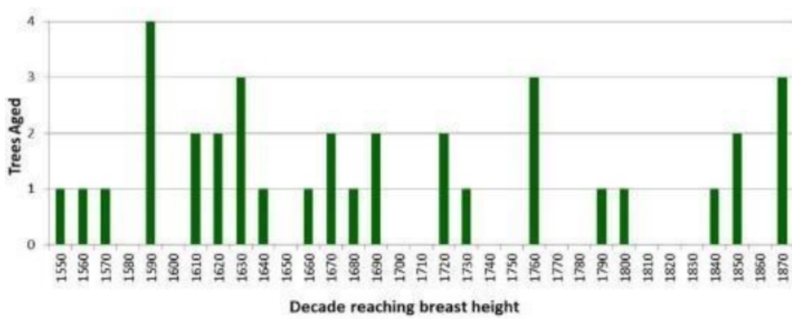
2013 findings:

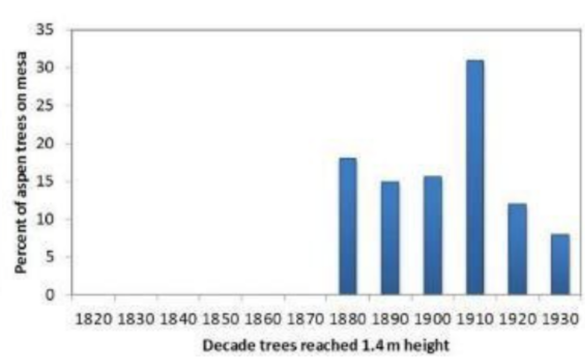
- 80% of plots on soils less than 6" deep had one or more heritage trees, compared with 20% of the deep soil plots; heritage trees are much more likely to be found on shallow soils.
- Many of the larger trees predate the known fire years of 1842 and 1879, indicating that fire intensity did not reach stand-replacing levels at the scale of the unroaded mesas (~250 ac).
- The current spatial pattern of surviving heritage trees shows that most of the area remained within 50 m of surviving conifers after the 1879 fire. This spatial pattern is important for providing seed for post-fire tree establishment.
- Aspen trees indicated that the 1879 fire had stand-replacing fire intensity (and perhaps earlier fires), but the 1879 fire removed any evidence of aspen stems.

Key questions to be examined:

1. Are heritage trees largely restricted to areas of shallow soil, where low biomass accumulation would have led to lower severity fires, allowing higher survival?
2. What was the dominant fire regime for these mesas?

Protocol:





Spatial scale of the area under consideration:
The ponderosa pine and dry mixed-conifer forests on the eastern side of the Plateau.

General approach:
Systematic plots covering the mesas, determining the species, size, and ages of dominant, old trees.

<u>Locations to be assessed:</u>
Primarily the three unroaded mesas, with some ancillary plots on Sawmill, Love, and KelsoMesas.

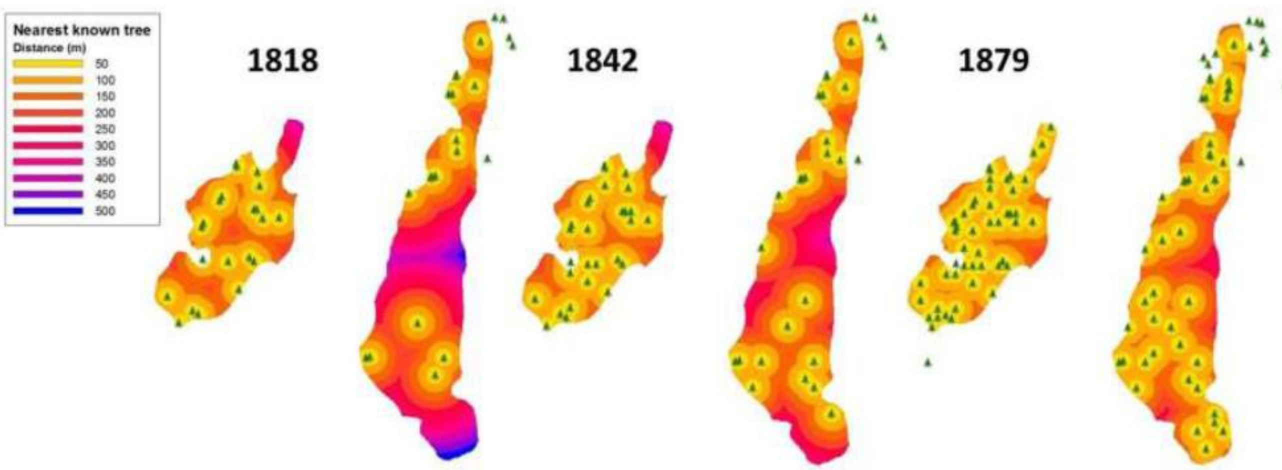
<u>Measurements to be taken at each location:</u>
Species, size, and ages of dominant, old trees.

<u>People engaged in measuring (agency, volunteers, etc.):</u>
Steve Hasstedt, Dan Binkley.

<u>Data management plans</u>:
Xcel spreadsheets.

<u>Data archiving plans</u>:
Copies of the data will be stored on the UP and CFRI websites.

<u>Plan for communicating findings to collaborators, line officers</u>
The results of the study will form the core of Steve Hasstedt's PhD dissertation and will be published in scientific journals (https://www.proquest.com/docview/1438884823?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses). The results have been shared with UP collaborators as theydeveloped, including a draft report to support the EA for the Escalante Project.



Gambel Oak Understory Response to Mechanical Treatments

Leadership people:
Marin Chambers (Colorado Forest Restoration Institute), Eric Freels (USFS- Grand Valley Ranger District)

Overall goals and objectives:
Gambel oak treatments in the La Fair project area were implemented in August of 2016 to improve wildlife browse and reduce ladder fuels in areas where ponderosa pine is interspersedwith Gambel oak understory. The area was mechanically treated in the form of mowing; prescribed fire is planned for the area in 2017-2018. The goals for treatments were to:

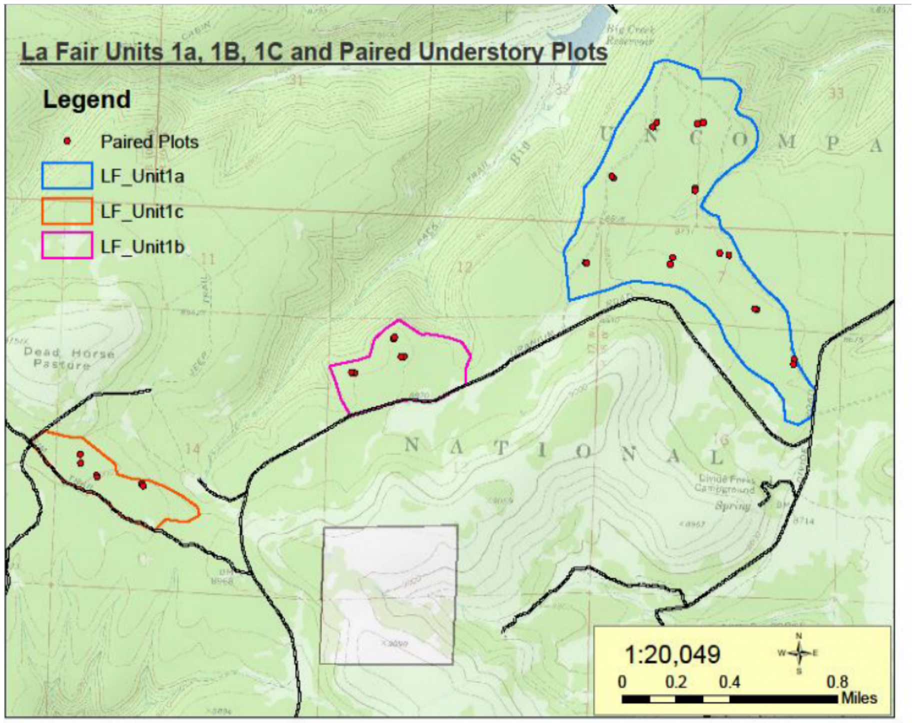
1. Thin ponderosa pine stands by mastication and burning to improve stand growth andhealth of the pine stand. This will maintain this timber component for potential future harvests and wildlife habitat.
2. Promote the growth of understory forbs and shrubs in treated stands.
3. Reduce the threat of a catastrophic wildfire to the forest and to adjacent private lands.
4. Reduce the threat of pine beetle infestation within the ponderosa pine stands.
5. Improve growing conditions for shrubs, grasses, and forbs in the understory and enhance the available forage for big game species and the livestock that utilize this area.

Gambel oak is a major component species that has contrasting management concerns as it is both an important wildlife habitat and a hazardous ladder fuel. Understory vegetation response to the removal of Gambel oak is important for wildlife managers to ensure the overall improvement of browse potential for many understory grass, forb, and shrub species. However, little is known about understory vegetation response to Gambel oak treatments (cutting, mowing, or prescribed burning); thus, treatments aimed at reducing Gambel oak may or may not actually improve wildlife browse potential. Locally relevant information on Gambel oak management is greatly needed to understand understory vegetation response to cutting and prescribed burning treatments in this species, in addition to the resprouting potential of this speciesto better understand treatment longevity and success.

Key questions to be examined:

1. How does understory vegetation respond to treatments (mowing or prescribed burning) ofGambel oak?
2. What is the growth response of Gambel oak following treatments in terms of density andgrowth of sprouts?
3. What influence does Gambel oak treatment have on conifer regeneration?

Objectives for [2016] monitoring (multi-year monitoring project):
Establish pre-treatment paired plots across all La Fair project units, where data will be collected on regenerating and overstory stems of Gambel oak, understory vegetation (to species level), other ground cover variables, and abiotic conditions. For each paired plot, one will be mowed and the other will be retained as a control plot.



Above: Map of La Fair treatment areas 1A, 1B, 1C, and paired plots (red dots) in the northern Uncompahgre Plateau. Unit 1a: 320 ac; Unit 1b: 150 ac; Unit 1c: 54 ac

<u>Objectives for [2017] monitoring (multi-year monitoring project):</u>
Return to paired plots following treatments and collect post-treatment data. CFRI will collect, retain, and analyze data, and provide a report for either the monitoring jam session in fall 2017 or for the 2018 annual meeting.

<u>Objectives for [2018] monitoring (multi-year monitoring project):</u>
If prescribed burning is successful in 2017-2018, CFRI will return to collect post-prescribe burning data in all paired plots. This could also occur in 2019 if prescribed burning is not completed until 2018 and if funding allows.

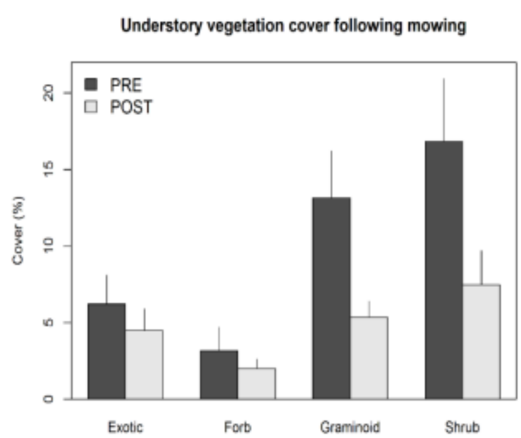


Figure 5: Bar plots depicting mean (±1 standard error of the mean) understory vegetation cover by functional group in mowed stands.

Findings:
Preliminary results one-year post-treatment in the La Fair treatment area illustrate that understory vegetation cover has declined and that understory species richness has little change. Mean percent cover of all understory vegetation functional groups declined following mowing (Figure 5); however, vegetation may recover 2-5 years following treatment. The mean cover of Kentucky bluegrass (*Poa pratensis*) and Tracy's bluegrass (*Poa tracyi*) declined one-year post-treatment, and mean cover of common dandelion (*Taraxacum officionale*) increased slightly (Figure 6). Mean percent cover of each mountain shrub species observed in the study area declined by > 50% (Figure 7). Total species richness (the number of different species represented in our study area) declined in control plots one year posttreatment, whereas total species remained constant in treated areas one year following mowing treatments (Figure 8). The decrease in species richness in untreated plots may be explained by the presence and absence of annual or biennial species or by human error (missed species in surveys). Species richness remained constant for shrubs following mowing, whereas exotic graminoid species richness decreased slightly, and richness of forb species increased following mowing (Figure 9). Species richness and evenness, as assessed by Shannon's and Simpson's Diversity Indices, were nearly constant across mowed and unmowed plots pre- and post-treatment (Table 1), indicating that mowing treatments did not negatively impact understory species diversity in the La Fair treatment area one-year post-treatment. Gambel oak regeneration remained constant in control plots, but mowed plots observed a 300% increase in regeneration density one year following treatment (Figure 10). Gambel oak regeneration was dominated by regeneration 6-24" tall one year following treatment (Figure 11 & 12), indicating that one year following mowing, Gambel oak sprouts can easily reach heights up to 2 feet tall. However, abundant regeneration occurred that was Tree and shrub regeneration was dominated by Gambel oak in our study area following mowing treatment, followed by aspen regeneration (Figure 13). Ponderosa pine regeneration occurred in the study area prior to mowing, but likely experienced mortality during mowing treatments; no Ponderosa pine regeneration was found following treatments.

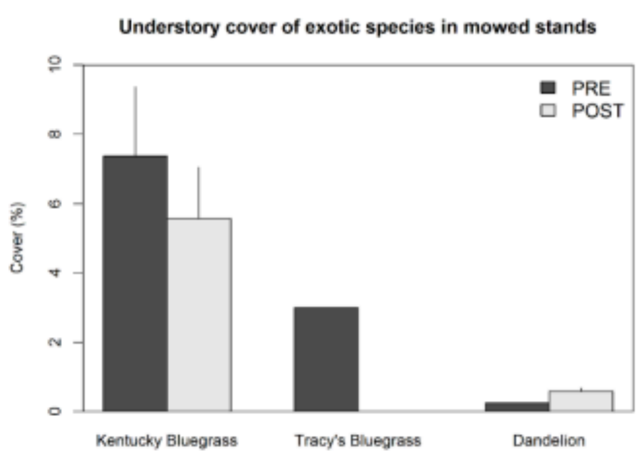


Figure 6: Bar plots depicting mean (±1 standard error of the mean) cover of individual exotic species in mowed stands of Gambel oak.

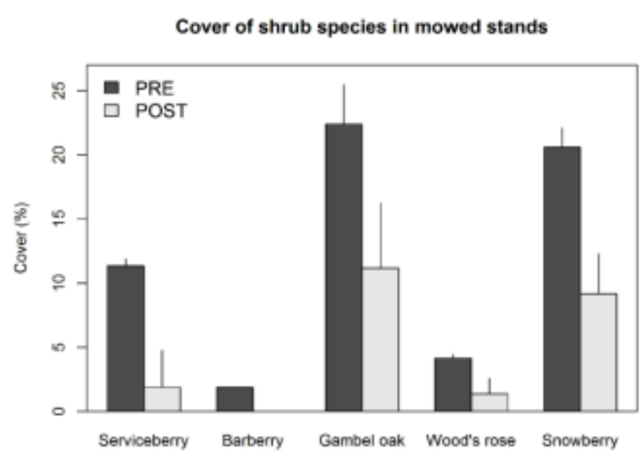


Figure 7: Bar plots depicting mean (±1 standard error of the mean) cover of mountain shrub species in mowed stands; mountain shrub cover declined by >50% in mowed stands for each species.

	Unmowed		Mowed	
	Pre	Post	Pre	Post
Shannon's Index	3.8062	3.6894	3.6627	3.7211
Simpson's Index	0.9710	0.9683	0.9669	0.9710

Table 1: Results for Shannon's and Simpson's Diversity Index in control and mowed plots pre- and post-treatment. Shannon's Diversity Index values range from 0-4, where 4 indicates a high level of species richness and evenness. Simpson's Diversity Index values range from 0-1, where 1 indicates the highest level of species richness and evenness.

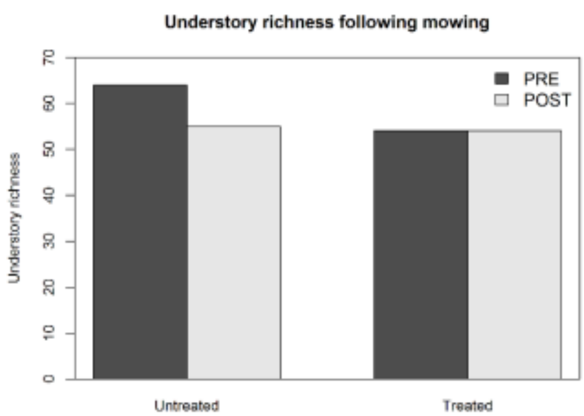


Figure 8: Bar plots depicting total understory vegetation richness in control and mowed stands.

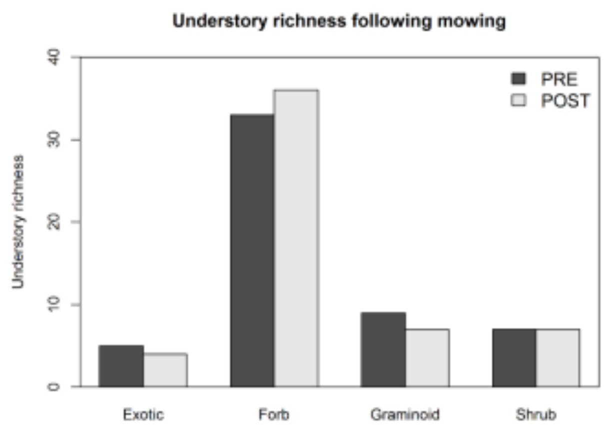


Figure 9: Bar plots depicting understory vegetation richness by functional group following mowing treatments.

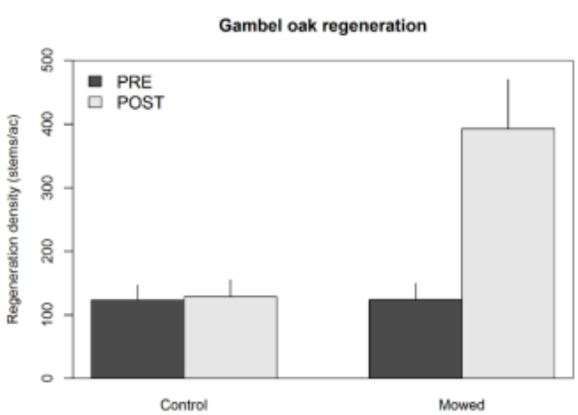


Figure 10: Bar plots depicting mean (±1 standard error of the mean) Gambel oak regeneration density in control and mowed plots pre- and post-treatment.

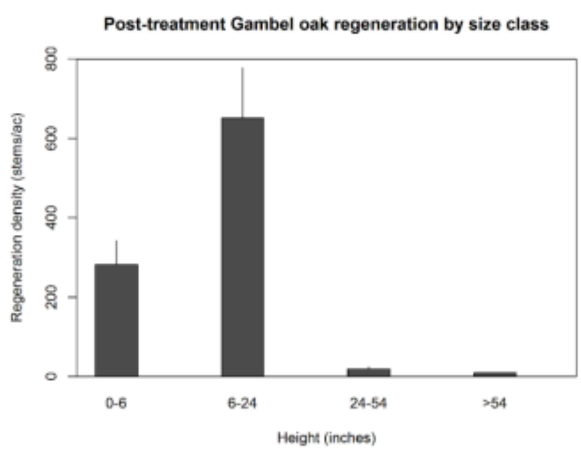


Figure 11: Bar plots depicting mean (±1 standard error of the mean) Gambel oak regeneration density by size class in mowed plots.

Figure 12: Photos illustrating a) Gambel oak regeneration representative of size class 0-6" tall; b) Gambel oak regeneration representative of size class 6-24" tall; c) Gambel oak regeneration representative of size class 6-24" tall and with many stems regenerating from a mowed stump.

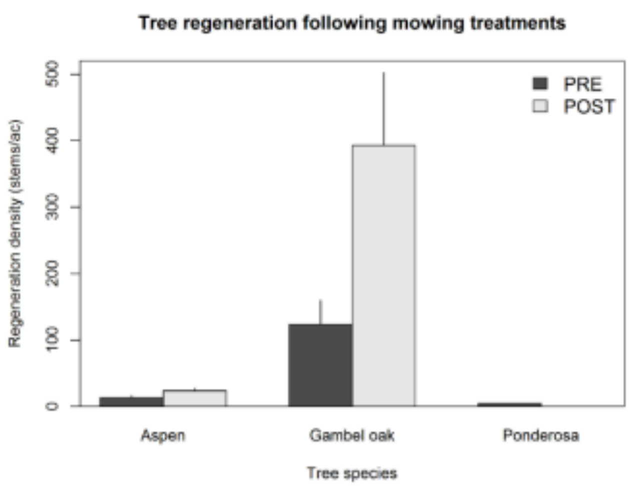


Figure 13: Bar plots depicting mean (±1 standard error of the mean) tree regeneration density in mowed plots pre- and post-treatment.

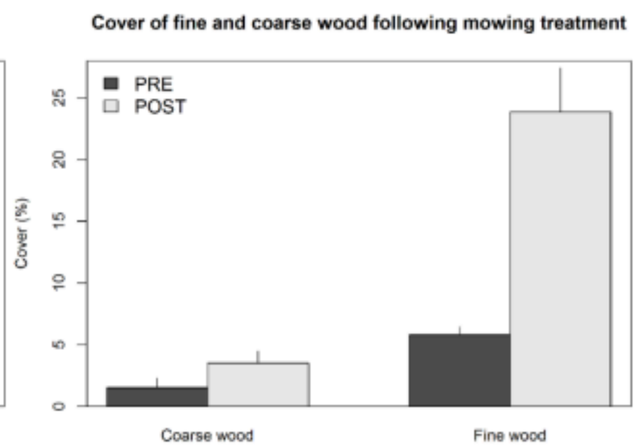


Figure 14: Bar plots depicting mean (±1 standard error of the mean) coarse and fine wood cover pre- and post-mowing treatments.

<u>Objectives for [2019] monitoring (multi-year monitoring project):</u>
CFRI returned for 5-year post-mowing monitoring in 2019. Highlights of the results of that monitoring effort are below.

Results and Discussion
Following mowing, understory vegetation saw small changes in richness and diversity and notable changes in percent cover by growth form in the first 3 years following treatment, and larger changes 5-years post-treatment. In mowed plots, richness increased from 54 to 66 total species between pre-treatment and year-3 measurements (Figure 5), most of which is accounted for by native forbs (Figure 6) but declined to 38 total species 5-years post-treatment. Richness of exotic species increased from two species (Kentucky bluegrass (*Poa pratensis*) and dandelion (*Taraxacum officionale*)) during pre-treatment and 1-year post treatment measurements, to three species (aforementioned species and Shepherd's purse (*Capsella bursa-pastoris*))

during 3-year post-treatment measurements and then declined to just one species (Kentucky bluegrass) during 5-year post-treatment measurements (Figure 7).

Figure 5: Bar plots depicting total understory vegetation richness in control and mowed stands.

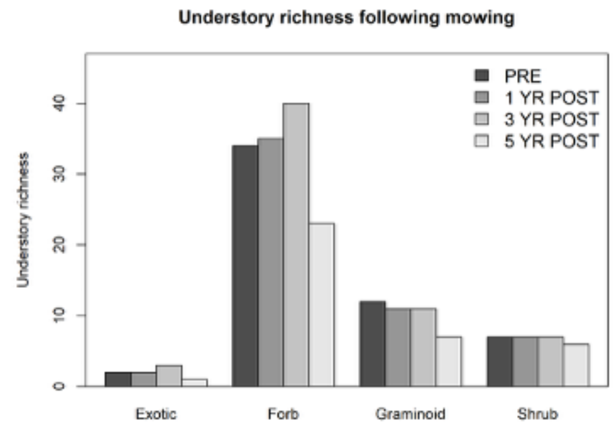


Figure 6: Bar plots depicting understory vegetation richness by functional group following mowing treatments.

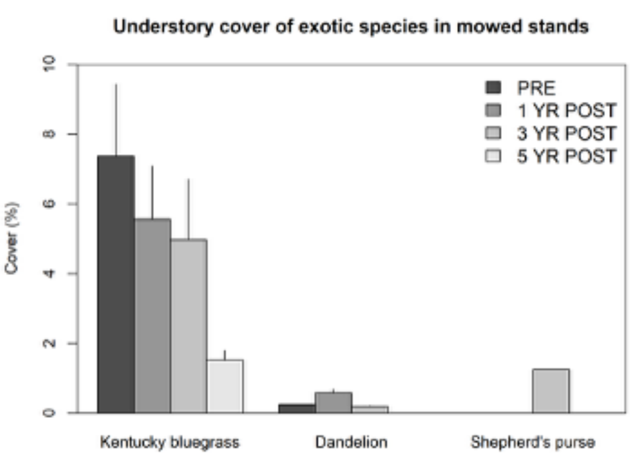


Figure 7: Bar plots depicting mean (±1 standard error of the mean) cover of individual exotic species in mowed stands of Gambel oak.

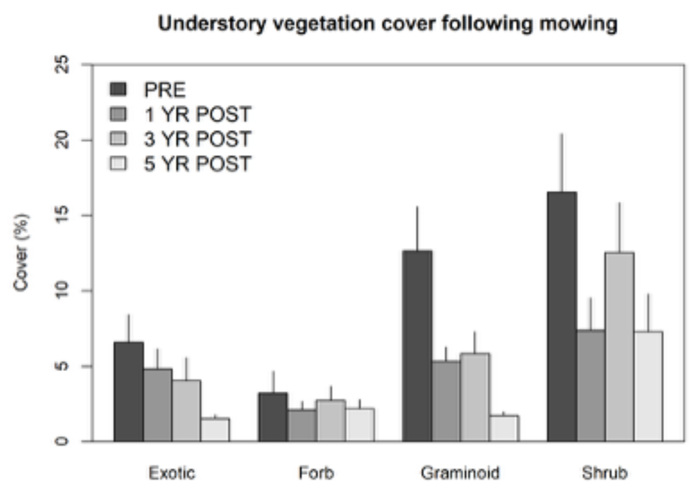


Figure 8: Bar plots depicting mean (±1 standard error of the mean) understory vegetation cover by functional group in mowed stands.

While the richness of exotic species increased, percent cover of exotics decreased by one third in the 5-year period (Figure 8), accounted for by decreases in Kentucky bluegrass (*Poa pratensis*) and dandelion (*Taraxacum officionale*) (Figure 8). After mowing in 2016, percent cover of every category of growth form (graminoid, forb, shrub, and exotic) decreased during year-1 post-treatment measurements, then increased during 3-year post-treatment measurements but not to the level they were during 1-year measurements, then declined further during 5-year post-treatment measurements (Figure 8). Percent cover of forbs decreased from 3% to 2% cover in the same period. Percent cover of graminoids decreased by >50% pre-treatment measurements and 1- and 3-year post-treatment measurements and decreased by >70% between pre-treatment and 5-year post-treatment measurements. This contradicts the expected trend that mechanical treatments will improve production of grasses and forbs (Kaufmann et al, 2016), but this is likely due to a dramatic increase in Gambel oak resprouting following treatment (Figure 10).

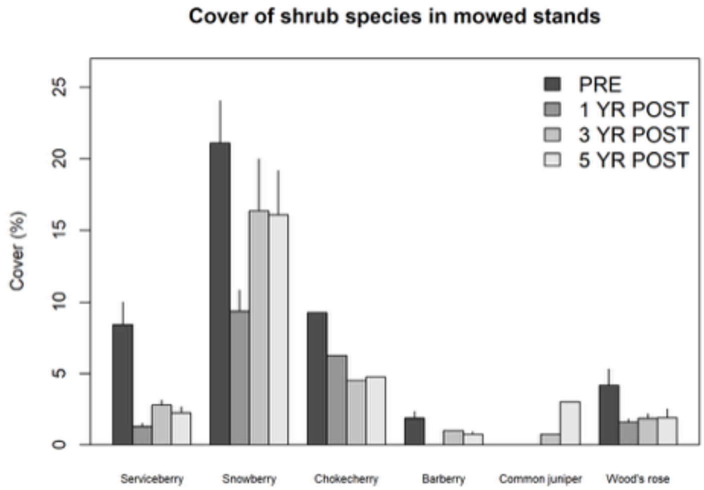


Figure 9:Bar plots depicting mean (±1 standard error of the mean) of the cover of shrub species by functional group. Gambel oak is omitted from this summary, as it is included in its own figure (Figure 10).

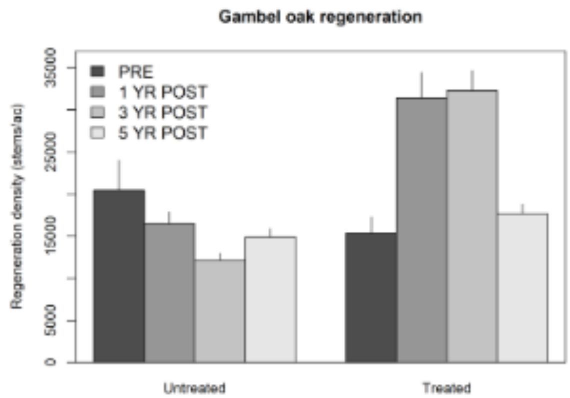


Figure 10: Bar plots depicting mean (±1 standard error of the mean) Gambel oak regeneration density in control and mowed plots pre- and post-treatment.

Additionally, during 5-year post-treatment measurements, a decline in Diversity Indices (Table 1) illustrate that in both untreated and mowed plots there was a decline in understory species diversity, so it is likely that climatic influences account for declines in cover of graminoid and forb cover during year-5. Predictably, shrub cover decreased drastically the first year after mowing, with percent cover reduced by >50%. By 3-years post-treatment, Cover shrub cover had increased to 75% of the pre-treatment value but declined back to <50% of the pre-treatment values 5-years following mowing (Figure 8). This large increase years post-treatment was largely due to the quick regrowth of snowberry (*Symphoricarpos rotundifolia*) (Figure 9). In 2017, snowberry cover was half of what it had been before mowing, and by 2019 cover of snowberry regained 75% of the pre-treatment value (Figure 9). Serviceberry (*Amelanchier alnifolia*), barberry (*Mahonia repens*), and Wood's rose (*Rosa woodsii*) grew back but more slowly. Chokecherry (*Prunus* virginiana) cover decreased through 3-years post-mowing, then slightly increased 5-years post-mowing. Additionally, one new shrub species - common juniper (*Juniperus communis*) - established in mowed plots where it had not been observed before 2017 (Figure 9). Diversity Indices fluctuated between years in un-mowed plots and slightly but steadily increased in mowed plots except in year-5 measurements when both Indices saw a decline in species diversity; again, this is likely due to a climatic influence such as drought. On average, these plots have very high diversity values (Table 1).

	Untreated				**Treated**			
	Pre	**1-yr post**	**3-yr post**	**5-yr post**	**Pre**	**1-yr post**	**3-yr post**	**5-yr post**
Shannon	3.8025	3.7296	3.8591	3.1276	3.6627	3.7582	3.8815	3.1882
Simpson	0.9708	0.9694	0.9740	0.9381	0.9669	0.9718	0.9746	0.9462

Table 1: Results for Shannon's and Simpson's Diversity Index in control and mowed plots pre- and post-treatment. Shannon's Diversity Index values range from 0-4, where 4 indicates a high level of species richness and evenness. Simpson's Diversity Index values range from 0- 1, where 1 indicates the highest level of species richness and evenness.

In un-mowed plots, there was a small and steady decrease in density of Gambel oak in 1- and 3- year measurements, with a slight increase in 5-year measurements, while treated plots had a large increase in regeneration density between 1- and 3-year post-treatment measurements, and dropped dramatically during 5-year post-treatment measurements (Figure 10). One- and 3-years after mowing, Gambel oak regeneration density more than doubled. This drastic increase in Gambel oak sprouts suggests that mowing might be counter-productive if removing Gambel oak is the goal, at least in the short term. However, there was a dramatic drop in Gambel oak regeneration 5-years post-treatment, indicating that this sprouting species may have leveled off in resprouting following disturbance, or have begun a self-selection process. Longer term monitoring will yield more information on regeneration trends.

Future actions: Prescribed burning is planned for this treatment area, pending appropriate conditions. This will provide more information on the combined effects of mechanical thinning and prescribed burning for the management of Gambel oak. At the time of writing there is no funding available to remeasure these plots, but continued long-term monitoring would enhance understanding of Gambel oak regeneration and understory recovery dynamics.

To view the full monitoring report in more detail, visit: https://cfri.colostate.edu/wp-content/uploads/sites/22/2025/06/Weimer_Uncompahgre-CFLRP-Gambel-Oak-Study-Summary.pdf

Protocol:

Spatial scale of the area under consideration:
Three treatment units, over 500 acrestotal (Fig. below).

General approach:
Paired plot sampling design.

Locations to be assessed:
Gambel oak patches within La Fair treatment units.

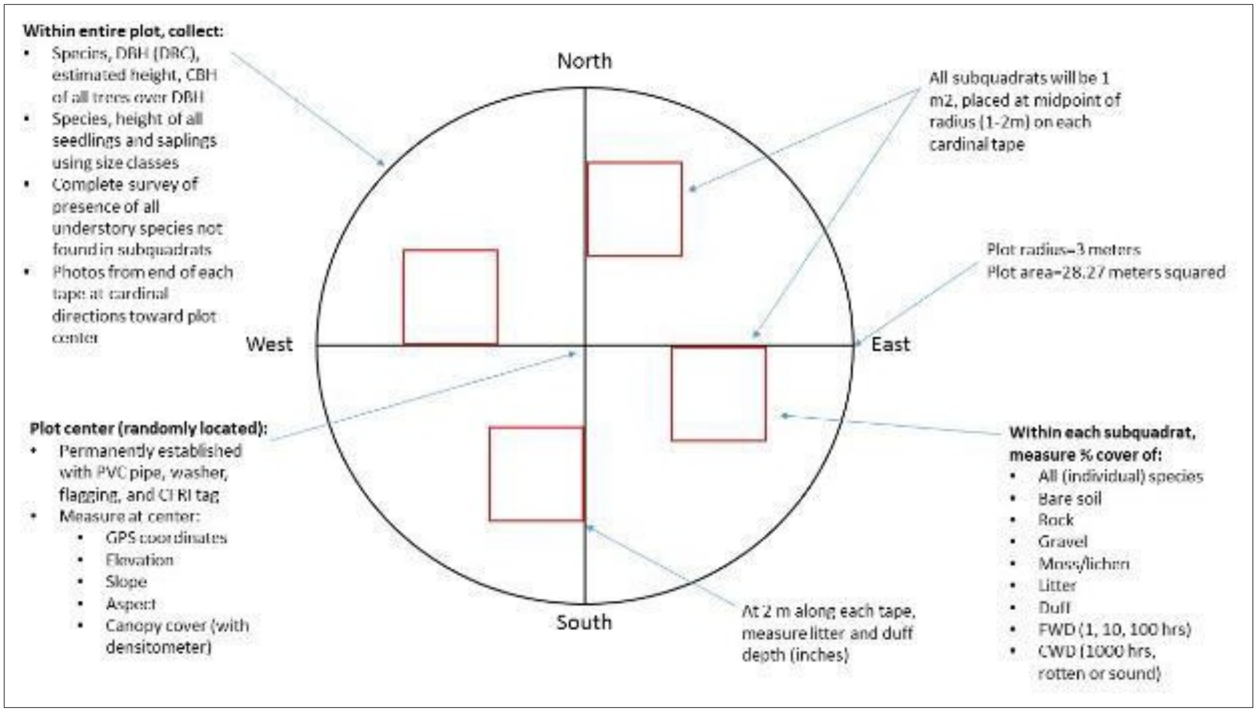
Measurements to be taken at each location:
Within the 3m radius circular plots, regenerating and overstory stems of Gambel oak and other tree species were measured. Understory vegetation(by species cover and abundance), other ground cover variables, and abiotic conditions of eachpaired plot were also measured (see plot depiction below).

People engaged in measuring (agency, volunteers, etc.):
Marin Chambers and field crew (CFRI), Eric Freels and field crew (USFS-Grand Valley Ranger District).

Data management plans:
Data collected, entered into Excel spreadsheets, archived, andanalyzed by CFRI.

Data archiving plans:
Colorado Forest Restoration Institute, Colorado State University.

Plan for communicating findings to collaborators, line officers:
See report links above.



Plot depiction (above). Transects were placed along cardinal directions, 3 m from a permanently established plot center. Tree species height, DBH, CBH; tree seedlings and saplings species and size class; and understory species presence were measured for the entire plot. Within 1 m^2 subplots centered on each transect, understory species and forest floor cover wererecorded. Plot-level topographic variables, such as elevation, slope, and aspect, were measured at plot center.

General Land Office Survey Analysis

Leadership people:
William L. Baker (University of Wyoming)

Overall goals and objectives:

1. Input into GIS the section-line and section-corner data from the original land surveys conducted on Forest Service land on the Uncompahgre Plateau, which were mostly done in 1881-1902.
2. Reconstruct historical forest structure (tree density, basal area, tree diameters) and fire severity proportions (low, moderate, high) in ponderosa pine and mixed-conifer forests. Acquire and use ancillary early historical reports and photographs.

Key questions to be examined:

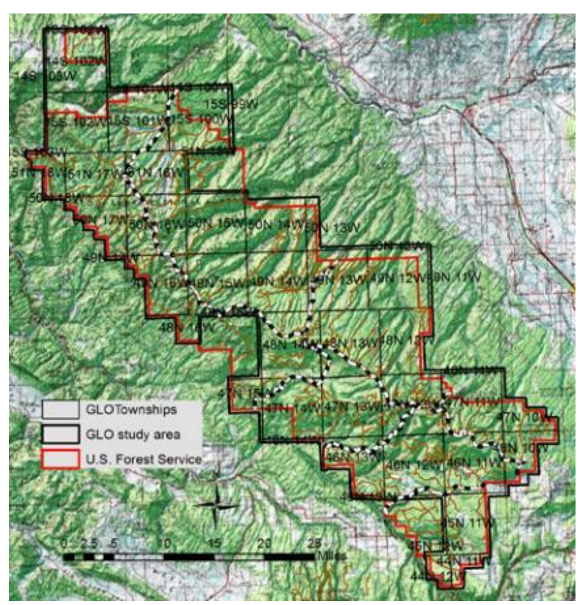
1. Early settlers and early scientific documents reported severe fires burned large areas on thePlateau in the early 1800s, in 1879, and in 1900; do the land-survey records support the occurrence of these fires and allow them to be reconstructed and mapped?
2. If large, infrequent, severe fires occurred historically on the Plateau in the 1800s, what is the legacy of these fires in today's forests? Are forests still recovering from these 1800s fires?
3. How variable was historical forest structure across the large land area covered by the landsurveys?
4. How large were the trees at the time of the surveys—were old forests with large treescommon?
5. What are the ecological implications of findings from the land-survey records for restoration?

Objectives for [2016] monitoring (multi-year monitoring project):
Complete input and analysis of the land-survey data for US Forest Service land on the Plateau.

Objectives for [2017] monitoring (multi-year monitoring project):
Complete a report on the findings from the analysis of land-survey records on the Plateau.

Protocol:

Spatial scale of the area under consideration:
About 561,000 ac, mostly US Forest Service land on the Plateau.



General approach:
Data were entered for the Forest Service land on the Plateau, then analyzed in GIS.

Locations to be assessed:
The whole of the area mapped as "GLO study area" above.

Measurements to be taken at each location:

1. Section-line data, which include a list of the dominant canopy trees or other vegetation in order of abundance along with understory trees and shrubs also in order of abundance. Also recorded are entry and exit locations into and out of forests.
2. Section-corner data, which includes information

on up to four bearing trees at each section corner and two bearing trees at each quarter corner. Information includes the species of trees, their diameter, the distance from the corner and the azimuth to the tree from the corner.

People engaged in measuring (agency, volunteers, etc.):
Early land surveyors recorded the data in field notebooks, which were scanned by the BLM. Data was extracted from the field notebooks and entered into GIS.

Data management plans:
Data have been input into shapefiles in ArcGIS 10.

Data archiving plans:
Data will be archived with the Colorado Forest Restoration Institute (CFRI) at CSU

Plan for communicating findings to collaborators, line officers:
A final report with maps, photographs, tables, and descriptions of the findings can be found on the CFRI website: https://cfri.colostate.edu/wp-content/uploads/sites/22/2017/12/2015-UP-CFLR-GLO-Summary.pdf.

High Resolution Airborne Imagery for the Escalante Project Area

Leadership people:
Dan Binkley and Michael Lefsky (CSU), John Musinsky (National Environmental Observation Network (NEON)- Airborne Observation Platform (AOP)).

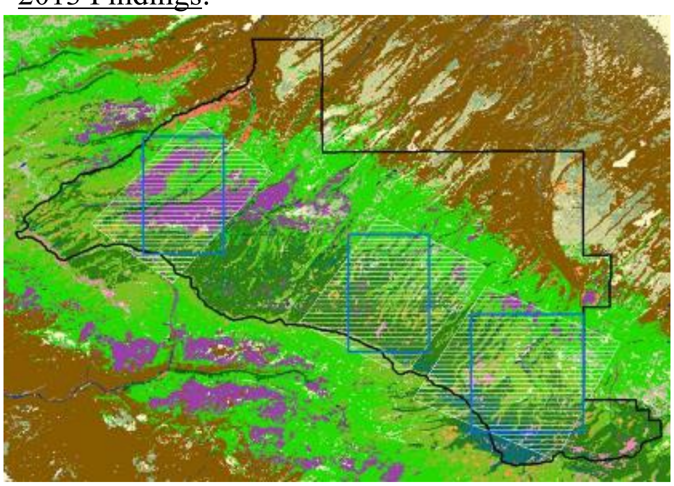
Other leadership people:
Kristen Pelz (CFRI), Jeff Cannon (CFRI).

Overall goals and objectives:
To obtain state-of-the-art data on the composition and structure of the forests and landscape of the Escalante Project area, using the Airborne Observation Platform (AOP) of the National Environmental Observation Network. The AOP provides high-resolution images; multi-spectral data; and LIDAR (height) data at 1-3 m scale resolution. Our goal is to have very high precision information on forest composition and structure, and to follow changes after forest restoration (including information to allow for simulation of fire behavior).

Objectives for 2013 monitoring:
To obtain AOP characterization for three large portions of the Escalante Project area and interpret forest composition and structure.

Key questions to be examined:
1. Which tree species comprise the forests within each area?
2. What is the vertical fuel structure of the forest?

2013 Findings:



The AOP flew one-third of the planned area (three blocks outlined in blue) in the summer of 2013, covering parts of Love Mesa and Lockhart Mesa. This project was not implemented due to unforeseen logistical and operational changes. In lieu of the NEON imagery, the collaborative group approved using an aerial imagery analysis to gauge changes in horizontal forest structural patterns resulting from treatments. This analysis provides information to address the Uncompahgre CFLRP restoration goal #5: "Reestablish meadows and open parks and re-establish grasses, forbs, and robust understory communities."

Protocol:

Spatial scale of the area under consideration:
Three large areas of the Escalante Project area.

General approach:
Obtain coverage when possible, beginning in 2013 and continuing into the future, and interpret current forest composition and structure, as well as changes over time.

Locations to be assessed:
Three large blocks in the Escalante Project area (see map above).

Measurements to be taken at each location:
High resolution imagery, hyperspectral coverage, and LIDAR – all combined for each 1 (to 3) m pixel to provide an information system that allows almost any sort of question to be asked in aspatially explicit context.

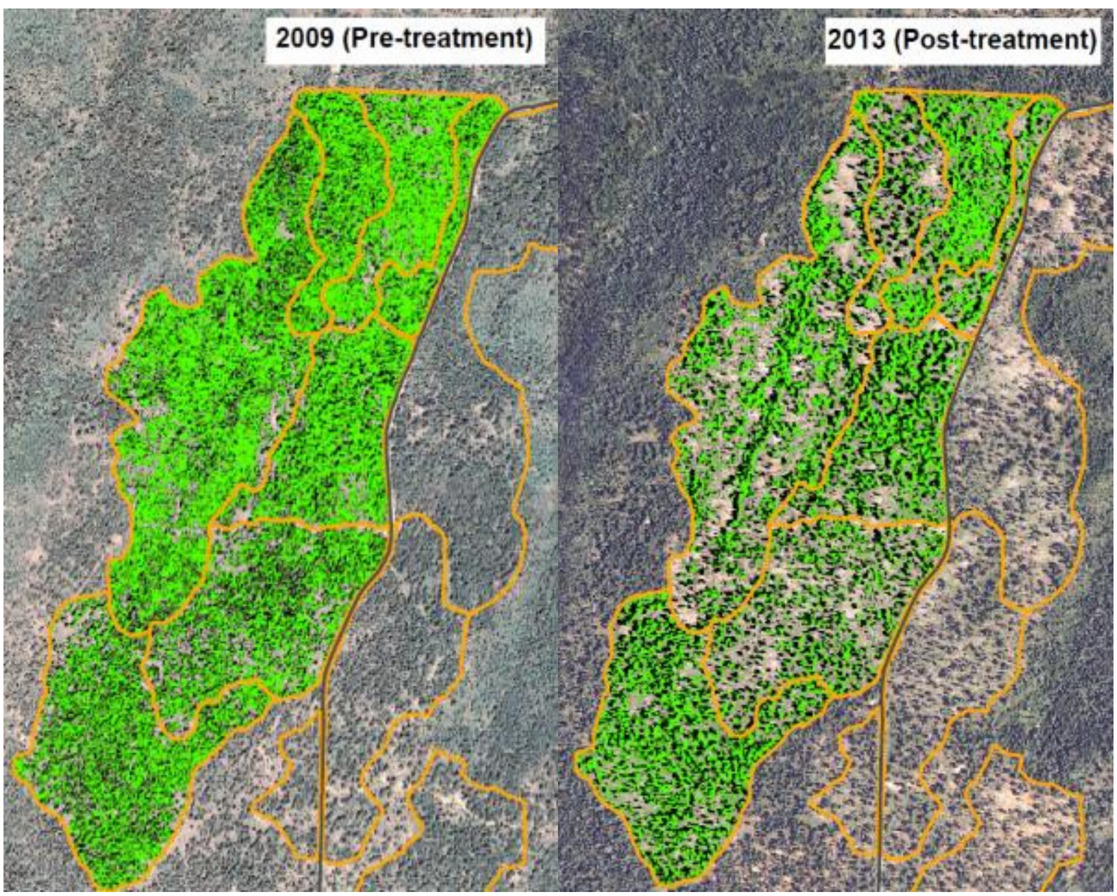
People engaged in measuring (agency, volunteers, etc.):
Dan Binkley, Michael Lefsky, and John Musinsky.

Objectives for 2014 monitoring:
To gauge changes in horizontal forest structure patterns resulting from treatments.

Key questions to be examined:

1. Quantify tree spatial pattern to ensure post-treatment forest condition goals aremet.

2014 Findings:



Pre- (left) and post-treatment (right) aerial imagery of Unc Mesas project area. We analyzed canopy cover in all units outlined in orange here in 2015.

Metric		Time	Mean	Std Dev	Max	Min
*Canopy cover as % of unit	PLAND	*Pre*	**52**	12	76	35
		Post	**25**	11	52	11
*Patch density (patches / 100 hectares)	PD	*Pre*	**1,305**	954	3,464	102
		Post	**3,244**	2,872	15,707	850
*Largest Patch Index (Largest canopy patch as % of unit)	LPI	*Pre*	**36.8**	23.5	75.5	2.5
		Post	**3.8**	4.9	21.1	0.1
Edge density (meters / ha)	ED	*Pre*	675	241	1,136	335
		Post	700	133	929	435
*Mean patch area (ha)	AREA	*Pre*	**0.12**	0.17	0.74	0.01
		Post	**0.01**	0.01	0.06	0.00
*Range of patch areas (ha)	AREA_RA	*Pre*	**7.7**	11.2	52.0	0.5
		Post	**0.6**	0.7	2.1	0.0
*Euclidian nearest neighbor distances (m)	ENN	*Pre*	**5.3**	0.7	5.0	5.9
		Post	**6.4**	0.2	5.4	7.5
*Range of Euclidian nearest neighbor distances (m)	ENN_RA	*Pre*	**6.8**	3.2	12.2	2.0
		Post	**16.4**	7.9	38.5	7.2

Pictures above show classified canopy (bright green) in a subset of stands along the Delta-Nucla Road. Our analysis of pre- and post-treatment canopy cover showed desirable trends (see table below). The coverage of coniferous canopy has been reduced, and the number of distinct canopypatches has increased. The complexity of forest canopy cover has increased in some ways: the number of patches, distance between patches, and range of distances between patches have increased. However, the range of patch sizes decreased, and the edge density did not change significantly. In the table, asterisks represent significant differences between pre and post treatment metrics. Underlines show where the change was in the desired direction.

Protocol:

Spatial scale of the area under consideration:
Unc Mesa project area.

General approach:
Spatial analysis of forest cover using NAIP imagery and FRAGSTATS spatial analysis package.

Measurements to be taken at each location:
In 2015, CFRI used National Aerial Imagery Program (NAIP) imagery to quantify the spatial pattern offorest cover. This imagery is collected every four years and is publicly available. We use the ENVI software package (Exelis Visual Information Solutions) to delineate areas of coniferous canopy, shadow, herbaceous ground cover, and bare soil (e.g., unpaved roads) from the imagery. The reflected wavelengths of these cover types are relatively unique and allow for the mapping of forest cover.

After mapping, the spatial distribution of coniferous forest canopy patches (groups of trees with continuous canopy) in a matrix of bare-ground and herbaceous groundcover (gaps between trees)can be quantified using FRAGSTATS (McGarigal et al. 2012), a program developed to analyze spatial patterns of landscape. Metrics such as the percent cover, largest patch index, edge density,patch size, patch density, patch perimeter-to-area ratio, and Euclidean nearest-neighbor distance can quantify forest cover patterns to make comparisons among different forests and monitor treatment effect through time.

NAIP imagery will be collected in the spring, summer, and fall of 2016; stay tuned for an update in 2017 regarding the spatial heterogeneity and complexity of forest openings following 2015- 2016 treatments.

People engaged in measuring (agency, volunteers, etc.):
Kristen Pelz (CFRI).

Data management plans:
Data will be archived at CFRI.

Data archiving plans:
Copies of the study results will be stored on the CFRI website.

Plan for communicating findings to collaborators, line officers:

- The results will be presented at UP meetings, including one or more field trips.
- Document: https://cfri.colostate.edu/wp-content/uploads/sites/22/2018/04/Cannon_UP_CFLRP_spatial.pdf

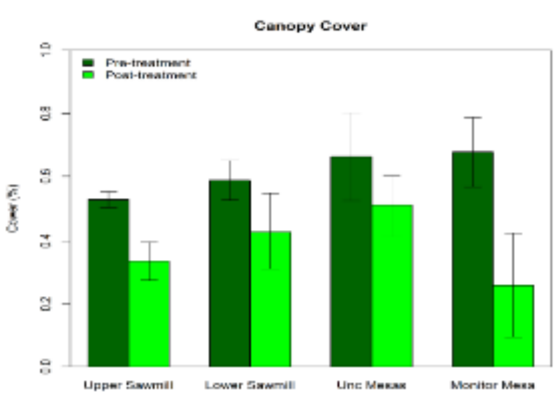
Objectives for 2017 monitoring:

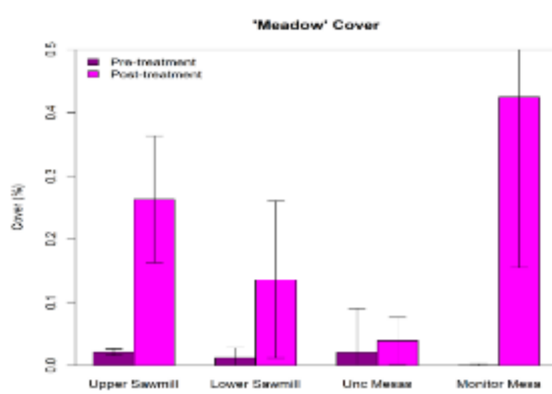
1. Analyze aerial imagery to evaluate changes in forest spatial structure from restoration treatments with an emphasis on identifying and measuring characteristics of meadows.
2. Comparison of spatial pattern results to information on historic spatial patterns based on the reconstruction of forests of the CFLRP focal area.

Key questions to be examined:
Characterize changes in pre- and post-treatment spatial patterns, including changes in:

1. Canopy cover.
2. Meadow cover.
3. Density, size, and shape characteristics of meadows.

2017 Findings:





Overall, canopy cover was reduced from 62 to 41% following treatments but varied considerably. Coverage of meadows increased from 1.5% to 16% cover over all treatments. The number of meadows increased from 0.1 per acre (1 meadow every 10 acres) to 0.5 per acre (5 meadows every 10 acres) following treatments. Meadow size also increased following treatments from 0.08 acres up to 0.25 acres. This change was most pronounced in the Monitor Mesa treatment units and less pronounced in the Unc Mesas treatment units. Historical forests on the Uncompahgre may have contained "meadows" which covered over 65% of forested area, due to the much lower historical density of trees, which allowed for connectivity between gaps and greater gap sizes. It should be noted that different methods were used to estimate coverage in these studies, so direct comparisons between results from remote sensing and stand reconstruction methodologies should be interpreted with caution.

Table 1. Pre- and post-treatment measurements of canopy cover and meadow cover, mean density, size, and shape index. Shape index is calculated as an area-weighted mean according to gap size. All result summaries areweighted by the area of treatment units.

Treatment	**Area (ac)**	**Canopy Cover (%)**		**Meadow Cover (%)**		**Meadow density (per acre)**		**Mean Meadow size (ac)**		**Meadow Shape Index***	
		Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Upper Sawmill	392	52.4%	34.3%	2.099%	25.247%	0.181	0.704	0.102	0.392	1.18	2.24
Lower Sawmill	879	59.2%	40.9%	1.122%	16.031%	0.089	0.553	0.116	0.230	1.12	1.67
Unc Mesas	561	64.0%	51.2%	2.524%	4.590%	0.130	0.289	0.063	0.122	1.13	1.30
Monitor Mesa	359	74.8%	34.9%	0.051%	24.363%	0.006	0.683	0.012	0.391	1.02	2.00
Overall	2,190	61.8%	41.4%	1.480%	16.115%	0.102	0.534	0.083	0.258	1.13	1.73

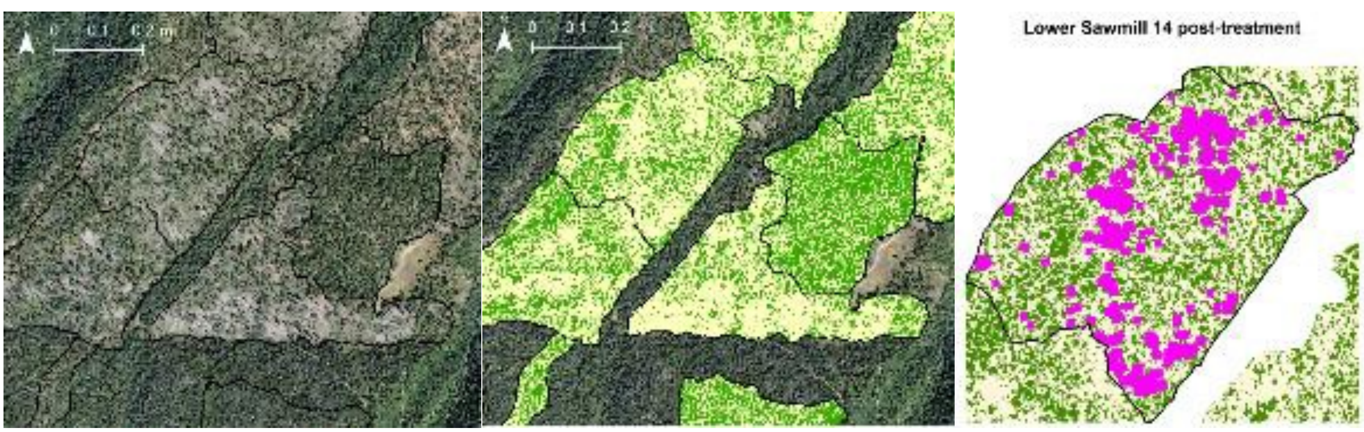
Protocol:

Spatial scale of the area under consideration

Unc Mesa project area including (1) Unc Mesas treatment, (2) Upper Sawmill, (3) Lower Sawmill, and (4) Monitor Mesa units.

General approach

Classification of 2011 and 2015 NAIP imagery using supervised classification and custom algorithms to identify and measure meadow characteristics developed in R statistical language.



Measurements to be taken at each location:

CFRI used National Aerial Imagery Program (NAIP) imagery to quantify spatial pattern of forest cover. This imagery is collected every four years and is publicly available. We use ESRI ArcMap software to delineate areas of coniferous canopy, shadow, and openings from the imagery. The reflected wavelengths of these cover types are relatively unique and allow for the mapping of forest cover. Shadows were classified using thresholding of the NDVI band. Meadows (continuous regions > 80 ft. minimum diameter) were identified using a distance-to-edge algorithm. Mean canopy cover and coverage of meadows were calculated for each unit. Meadow attributes, including mean meadow density, size, and shape index were quantified for each unit.

People engaged in measuring (agency, volunteers, etc.):
Jeff Cannon (CFRI).

Data management plans:
Data will be archived at CFRI.

Data archiving plans:
Copies of the study results will be stored on the CFRI website.

Plan for communicating findings to collaborators, line officers
The results will be presented at UP meetings, including one or more field trips.
https://cfri.colostate.edu/wp-content/uploads/sites/22/2018/04/Cannon_UP_CFLRP_spatial.pdf

Historical Conditions for Pinyon/Juniper Woodlands

Leadership people:
Bill Romme (CSU).

Overall goals and objectives:
Through a literature review, determine PJ and sagebrush historical patterns and vegetative conditions on the Uncompahgre Plateau, identifying important gaps where follow-up field workwill be important.

Objectives for 2013 monitoring:
Collect necessary literature and information and begin synthesis.

Key questions to be examined:

1. What are the ranges of historical conditions that characterized PJ woodlands and sagebrush shrublands?
2. What geographic features influenced the historical differences in community distributions?
3. How much change has occurred in these communities in the past century?
4. What key issues and risks warrant consideration for the future of the Plateau?

2013 Findings:

1. There is variation in PJ and sagebrush vegetation across the UncompahgrePlateau.
2. Historical dynamics, in particular the role of fire, drought, and insects, played importantroles in influencing different “types” of PJ and sagebrush vegetation.
3. There were various kinds and magnitudes of change in the past century in the various“types” of PJ and sagebrush vegetation.
4. Details suggested priorities for additional information needs.

Protocol:

Spatial scale of the area under consideration:
Lower elevations of the Uncompahgre Plateau.

General approach:
Compile and assess available information from a variety of sources.

Locations to be assessed:
No field sites.

Measurements to be taken at each location:
None.

People engaged in measuring (agency, volunteers, etc.):
Bill Romme.

Data management plans:
Not applicable.

Data archiving plans:
Not applicable.

Plan for communicating findings to collaborators, line officers:

- Results were communicated at collaborator meetings (2014).
- Results communicated as a report: Pinyon-Juniper Ecosystems on the Uncompahgre Plateau: Assessment of our current knowledge and information needs (2014) (https://cfri.colostate.edu/wp-content/uploads/sites/22/2017/12/2014_02_UP-PJ-Assessment-Romme_Feb-2014.pdf).

Invasive Species

Leadership people:
Clare Hydock (USFS GMUG Supervisor's Office), retired. No current leader established for this project.

Overall goals and objectives:
To minimize invasive species on the Plateau, through early identification and treatment of newhotspots, and sustained efforts to impede expansion from other sites.

Objectives for annual monitoring:
1. Continue with weed monitoring/treatment programs as in previous years.
2. Focus on assessing road, treated stands to determine impact of restoration on invasive weeds.
3. Record spatial locations and percent cover of Colorado Listed Noxious Weed populations and otherspecies of management concern using NRIS Data Recording Protocols for Invasive Species Management.

Results (2012 – 2016)
The stated goal is 6,800 ac of treatment with at least 80% efficacy over 10-yrs. As of last monitoring update, currently 4,098 ac are treated with an average efficacy of 81%.

	Acres Treated			
Fiscal Year	CFLRP Funding	All Other Funding	Acres Monitored	Percent Efficacy
2012	789.5	801.7	351.8	82
2013	830.9	214	632.9	81
2014	758.5	34.5	687.6	81
2015	792.5	0.3	682.4	80
2016	918.4	1132.9	666.2	81
Totals	4,089.8	2,183.4	3,020.9	81 (average)

Key questions to be examined:
1. Where are critical invasion hotspots?
2. How do restoration treatments affect the success of invasive species?
3. How might restoration treatments be modified to reduce invasive risks?

Protocol:

Spatial scale of the area under consideration:
The entire Uncompahgre Plateau and the Naturita Division.

General approach:
- Ocular monitoring during routine travel on the Plateau.
- Soliciting observations from livestock permittees and others.

Locations to be assessed:
Phase 1:
100% inventory of high probability infestation areas in the Sawmill and Uncompahgre Mesas Contract

Areas within 100 ft of:

- All National Forest System roads (with exception of Delta Nucla Road)
- National Forest System Trails
- Existing decommissioned roads
- Any identified existing old skid trails or landings
- Fence lines
- Large Meadows
- Low slope drainages impacted by harvesting/thinning or burning in Unc Mesa/Sawmill Mesa Contracts
- Ditches

Phase 2:

100% inventory of entire contract units:

- Where significant weed populations have been identified
- Harvested Units (Unit 7, Unc Mesas Stewardship Contract Area)

Measurements to be taken at each location:

Species, and notes on extent.

People engaged in measuring (agency, volunteers, etc.):

USDA Forest Service staff, county weed experts, permitees, and other volunteers.

Data management plans:

Spatial Survey:

- Locations of weed populations will be surveyed with GPS receivers. The center of isolated individualweeds smaller than 0.1 ac shall be recorded as point features and a radius of the infestation areawill be recorded on the attribute data sheet.
- Larger distinct populations will be recorded using a track file to survey the areal extent of the weedpopulation.
- Survey units and/or contract units will serve as the spatial location for widely dispersed populationswith very low cover (i.e., less than 3% cover).
- A unique spatial identifier will be associated with each distinct weed population. These identifiers willbe compiled and indexed using NRIS business rules after survey completion for incorporation into theNRIS invasive weed population database.
- Shapefiles of weed populations indexed with NRIS compatible identifiers will be created from GPSand track and point files and uploaded into the NRIS enterprise database.

Attribute Data:

- All required data fields from the NRIS Data Recording Protocols for Invasive Species Management willbe completed for each identified weed population.
- NRIS Data Recording Protocols for Invasive Species Management data forms will be used for datarecording purposes.
- Spatial attribute identifiers will be recorded for every distinct weed population surveyed.
- This data will be uploaded into attribute fields of the NRIS invasive plant database.

Standards:

- Data will be recorded at accuracies less than ±30 ft.
- NRIS Data Recording Protocols for Invasive Species Management will be followed to the

greatestextent possible. Any deviation from the protocol will be recorded and discussed with the monitoringwork crew members as soon as possible.

Data archiving plans:
Data uploaded into NRIS invasive plant database; copy also stored in GMUG database.

Plan for communicating findings to collaborators, line officers:

- Summary report in the annual CFLRP Accomplishment.
- ReportPresentation at annual UP CFLRP collaborators meeting.

Landscape Scale Monitoring, Fire Risk

Leadership people:
Megan Matonis, Justin Ziegler, Dan Binkley (CSU), Carmine Lockwood, Tammy Randall-Parker(USDA Forest Service).

Overall goals and objectives:

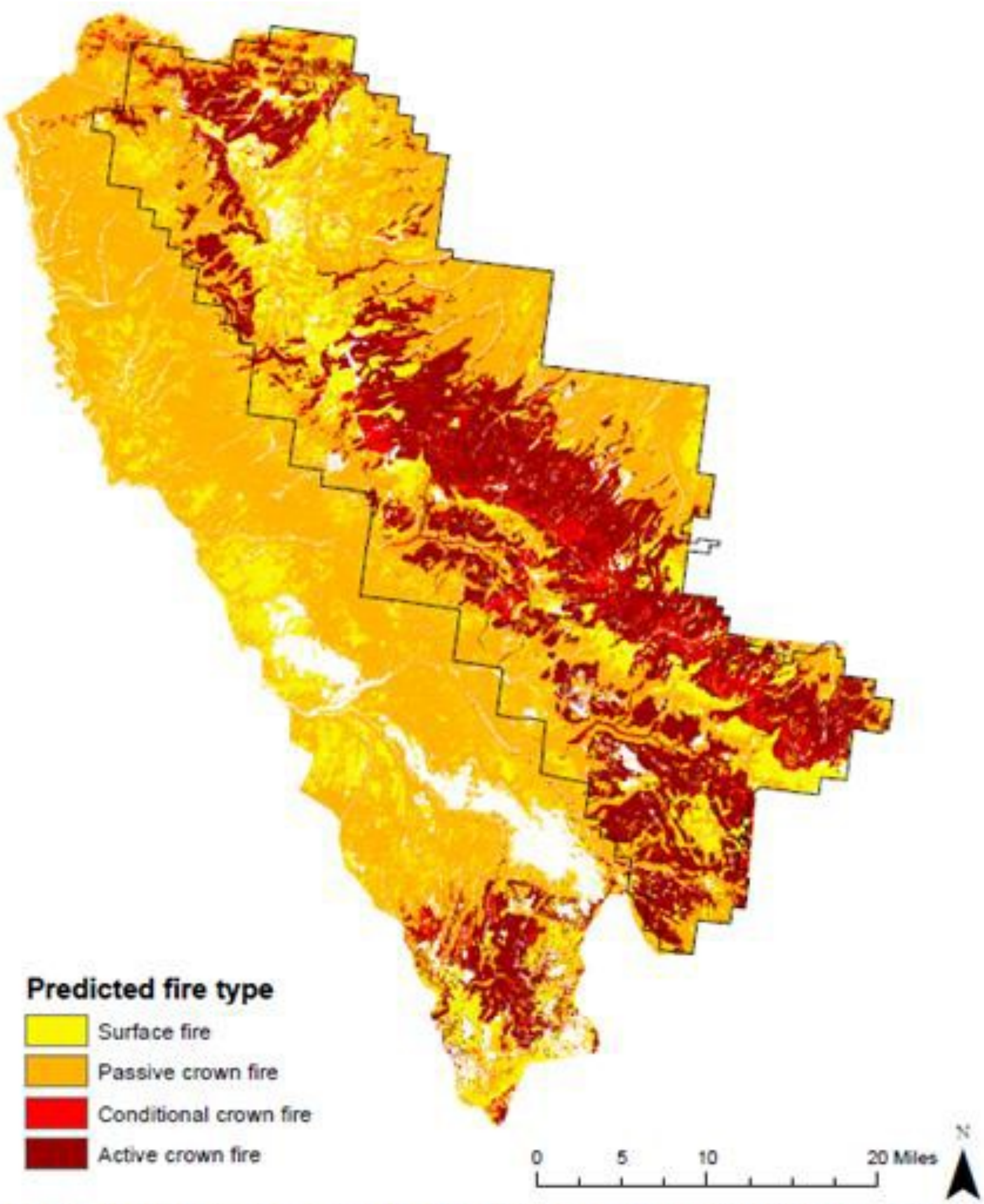
1. Enhance the resiliency, diversity, and productivity of the native ecosystem on the Uncompahgre Plateau using best available science and collaboration.
2. Reintegrate and manage wildfire as a natural landscape-scale ecosystem component that will reduce the risk of unnaturally severe or large crown fires.
3. Restore ecosystem structure, composition, and function.
4. Preserve old or large trees while maintaining structural diversity and resilience.
5. Reestablish meadows and open parks and re-establish grasses, forbs, and robust understory communities.
6. Manage herbivory. Robust understories are necessary to restore natural fire regimes and limit excessive establishment of tree seedlings.
7. Evaluate the landscape-scale changes brought about by restoration treatments, including both the local scale (treated stands) and landscape scales (such as fire propagation potentials).

Our initial guiding questions include:

1. How can stand-level restoration treatments, and other stand treatments be used to interrupt the spread of fires?
2. How extensive are invasive weed problems across the Plateau, and how can their spread be contained (and reversed) across the landscapes?
3. How is vegetation changing in relation to disturbances (treatment, roads, fires, climate change)? We have a lot of interesting data, but we are not developing an integrated set of landscape-scale insights from the information.
4. We know that fire was more frequent and extensive on the Plateau prior to 1880. The UP collaborators agree that an increased role of fire is a key goal for landscape-scale restoration, but how much more fire (and what sorts) do we need?
5. How resilient are the functional processes of the Plateau's ecosystems? Are historical and current conditions sustainable if the climate shifts?
6. What is missing from the plateau? Is the Plateau lacking in young forests? The 2005 GMUG assessment likely has most of the information we need, but then we need to create a clear interpretation of this information for our landscape goals.
7. How effective are various treatments at achieving stand-level goals, and at influencing landscape-level issues?
8. What are the implications of our current populations of deer, elk, and livestock for the future ecosystems of the Plateau, and how will restoration activities impact the ability of the ecosystems to support animals?

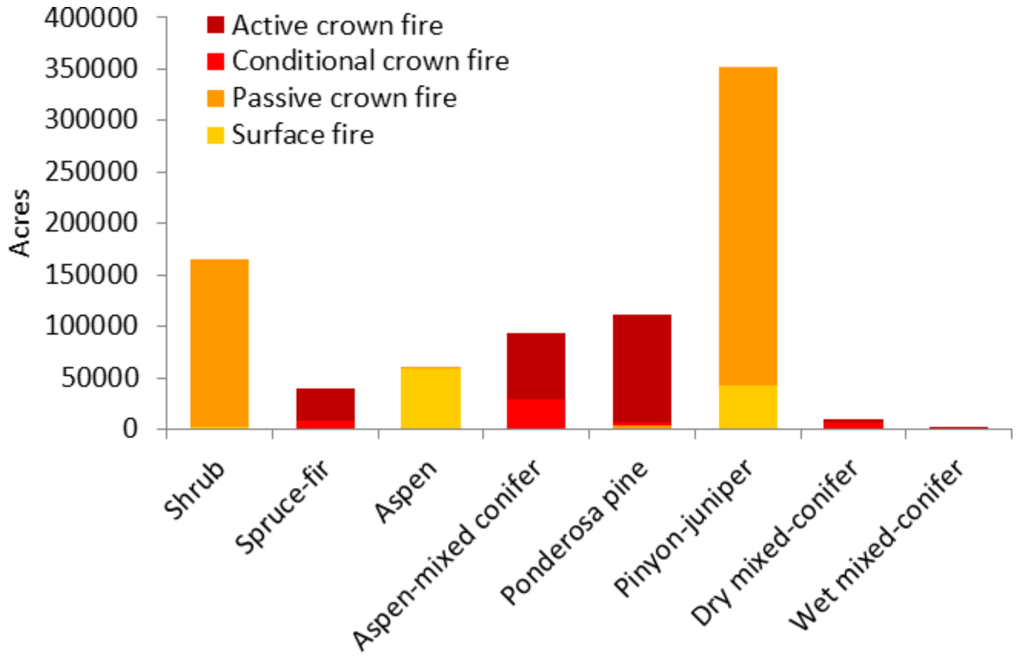
Objectives for 2013 monitoring:
To improve the spatially explicit representation of fire risk for the Plateau using a variety of fire models.

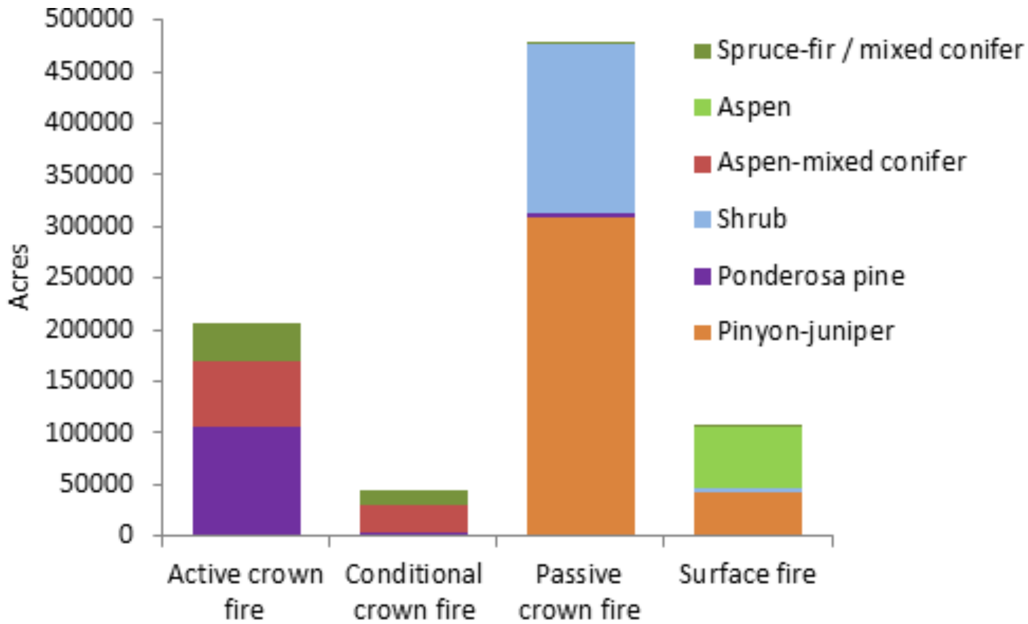
2013 Findings:



Predicted fire behavior across the Uncompahgre Plateau under 97th-percentile weather conditions.

One of the major concerns for landscape-scale restoration is the severity of potential fires and its propagation across the Plateau. The NEXUS model was parametrized to assess the current risk of surface fir and crown fires across the Plateau:





Over 871,200 acres on the Uncompahgre Plateau are capable of propagating active crown fire based on predictions from NEXUS (see Appendix B for details). In addition, about 189,000 acres are predicted for conditional crown fire, 2,022,400 acres for passive crown fire, and 776,400 acres for surface fire. This analysis excluded grasslands, riparian vegetation, and developed portions of the Plateau.

The conditions that the collaborators would like to avoid (and therefore serve as indicators) are summarized as:

Ponderosa pine and dry mixed-conifer forests:

Conditions we seek to move from / avoid through management:

Undesirable condition #1: Active crown fires are likely across >300 contiguous ac or in patches >30% of burnunits under 90th percentile weather conditions.
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #2: We are overly cautious with prescribed fires. We fail to burn in over half of the units wemechanically treat, and when we do burn, we burn areas smaller than historical fires (about <500 ac).
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #3: We implement treatments that fail to reduce crown fire hazards. We leave ladder fuelscovering >30% of the stand, and crown continuity remains high because we didn't create treeless openings (0.25 to 0.5 ac) across the stand.
Spatial/temporal scale: Stand / 2 to 3 years post-treatment

Undesirable condition #4: Prescribed burning kills >10% of residual ponderosa pine and Douglas-fir trees >8" DBH.
Spatial/temporal scale: Stand / 1 week

Undesirable condition #5: Post-fire browsing by livestock and wildlife reduces regeneration to less than 50 aspensuckers/acre in stands capable of supporting aspen.
Spatial/temporal scale: Stand / 3 years

Spruce-fir forests:

Conditions we seek to move away from / avoid through management:

Undesirable condition #1: Young, regenerating spruce-fire forest occupy either less than 10% or more than 30% of the area due to natural or management induced disturbances (i.e., insects, fire, or cutting).
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #2: Over 80% of our treatments in spruce-fire forest are very unlike historical disturbances, creating numerous small forest patches with linear boundaries. We fail to experiment with alternatives to this approach, such as the judicious use of prescribed fire to create young spruce-fir forests.
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #3: Post-fire browsing by livestock and wildfire reduces regeneration to less than 50 aspen suckers / ac in stands capable of supporting aspen.
Spatial/temporal scale: Stand / 3 years

Piñon-juniper forests and woodlands:

Conditions we seek to move away from / avoid through management:

Undesirable condition #1: Prescribed burns in PJ woodlands behave very differently from historical fires, burningat low severity (<75% mortality) and across small areas (<50 ac).
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #2: Natural start or prescribed fires in PJ escape into the proposed habitat for the Gunnison sage-grouse, burning >5 ac.
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #3: The number and cover of weedy species in unseeded, burned areas and unseededcontrol areas are allowed to expand unchecked into seeded, burned areas.
Spatial/temporal scale: Stand / 1-5 yr post-treatment

All vegetation types:

Conditions we seek to move away from / avoid through management:

Undesirable condition #1: We fail to inform future planning efforts with lessons learned from fires on the Plateauand experiences shared by others in similar forest types.
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #2: We implement prescribed burns that escape from control and/or produce smokeexceeding State regulations.
Spatial/temporal scale: Landscape / 1 week

Undesirable condition #3: We indiscriminately suppress natural start fires without considering the benefits to ecosystems, firefighter safety, and avoided suppression costs. We proceed without arapid case-specific assessment of hazards and risks (e.g., fuel loads, public support, damage to property, etc.)
Spatial/temporal scale: Landscape / 10 years

Undesirable condition #4: Post-fire tree planting homogenizes conditions and sets the stage for dense forests inthe future. Less than 30% of the planted area receives micro-site and/or dispersed group planting.
Spatial/temporal scale: Stand / 3-5 years post-treatment

Undesirable condition #5: Restoration treatments fail to prevent continual growth of annual expenditures on firesuppression.
Spatial/temporal scale: Landscape / 10 years

Protocol:

Spatial scale of the area under consideration:

The entire Uncompahgre Plateau.

General approach:

Use existing vegetation maps (LANDFIRE, National Land Cover Dataset, and FSVeg) to parameterize fire models and simulate fire risks. Four fire models were used to compare theirpredictions: FlamMap, NEXUS, Crown Fire Initiation & Spread (CFIS), and Fuel Characteristic Classification System. After initial exploration, we focused on model results from NEXUS becausethey fell between the predictions of CFIS and FlamMap and aligned more closely with expert opinions of potential fire behavior on the Plateau. We did not opt for FCCS because LANDFIRE data on FCCS fuelbeds are incomplete for the Plateau, and we lack alternative sources of data tocustomize FCCS fuelbeds. For the broader issues of landscape-scale monitoring, further discussion is needed. Using fire models to look at potential spread with and without treatments at watershed-scales would befruitful

Locations to be assessed:

The entire Plateau for fire modeling, 11 sites in aspen, ponderosa pine, and spruce-fir forests forfuel measurements.

Measurements to be taken at each location:

In 2013, the following measurements were taken:

- Crown base height.
- Fuel loads (tons/acre) of duff, litter, 1-hr, 10-hr, 100-hr, and 1000-hr fuels.
- Density of ladder fuels (trees with DBH < 4 inches).
- We used the Canopy Fuel Calculator (Cruz et al. 2013) to calculate canopy fuel loads and canopy bulk density from field data

We used these fuel measurements to validate fuel models used by NEXUS and test customizedfuel beds in FCCS.

People engaged in measuring (agency, volunteers, etc.):

- No field measurements at this time
- CFRI undergraduate field techs and FIP high school interns helped collect fuel load data in 2013.

Data management plans:

Under development, likely based on using USDA Forest Service FACTS database

Data archiving plans:

Under development, likely based on using USDA Forest Service FACTS database; additional data archiving with CFRI is likely.

Plan for communicating findings to collaborators, line officers:

A broad suite of approaches will be used, including field trips, an annual meeting that coversprogress and develops plans, various reports, and outreach products.

Microsite Conditions in a Low-Elevation Engelmann Spruce Forest Favor Ponderosa Pine Establishment During Drought Conditions

Leadership people:
Edward M. Hill, Seth Ex

Overall goals and objectives:
Due to a changing climate, there is concern about the viability of high-elevation species at their lower-elevation range. There is concern that the more drought-adapted species could potentially encroach into higher elevations, thus changing the species distribution. Adaptive management is an important management tool that could help address future concerns of species migration by helping to facilitate regeneration using different silvicultural tactics. This study took place in Southwest Colorado on the Uncompahgre Plateau on a recently harvested site (Hill & Ex, 2020)(Figure 1). For this site, the high-elevation species are primarily spruce with ponderosa pine at lower elevations.

Findings:
The study found that the survival of ponderosa pine was almost two times higher than the survival rate of Engelmann spruce on the site (figure 5). Additionally, they found that coarse woody debris shelters improved the probability of survival by about 357%, with spruce success rates being slightly higher. They found that canopy cover had little to no effect on the survival rates for both species, but slightly inhibited spruce while increasing survival rates for ponderosa slightly. This is the opposite of what was expected for these species. In this study, they found that smaller seedling heights improved the probability of survival for both species by 179% and that pine root growth was 150% greater in open versus more closed canopy microsites and limited shelter from coarse woody debris.

From this study, they concluded that regeneration efforts in the future should consider more drought-adapted species as viable supplements to moisture-dependent species to improve forest resilience in climate-related issues in the future. The authors suggest that ponderosa may be better suited to the lower-elevation Engelmann spruce forests, as they are better suited for warmer and drier conditions due to climate change. Lastly, the authors suggest that shelter from coarse woody debris should be considered when planting trees as this can help to increase tree survival rates.

Protocol:

General approach:
In the Hill & Ex paper, they used a planting study to evaluate the microsite conditions that support the first-season survival and root growth of both spruce and ponderosa trees. The study assessed different microsite conditions, such as species responses to varying canopy cover, regeneration treatments, and varying shelter from coarse woody debris. Additional variables included seedling size, vegetation and litter cover, soil moisture and depth, and competition from previously established tree regeneration. A summary of the microsite variables can be seen in Table 1.

People engaged in measuring (agency, volunteers, etc.):
Ed Hill and Seth Ex (CSU)

Data management plans:
Data are in spreadsheets that are stored on redundant hard drives in the Silviculture Lab at CSU.

<u>Plan for communicating findings to collaborators, line officers:</u>

Hill, E. M., & Ex, S. (2020). Microsite conditions in a low-elevation Engelmann spruce forest favor ponderosa pine establishment during drought conditions. *Forest Ecology and Management*, *463*, 118037. https://doi.org/10.1016/j.foreco.2020.118037

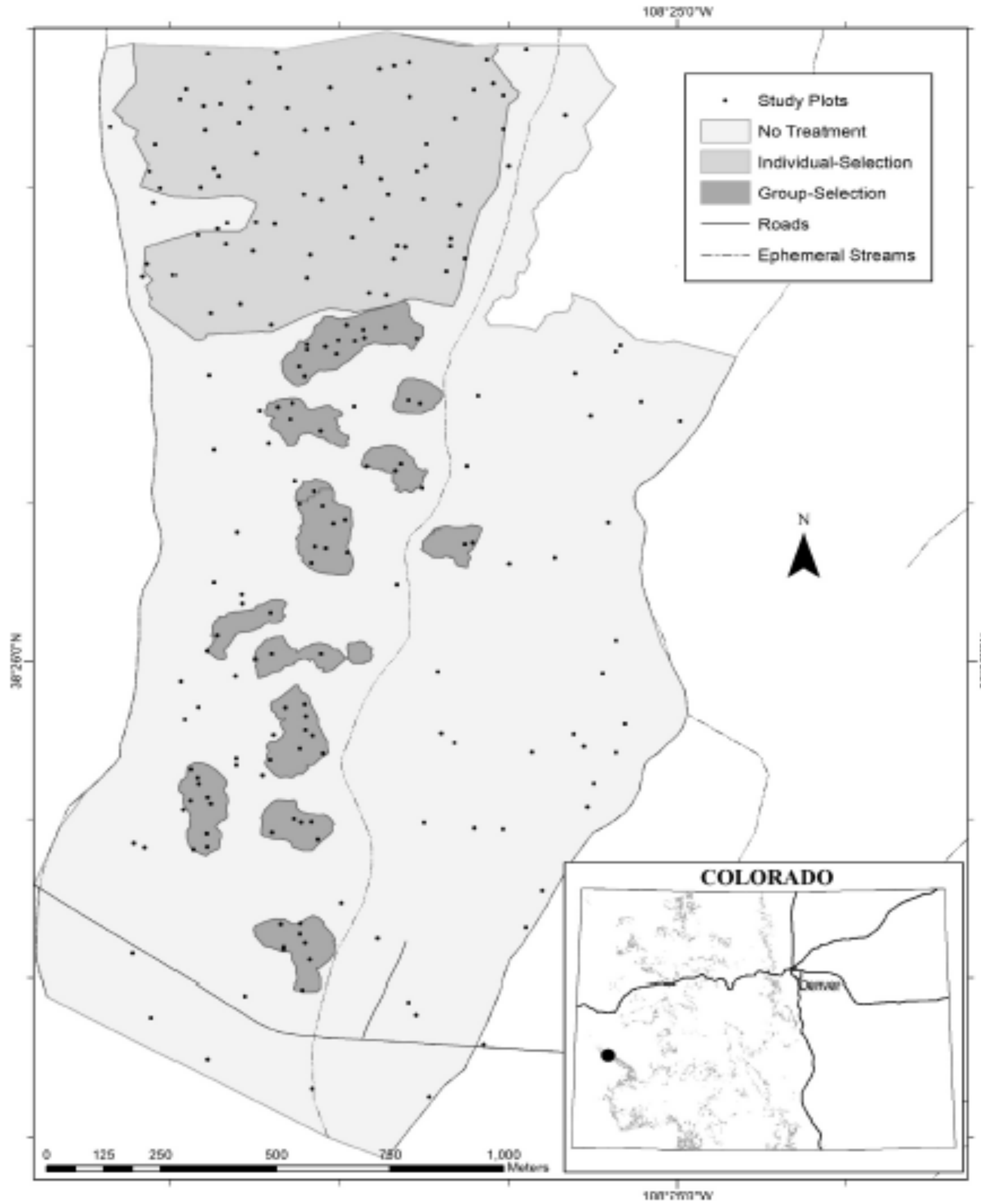


Fig. 1. The study was located on the Uncompahgre Plateau in southwest Colorado (black circle, locator map). Gray detail on the Colorado locator map shows area of overlap in predicted Engelmann spruce habitat declines and ponderosa pine habitat increases (Mathys et al., 2014). The study area was established in a recently harvested timber sale area. In the harvest area (data via Todd Gardiner, personal communication, April 11, 2018), dark shading indicates group-selection treatment openings and medium shading indicates individual-tree selection treatment area. No treatment (unharvested) areas are indicated by light shading. Elevation of the area ranges from 2,714 to 2,805 m, and slopes are largely < 10% with northerly aspects. Plots in our study are indicated by circles; two seedlings of each species were planted at each plot location, one with coarse woody debris shelter and one without. All data, unless otherwise indicated, were retrieved from the USDA NRCS Geospatial Data Gateway (USDA NRCS, 2018).

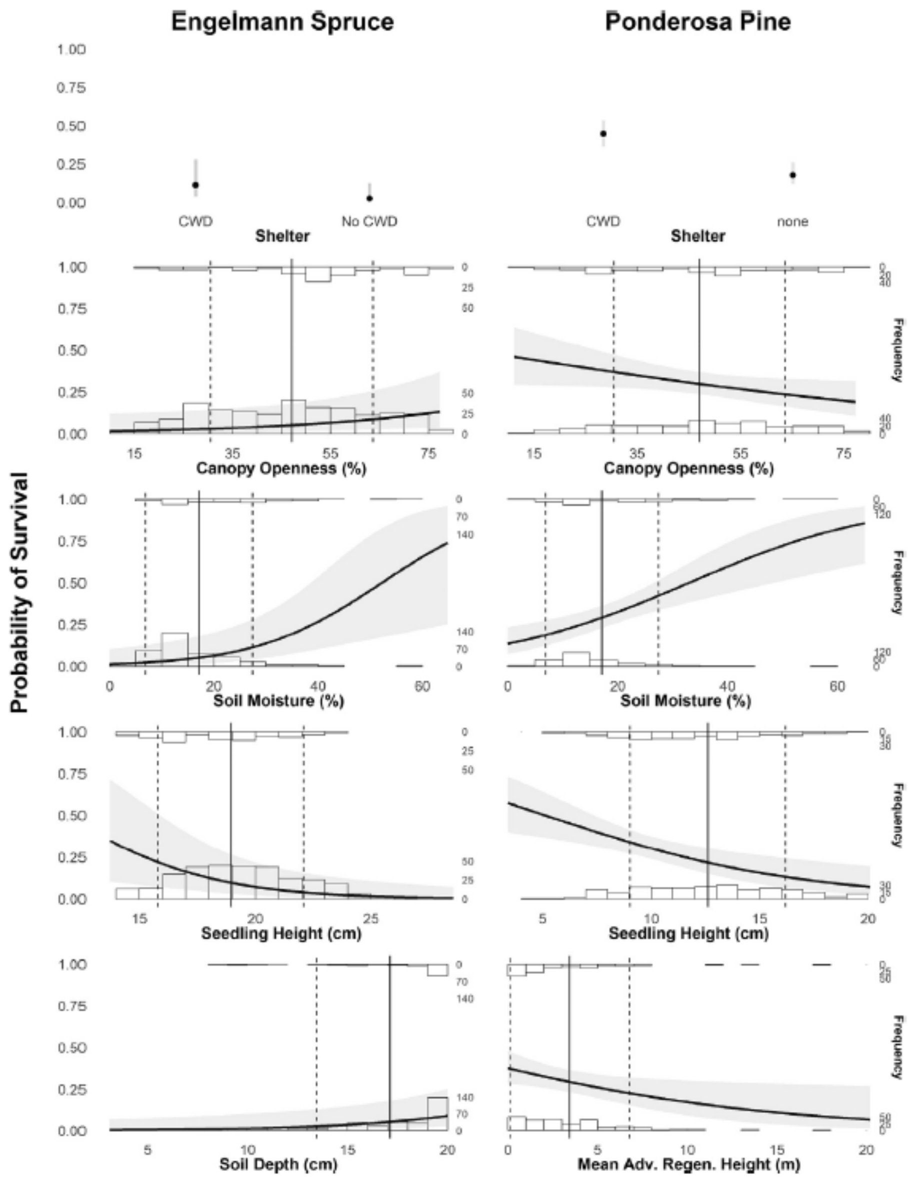


Fig. 5. Predicted mean effects of microsite variables in the final selected survival models for Engelmann spruce (left column) and ponderosa pine (right column). Covariates for both species include coarse woody debris shelter treatment (CWD shelter or no shelter), canopy cover (% canopy openness), seedling height at planting, and percent soil moisture (GWC). The Engelmann spruce final survival model also included soil depth, and the ponderosa model also included mean height of surrounding advanced regeneration trees ("Mean Adv. Regen. Height"). Predictions were made across observed values of each variable. Predicted survival is indicated by the solid black line (points for CWD shelter effects), and gray bands (bars for CWD shelter effects) on either side of the line show 95% confidence intervals for predicted mean survival. Frequency distributions (frequency on secondary y-axis) of observed survivorship are displayed with histograms for each continuous covariate. Vertical black lines indicate the mean (solid) and one standard deviation (dashed) of observed values for each continuous covariate, aiding interpretations of model effects. All effects were significant.

Table 1

Summary characteristics (mean ± SD) for microsite variables considered for survival models of both species. Bolded and italicized figures indicate a significant difference across canopy strata for each reported microsite variable; corresponding superscripted letters indicate associated pairwise differences between canopy strata for each reported microsite variable, where strata sharing the same letter are not significantly different.

Canopy Stratum	Plots	Basal Area (m^2 ha^{-1})	Canopy Cover (% openness)	Coarse Woody Debris shelter size (cm)	Soil Moisture* (%)	Soil Depth (cm)	Bare Soil (%)	Litter/Debris (%)	Vegetation** (%)	Mean Adv. Regen. Height† (m)	Adv. Regen. Count†
No harvest	69	***25.12 (± 10.72)***^{a}	***28.56 (± 7.84)***^{a}	16.51 (± 4.77)	***14.21 (± 5.45)***^{a}	17.56 (± 3.21)	10.22 (± 18.22)	61.52 (± 24.68)	***47.61 (± 28.71)***^{a}	***4.99 (± 3.57)***^{a}	***23.73 (± 13.61)***^{a}
Individual-tree selection	68	***14.45 (± 8.59)***^{c}	***49.89 (± 8.33)***^{c}	16.32 (± 5.51)	***16.98 (± 9.75)***^{b}	16.76 (± 3.81)	9.34 (± 15.31)	71.03 (± 23.49)	***36.99 (± 26.87)***^{b}	***2.40 (± 2.49)***^{b}	***8.84 (± 10.69)***^{b}
Group-selection	69	***4.13 (± 4.58)***^{b}	***62.90 (± 9.26)***^{b}	15.40 (± 3.73)	***20.22 (± 13.30)***^{b}	17.01 (± 3.96)	9.42 (± 15.71)	66.09 (± 23.12)	***36.59 (± 27.61)***^{b}	***2.96 (± 3.31)***^{b}	***12.22 (± 15.68)***^{b}

* Estimated by gravimetric water content.

** Vegetation is a summation of cover measurements for graminoid, forb, shrub, and moss life-forms.

† Sample sizes for advanced regeneration ("Adv. Regen.") were 60 for no harvest, 69 for group-selection, and 57 for individual-tree selection overstory types.

Monitoring of National Indicators

Leadership people:
Megan Matonis (CSU), Leigh Robertson (UP), Barry Johnson (USFS), Clay Speas (USFS)

Overall goals and objectives:
- Identify desired and/or undesirable future conditions on the Uncompahgre Plateau for the four national monitoring indicators: wildfire, watersheds, wildlife, and invasive species.
- Design a monitoring framework to track and report these indicators over the next 10 yrs.

Key questions to be examined:
1. What key features of the landscape does the Uncompahgre Partnership want to restore over the next10 years?
2. What outcomes do we want to avoid related to wildfire, watershed condition, invasive species, and wildlife habitats / populations?
3. What is the least amount of information we need to effectively monitor our movement away from undesirable conditions and/or towards desired conditions for wildfire, watershed, invasive species, andwildlife indicators?
4. What ongoing monitoring projects can we leverage to address the national indicators? What additionaldata collection is needed?

Objectives for 2013 monitoring:
- Create four working groups to tackle each of the four national indicators.
- Develop draft goals and protocols for the national indicators.
- Share products with the Uncompahgre Partnership for feedback.

2013 Findings:
Wildfire indicators—the wildfire working group used local knowledge of fire behavior and vegetation cover to update LANDFIRE data. They used this updated dataset and the fire behavior model NEXUS to assess crown fire risk across the Plateau. The group also summarized data on the extent of natural, historic fires in ponderosa pine forests to inform undesirable future conditions for wildfire. See more details in the summary of Landscape Scale Monitoring.

The conditions that the collaborators would like to avoid (and therefore serve as indicators) are summarized as:

Ponderosa pine and dry mixed-conifer forests

Conditions we seek to move away from / avoid through management:

Undesirable condition #1: Active crown fires are likely across >300 contiguous ac or in patches >30% of burn units under 90th percentile weather conditions.
Spatial / temporal scale: Landscape / 10 yr

Undesirable condition #2: We are overly cautious with prescribed fires. We fail to burn in over half of the units we mechanically treat, and when we do burn, we burn areas smaller than historical fires (about <500 ac).
Spatial / temporal scale: Landscape / 10 yr

Undesirable condition #3: We implement treatments that fail to reduce crown fire hazards. We leave ladder fuels covering >30% of the stand, and crown continuity remains high because we didn't create treeless openings (0.25 to 0.5 ac) across the stand.
Spatial / temporal scale: Stand / 2 to 3 yr post-treatment

Undesirable condition #4: Prescribed burning kills >10% of residual ponderosa pine andDouglas-fir trees >8" DBH.
Spatial / temporal scale: Stand / 1 week

Undesirable condition #5: Post-fire browsing by livestock and wildlife reduces regenerationto less than 50 aspen suckers / ac in stands capable of supporting aspen.
Spatial / temporal scale: Stand / 3 yr

Spruce-fir forests

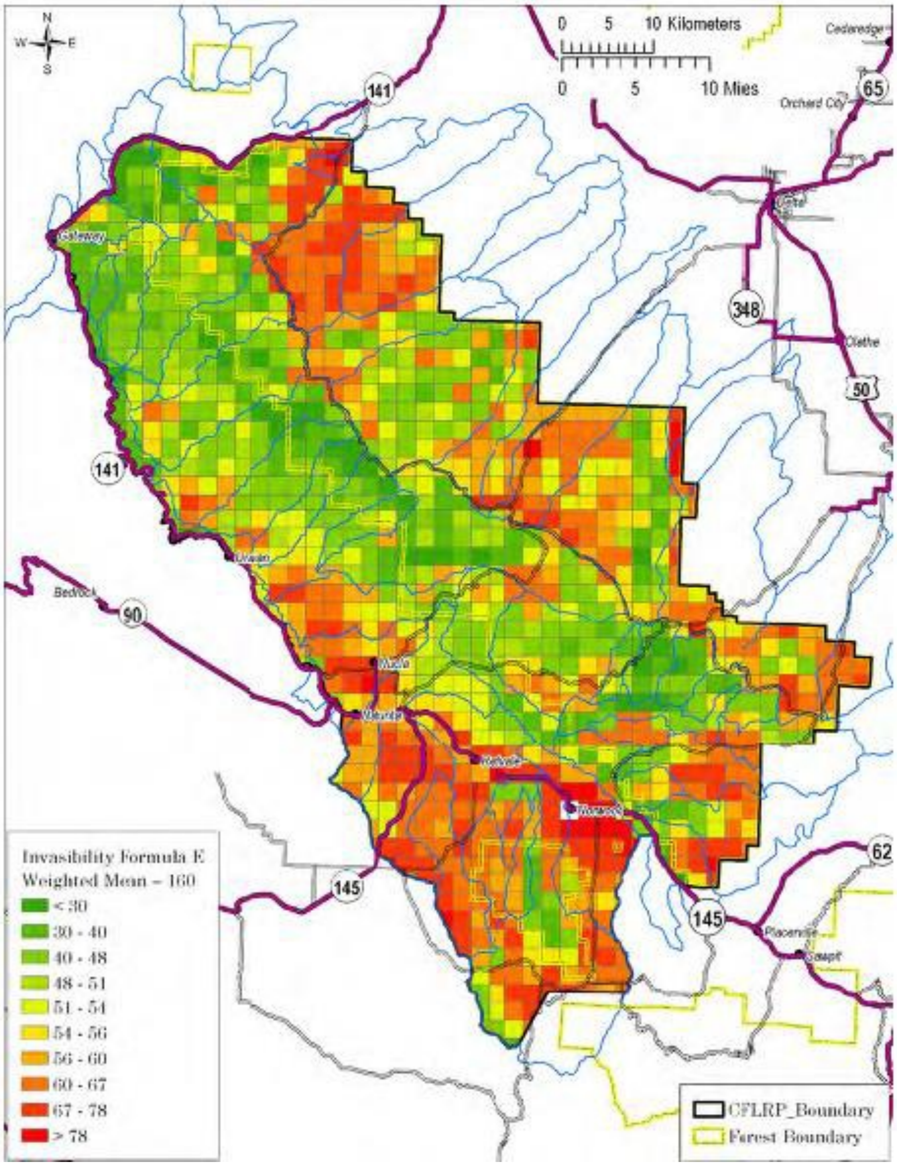
Conditions we seek to move away from / avoid through management:

Undesirable condition #1: Less than 10% or more than 30% of the area occupied by spruce-fir is in young, regenerating forests due to natural or management-induced disturbances (i.e., insects, fire, or cutting).
Spatial / temporal scale: Landscape / 10 yr

Undesirable condition #2: Over 80% of our treatments in spruce-fir forests are very unlike historical disturbances, creating numerous, small forest patches with linear boundaries. We fail to experiment with alternatives to this approach, such as the judicious use of prescribed fire to create young spruce-fir forests.
Spatial / temporal scale: Landscape / 10 yr

Undesirable condition #3: Post-fire browsing by livestock and wildlife reduces regenerationto less than 50 aspen suckers / ac in stands capable of supporting aspen.
Spatial / temporal scale: Stand / 3 yr

Watershed indicator—improving the condition of watersheds is important to the Uncompahgre Partnership, but it is not the top focus of our restoration projects. The watershed working group decided not to use the Watershed Classification and Assessment Tracking Tool (WCATT) because the tool is too coarse to show changes in watershed conditions based on the projects we have planned. They propose summarizing data we already collect regarding riparian restoration, travel management, and forest restoration.



Invasibility index in 2 x 2 km square grids across the Uncompahgre Plateau

Wildlife indicator—the wildlife working group is proposing a habitat-based approach for the wildlife national indicator. They decided that many wildlife-related goals in the Forest Plan and other GMUG documents are unrealistic and too difficult to monitor (e.g., "Self-sustaining populations of Gunnison sage-grouse thrive on areas of suitable habitat"). Returning forests to more natural, historic conditions should increase the diversity of habitats on the Plateau and benefit bird, ungulate, rodent, and feline species.

Invasive species indicator—the invasive working group created maps with the location of invasive plants and the relative risk of invasion across the Plateau. This information can help us prioritize treatments and focus ongoing monitoring in high-risk locations.

Protocol:

Spatial scale of the area under consideration:

Wildlife and wildfire indicators—the entire Uncompahgre Plateau, with data summarized by forest type.

Watershed and invasive species indicators—the entire Uncompahgre Plateau, with data summarized for each HUC6 watershed.

General approach:

Wildfire indicators—Use NEXUS and updated LANDFIRE data to monitor changes in crown fire hazards across the Plateau. Assess pre- and post-treatment crowning index for forest restoration projects. Map the location of prescribed burns and compare their extent and distribution to data on natural, historic fires in different vegetation types.

Watershed indicator—Summarize data we are already collecting for riparian areas, travel management, and invasive species across the Plateau.

Wildlife indicator—Use pre- and post-treatment monitoring at the stand and landscape scale to inform the wildlife national indictor, as well as data collected on native Cutthroat Trout as part of ongoing riparian monitoring. Historic reconstructions of forest structure and compositions can inform general targets for restoration projects that improve wildlife habitat.

Invasive species indicator—the invasive working group developed an "invasibility index" to identify locations on the Uncompahgre Plateau with the greatest risk from invasive plants. Data on vegetation cover, aspect, slope, elevation, and road density are combined to create a relative score of invasibility ranging from 9 to 98. The group also developed maps of invasive species occurrence using data from the Forest Service and Bureau of Land Management. Species assessed include Russian knapweed, spotted knapweed, whitetop, several invasive thistles, oxeye daisy, hound's-tongue, yellow toadflax, sulfur cinquefoil, and tamarisk.

Locations to be assessed:
Wildfire and wildlife indicators—the entire Plateau, with a focus on restoration treatment areas.

Watershed indicator—the entire Plateau, with a focus on areas with decommissioned roads and riparian restoration.

Invasive species indicator—Locations with a high invasibility index and treatment areas.

Measurements to be taken at each location:
Wildfire and wildlife indicators—Forest structure (basal area, trees per acre), the spatial arrangement of trees, and estimates of surface fuels.

Watershed indicator—See summary of monitoring for Riparian Restoration, Travel Management, Invasive Species, and Landscape Scale Monitoring.

Invasive species indicator—the location and cover of invasive species.

People engaged in measuring (agency, volunteers, etc.):
- High school students with the Forestry Internship Program and Riparian Monitoring Program. Forest and rangeland staff for the Forest Service.
- Citizens involved with the Uncompahgre Plateau.
- Students and field technicians with the Colorado Forest Restoration Institute.

Data management/archiving plans:
Under development, likely based on using USDA Forest Service FACTS database; additional data archiving with CFRI is likely.

Plan for communicating findings to collaborators, line officers
We will summarize data for each of the four indicators as part of the 5-yr and 10-yr report to the Washington Office of the Forest Service.

Native Seed Monitoring at Calamity Basin

Leadership people:
Julie Grode, Grand Valley Ranger District
Current contact: Carlyn Perovich, Forest Ecologist, Grand Mesa Uncompahgre Gunnison National Forest Supervisor's Office

Overall goals and objectives: (from Decision Memo)

1. Help to maintain and improve browse and forage quality for big game, wild turkey and sagebrush-associated species.
2. Help to reduce natural fuel loading.
3. Make browse species such as Gambel oak more available to big game by lowering the canopy level and stimulating new growth of desirable browse species.
4. Facilitate improved distribution of big game species and domestic stock through the project area by creating a mosaic of structural stages and size classes of vegetation.
5. Increase the acreage of sagebrush by opening mature piñon-juniper stands.
6. Maintain existing mule deer habitat and sage-associated species by treating the encroaching piñon-juniper.
7. Maintain existing stands of ponderosa pine.
8. Reduce the natural fuels within the project area, to lower the risk of large catastrophic wildfires.
9. Promote forest stand resilience by diversifying age classes across the landscape

Objectives for 2013 monitoring:
Measure success in meeting management goals.

- Determine effectiveness of aerial seeding with native species before treatment.

Findings: (summarized from the report[1])

1. The treatments were completed in May 2012, during and after which there was a severe drought on the northern Uncompahgre Plateau. During the spring and summer of 2012 there was over three months without any measurable precipitation in this area. When the precipitation did come, it was too late for many herbaceous plants, and many apparently died. Shrubs experienced widespread mortality. The winter of 2012-2013 was mild, and there was little rain until mid-July 2013 – thus the drought lasted over a year.
2. In the treatment areas in July 2013, shrub cover ranged 7 – 29%, averaging 14.6%, mostly Gambel oak (*Quercus gambelii*)[2] and Utah serviceberry (*Amelanchier utahensis*), both sprouting from the root crown.
3. Some of the sagebrush had been damaged by heavy equipment during the treatment, but it seems to be recovering.
4. Graminoid cover was greater than expected, given the drought conditions that preceded the sampling. Graminoid cover ranged 6 – 53%, averaging 20.0%. Species such as prairie junegrass (*Koeleria macrantha*) and mountain brome (*Ceratochloa marginata*) were often conspicuous, both in the seed mix (Table 1). But species not in the mix were also conspicuous, such as needle-and-thread (*Hesperostipa comata*) and bottlebrush squirreltail (*Elymus elymoides*). Seeding before the mastication apparently had a beneficial effect, but the moisture-holding capacity of the mulch produced by mastication was also beneficial.
5. There was noticeable cheatgrass (Bromus tectorum) at most of the transects. Cheatgrass cover is

now at relatively low levels, but it must be remembered that it is a spring annual, and the last two springs have been very dry, not favorable for this species. We can expect more cheatgrass cover in years with normal late winter and spring moisture.

6. The three forbs in the seed mix were not observed along any of the transects, although a few isolated plants of each were seen as I walked through the treatment units. It may be that these plants will appear later. Forb cover was low, ranging 3 – 27%, averaging 7.3%.

Key questions to be examined: (Recommended Further Work)

1. Resample these transects and retake all photos next year and five years after the treatment.
2. Consider establishing a few transects in untreated areas to serve as a control.
3. Co-sponsor a symposium or workshop on management of Gambel oak, to include discussion of treatment options, fire history, and fire behavior (see outcomes of a later workshop and publication that addresses Gambel oak (Gambel Oak Ecology and Management in Southern Rockies: The Status of Our Knowledge)

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[1] Johnston 2013
[2] Plant species names follow Weber and Wittmann 2012.

Protocol:

Spatial scale of the area under consideration:
Three treatment units, totaling about 120 acres (Fig. 1).

General approach:
Subjective sampling, to characterize stands treated, "subjective with no preconceived bias" (Mueller-Dombois and Ellenberg 1974).

Locations to be assessed:
Five locations within the areas treated, nine transects.

Measurements to be taken at each location:

- Standard cover-frequency transect (metric), 30 m long with 20 Daubenmire microplots evenly spaced in each.
- Cover by each plant species in microplots (estimate cover within circular plot with 30 m diameter); cover by each natural layer; cover by ground cover categories (bare soil, litter, and duff, etc.).
- Transects permanently marked on the ground. Consistent protocol for photos (around 30 photos for each transect).

People engaged in measuring (agency, volunteers, etc.):
1 agency person.

Data management plans:

- Summarize cover by species and ground cover for each transect, display in association table.
- Individual document for each transects, showing photographs, cover data, and summary

statistics.

Data archiving plans:
Grand Valley District office, Forest Service corporate data bases.

Plan for communicating findings to collaborators, line officers:
Regular reports (Johnston 2013). Initial report has been delivered to Grand Valley Ranger District.

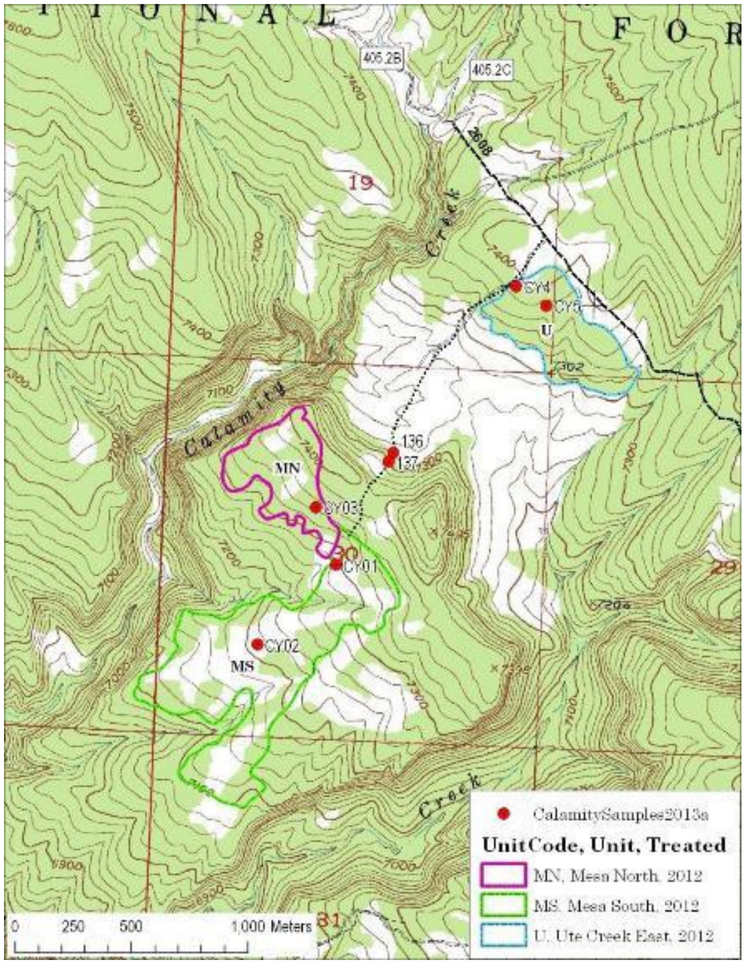


Figure 1. Units treated in 2012 as part of the Calamity Basin 2 Project.

Literature Cited

Johnston, Barry C. 2013. Report on monitoring for the Calamity Basin 2 Mastication Project 2012. Reportto Grand Valley Ranger District, Grand Junction, Colorado. Gunnison, Colorado: Grand Mesa, Uncompahgre, and Gunnison National Forests, 19 pp. September 24, 2013. Plus individual reports oneach of the nine transects.

Mueller-Dombois, Dieter; and Heinz Ellenberg. 1974. Aims and methods of vegetation ecology. 547 pp. New York, NY: John Wiley and Sons.

Weber, William A.; and Ronald C. Wittmann. 2012. Colorado flora: Western Slope, Fourth Edition. 532pp. Boulder, CO: University Press of Colorado.

North Uncompahgre Prescribed Burning Monitoring

Leadership people:
Eric Freels (USFS Grand Valley Ranger District), North Zone FMO and Module (temporary contact)

Overall goals and objectives: The goals of monitoring RX or managed fires is to determine the effects of the fire. Photo points are a great tool to compare vegetation before and after fire is introduced into the system. These points can be visited over a period of time to also evaluate the response of the vegetation.

Protocol: (CFRI was unable to acquire additional information in 2025 during this report update)

Spatial scale of the area under consideration

General approach:

- Keep ponderosa pine mortality under 10%
- Reduce brush by 50%

Locations to be assessed:

Measurements to be taken at each location

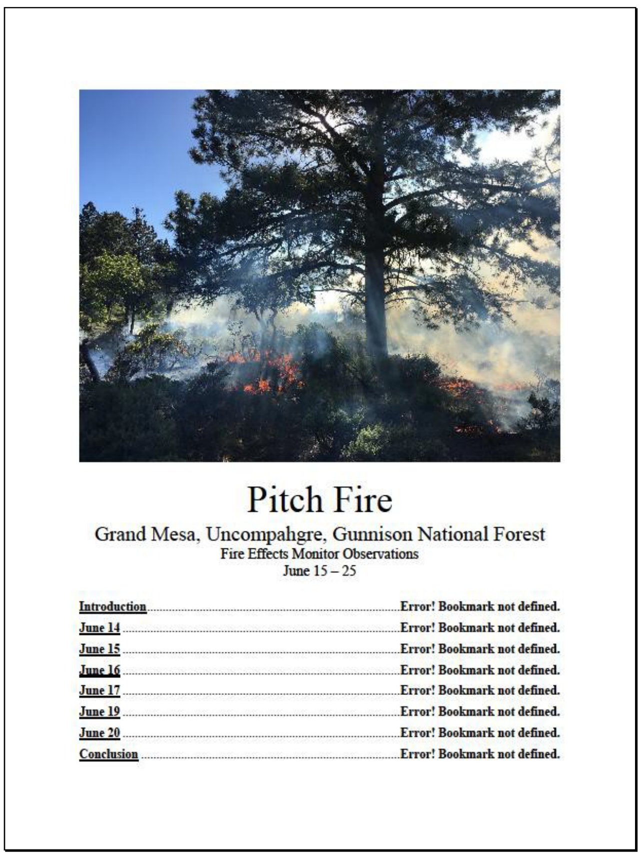
People engaged in measuring (agency, volunteers, etc.)

Data management plans

Data archiving plans

Plan for communicating findings to collaborators, line officers

Monitoring Report form 2016 fire



Pitch Fire

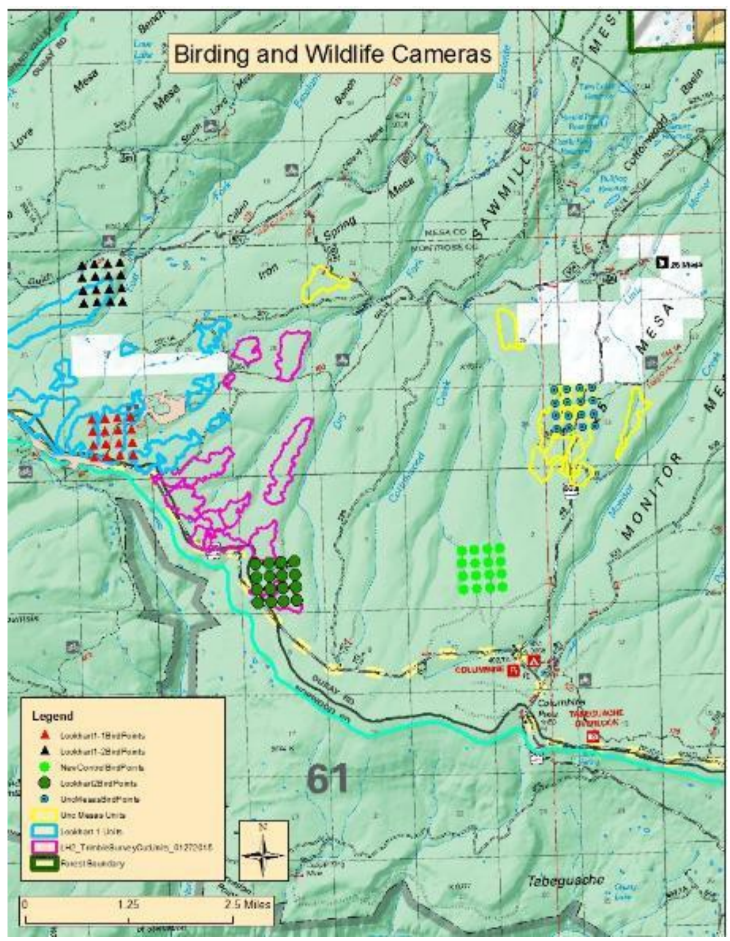
Grand Mesa, Uncompahgre, Gunnison National Forest
Fire Effects Monitor Observations
June 15 – 25

Norwood High School Internship Program

Leadership people:
Luke Holguin (USFS Norwood and Ouray Ranger District), Matthew Dare(USFS GMUG).

Overall goals and objectives:
This year we are also opening the opportunity to Nucla and Telluride High Schools. The goal is to complete 5-8 separate birding locations using the Integrated Monitoring in Bird Conservation Regions protocol. Along with the birding, trail cameras are setup within the birding areas to detect mammal use of the as well. The objective is to introduce the students to the Forest Service and have them assist the Forest with gatheringdata on birds and mammals.

Key questions to be examined:
How do the restoration activities affect bird and mammaldensity and diversity over the long term.



Objectives for [2016] monitoring (multi-year monitoring project):
Norwood High School did notparticipate in the internship program in 2016 as no applications were received.

Objectives for [2017] monitoring (multi-year monitoring project):
Open the opportunity to Nucla and Telluride High Schools to increase our applicant pool and draw interested applicantsfrom the two other area high schools. We hope to complete 5-8 birding and camera locations.We have pre-treatment data from 2014 and 2015. In 2016 restoration activities began in our monitoring areas.

Objectives for [2018] monitoring (multi-year monitoring project):
Continue gathering and analyzing data. Depending on the progress of the restoration activities, we may be able to see some post-treatment differences in our birding and camera data.

Protocol:

Spatial scale of the area under consideration:
Our focus is in the Escalante RestorationArea on the Ouray Ranger District on the Uncompahgre Plateau.

General approach:
Approximately 3 weeks of job shadowing with USFS personnel, followed byapproximately 3 weeks of guided research. Guided research projects are coordinated and supervised by USFS personnel and a High School Science teacher. For the birding the studentscamp at Columbine campground which

puts them in closer proximity to the birding areas.
Thirty minutes before sunup, the students and FS personnel are at the birding locations and generally finish around 11 am. Data are compiled and analyzed after all areas have been completed.

Locations to be assessed:

1. Lockhart 1 and Lockhart 2 restoration areas represent the pre- treatment data. The Uncompahgre Mesas project represents an area that has already been treated.
2. We have one control area at this point. Three additional areas will be identified and could include additional controls and or the Long Creek and 7N restoration areas.

Measurements to be taken at each location:

- Vegetation characteristics are gathered at each birding location (16 per site).
- All birds seen or heard at each location and the distance to observer are recorded.
- In 2017 we may also gather hare pellet data and may establish a photopoint at one of the birding locations.
- Photos taken from the trail cameras are also analyzed.

People engaged in measuring (agency, volunteers, etc.):
Two high school interns. Luke Holguin, and other agency personnel. We will be seeking volunteers from local Audubon chapters and The Bird Observatory of the Rockies.

Data management plans:
We are in the process of outreaching to the Bird Conservancy of the Rockies to partner with the Forest Service in our efforts. The Integrated Monitoring in Bird Conservation Regions protocol was developed by them and their expertise in analyzing and assisting with the monitoring would be very valuable.

Data archiving plans:
All data are stored on server drivers and uploaded to the appropriate corporate databases.

Plan for communicating findings to collaborators, line officers:
Students present their findings to USFS personnel and CFLRP stakeholders at the conclusion of each year's internship (July).

Plateau Elk Pilot Study: Recruitment and Habitat Use Monitoring

Leadership people:

Mat Alldredge (Mammals researcher, Colorado Parks and Wildlife) and Brad Banulis(Wildlife Biologist, Colorado Parks and Wildlife).

Overall goals and objectives:

Elk calf recruitment has been observed to be declining across southern Colorado over the last 10-20 years through annual aerial classification flights. Our overall goal is to determine what is limiting juvenile elk recruitment in southwestern Colorado and how to improve elkrecruitment. In addition, determine how elk utilize habitat on the Uncompahgre in relation to habitattype, travel management, hunting seasons, and habitat treatment and stand improvement projects.

Key questions to be examined:

- What are elk pregnancy rates on the Uncompahgre Plateau?
- What arejuvenile elk survival rates?
- What is limiting pregnancy rates or juvenile survival?
- How do elk move in relation to roads, seasonal recreation, and hunting seasons across the Uncompahgre?
- What is limitingpregnancy rates or juvenile survival?
- How do elk utilize habitat treatments and stand improvement projects?

Objectives for [2016] monitoring:

Develop research study proposal, acquire funding, and purchasesatellite GPS collars.

Objectives for [2017] monitoring:

- Capture adult female elk in the winter.
- Determine pregnancy statusand if pregnant fit with satellite GPS collar and VIT (vaginal implant transmitter).
- Monitor elk movements via GPS data.
- When VITs released, capture newborn calves, and fit with satellite GPS collar to monitor movements and monitor survival.
- Determine cause-specific mortality of cows and calves when needed.

Objectives for [2018] monitoring:

- Capture adult female elk in the winter.
- Determine pregnancy statusand if pregnant fit with satellite GPS collar and VIT (vaginal implant transmitter).
- Monitor elk movements via GPS data. When VITs released, capture newborn calves, and fit with satellite GPS collarto monitor movements and monitor survival.
- Determine cause-specific mortality of cows and calves when needed.
- Start to analyze data and determine if pregnancy rates or calf survival are limiting juvenile recruitment and then develop long term research project to address identified issues and test hypotheses to correct issues.

Protocol:

Spatial scale of the area under consideration:

The initial focus of the elk capture and collaring efforts will occur in smaller landscapes of the entire Uncompahgre Plateau. In GMU (Game Management Unit) 62, elk will be captured on winter range from Government Springs Road north to Roubideau. In GMU 61, elk will be captured on the south end from Sanborn Park Road north to Tabeguache Creek and then on the north end from Mesa Creek north to the Unaweep Canyon. Calf capture will be determined by where elk migrate to calving areas and summer range.

General approach:

Capture adult female elk in the winter. Determine pregnancy status and if pregnant fit with satellite GPS collar and VIT (vaginal implant transmitter). Monitor elk movements via GPS data. When VITs released, capture newborn calves, and fit with satellite GPS collar to monitor movements and monitor survival. Determine cause specific mortality of cows and calves when needed. Start to analyze data and determine if pregnancy rates or calf survival are limiting juvenile recruitment and then develop long term research project to address identified issues and test hypotheses to correct issues.

Locations to be assessed:

Specific location monitoring will be determined by movements of collared elk.

Measurements to be taken at each location:

People engaged in measuring (agency, volunteers, etc.):

Colorado Parks and Wildlife staff will attempt to capture elk on the ground when conditions allow as well as contracting with a helicopter capture company to capture elk more randomly within the area of interest. Seasonal temporaries will be hired to help capture and monitor elk calves. Volunteers will be incorporated in to capture operations to help with data collection and managing capture logistics. It is also probable that this research will turn into a graduate research project.

Data management plans:

Data archiving plans:

Plan for communicating findings to collaborators, line officers:

Data will be summarized annually to assess annual pregnancy rates and juvenile survival. In addition, GPS data will be analyzed annually to look at seasonal home ranges and habitat use in relation to hunting seasons and seasonal recreation activity. At the completion of the 2-year pilot study, a more thorough analysis will take place of all data to develop a long-term research project to address identified questions from pilot study. An annual report can be provided.

Mat Alldredge, CPW researcher, and Brad Banulis, CPW Wildlife biologist, measuring elk lointhickness as a gauge of overall body condition.

Riparian Restoration

(National Forest Foundation article: http://www.nationalforests.org/blog/post/50/science-and-engineering-apprenticeship-providing-students-a-hands-on-education)

Leadership people:
Clay Speas and Barry Johnston (USDA Forest Service). Teacher from Delta School District.

Overall goals and objectives:
To assess the current condition and trend of streambanks, channels, and streamside vegetation to determine if livestock grazing management strategies and other land management actions are making progress toward achieving the long-term restoration goals and objectives for streamside riparian vegetation and aquatic resources.

Objectives for 2012 monitoring:
Implement MIM protocols for initial assessment of two reaches of Dominguez Creek Provide summer internships for local high school students, informing them about career
potential in natural resources.

2012 Findings:
Baseline long-term indicators for vegetation were established on both MIM reaches. Greenline vegetation composition is moderate, similar to potential natural vegetation. Early seral species such as bull rush and dandelion still occur with most dominated by late seral species including several species of sedge. Floodplain vegetation composition is low similarity to natural vegetation composition along both reaches. The level of bare soil and presence of early seral species are the primary factors affecting ecological status. Woody species along reach 1 are also experiencing heavy browse resulting in few plants being more than 4 feet in height.

2013 Findings:
High School students from Delta High School collected data using the Multiple Indicator Monitoring (MIM) protocol along two sections of Dominguez Creek. Pre- and post- grazing data have been collected along both reaches. Short-term indicators (stubble height, streambank alteration, woody species use) and long-term indicators (streambank erosion, greenline species composition, floodplain vegetation composition,woody species age distribution, streambed substrate, residual pool depth and pool frequency) are being collected. At the end of the 2013 grazing season, stubble height was reduced by approximately 60% at both reaches but Forest Plan standards were still achieved. Season-end use on willow was 60% along reach 1 and 25% along reach 2. Streambank alterations increase from less than 5% pre-grazing to 15-20% post grazing. Greenline vegetation compositions along both reaches indicate a moderate similarity to potential natural vegetation composition. Floodplain vegetation composition is low similarity to natural vegetation composition along both reaches. To date, the prescribed grazing system has not been adequately implemented leaving season end vegetative conditions below the objective resulting in a decline in long-term vegetative indicators alongreach 1 and stagnant vegetative conditions along reach 2.

2014-2016:
In the 2013 study plan, students decided to defer monitoring to once every 3-4 yr since capturing changes in long-term indicators from year-to-year is not feasible. No resamples have occurred since 2013, and

there are not currently plans to resample this area.

Key questions to be examined:

1. What is the current condition of the riparian ecosystems in each reach?
2. What factors have contributed to any observed problems?
3. What management opportunities need further work to achieve restoration goals?

Protocol:

Spatial scale of the area under consideration:
Initially, the project focuses on two reaches of Dominguez Creek, with plans to expand to otherriparian systems on the Uncompahgre in the future.

General approach:
Using the MIM protocol, the project will assess seven indicators of long-term riparian condition:

1. Greenline composition
2. Woody species height class
3. Streambank stability and cover
4. Woody species age class
5. Greenline-to-greenline width
6. Substrate
7. Residual pool depth and pool frequency

Locations to be assessed:
Two reaches of Dominguez Creek.

Measurements to be taken at each location:
(7 indicators above)

People engaged in measuring (agency, volunteers, etc.):

- Clay Speas, Barry Johnston (thru a volunteer agreement).
- Delta High School or Cedaredge High School teacher and students.

Data management plans:
Excel spreadsheet (part of MIM protocols).

Data archiving plans:
Data will be archived in the GMUG database.

Plan for communicating findings to collaborators, line officersStudents will present findings to the CFLRP Monitoring Group
The results will be presented at UP meetings, including one or more field trips.

Sanborn Park Fuel Reduction Monitoring Project

Leadership people:

Corey Robinson, USFS Norwood Ranger District (temporary contact)

Overall goals and objectives: (extracted from the Decision Notice)

1. Reduce hazardous fuels in the wildland urban interface around Sanborn Park and along the Western Area Power Administration's power lines.
2. Protect the wildland urban interface around Sanborn Park and along the Western Area Power Administration's power lines from destructive wildfire.
3. Initiate a progressive change, so that over time, unplanned fires can be used more effectively over a larger percentage of the landscape during hotter and drier conditions without exceeding the desired fire severity.
4. Reduce risk to grazing permittees by achieving a desired range of fire-associated benefits while allowing them to plan their out-year grazing based upon the implementation schedule of planned projects.
5. Create vegetation conditions that are more resilient to wildfire, epidemic insects and diseases.
6. Reduce threats to life and property from destructive wildfires, epidemic insects, and diseases.

Objectives for [2013] monitoring: (multi-year monitoring project)

1. Determine whether goals are being met in the Sanborn Park area.
2. Determine whether aerial seeding by native species is effective at reducing soil loss and reducing the influence of noxious weeds.

2013-2016 Findings:

1. Based on three transects re-measured in 2013, the project was very successful at meeting fuels reduction, destructive fire prevention, permittee risk reduction, resiliency, and insect-disease risk reduction goals.
2. Mastication was more effective than roller chopping.

Key questions to be examined: (in future)

1. Determination that the project goals were met and more sampling across the whole area.
2. Determination of the success of aerial seeding since aerial seeding had not yet begun by the end of the 2013 season.
3. Follow-up sampling post-Rx burning will determine multi-treatment success.

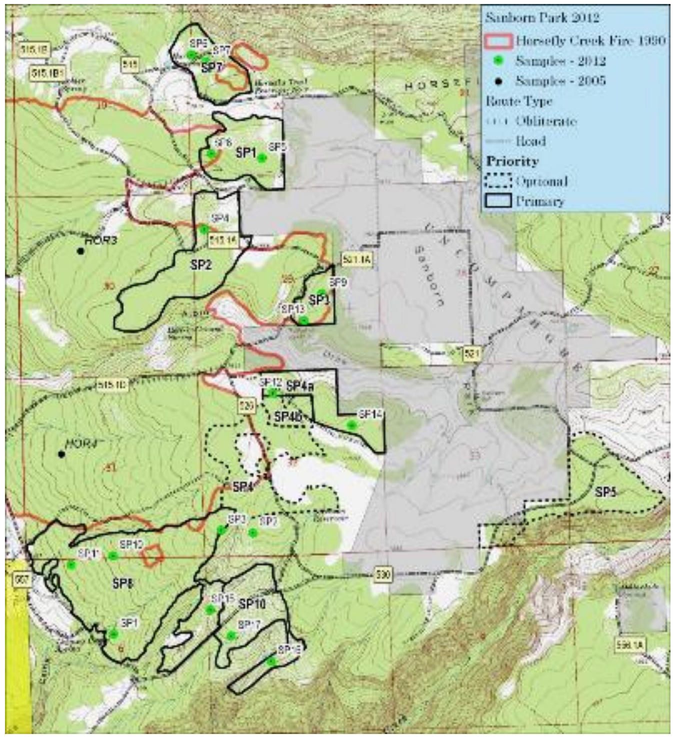
Protocol:

Spatial scale of the area under consideration:

Ten treatment units, over 1,170 ac total (Fig. below)

General approach:

Subjective sampling, to characterize stands treated, "subjective with no preconceived bias" (Mueller-Dombois and Ellenberg 1974).



<u>Locations to be assessed:</u>
Seventeen pre-treatment samples (Figure above).

<u>Measurements to be taken at each location:</u>

- Standard cover-frequency transect (metric), 30 m long with 20 Daubenmire microplots evenly spaced in each.
- Cover by each plant species in microplots (estimate cover within circular plot with 30 m diameter)
- Cover by each natural layer; cover by ground cover categories (bare soil, litter, and duff, etc.).
- Transects permanently marked on the ground.
- Consistent protocol for photos (around 30 photos for each transect).

<u>People engaged in measuring (agency, volunteers, etc.):</u>
Three agency employees, two volunteers.

<u>Data management plans:</u>

- Summarize cover by species and ground cover for each transect, display in association table.
- Individual document for each transect, showing photographs, cover data, and summary statistics.

<u>Data archiving plans:</u>
Norwood District office, Forest Service corporate data bases.

<u>Plan for communicating findings to collaborators, line officers:</u>
Final report to be prepared following Rx fire.

Travel Management

Leadership people:
Loren Paulson

Overall goals and objectives:
Conduct monitoring of the route-by-route travel implementation on the Grand Valley Ranger District.

Objectives for 2013-2016 monitoring:
Field crews will conduct inspections of all signs placed on existing “system” roads and trails to ensure all routes are marked in accordance with travel management decisions. All non-system routes will be inspected to ensure that previous signage, barriers, and/or obliteration efforts arestill in place and effective. Overall, all routes, signs, kiosks, and maps will be reviewed to ensure that travel opportunities and restrictions are clear and concise to the public. Attached is a copyof “Travel Monitoring, Pg. 1” which the crews will complete to document the above objectives.

In addition, district personnel will also conduct visitor contacts and surveys during high-use periods such as holiday weekends and throughout the fall hunting seasons. In addition to documenting the amount and type of recreation use the district receives, this survey will also document the district’s efforts towards education and the public’s understanding and opinionsof the current travel management regulations. The second page of the “Travel Monitoring” form has been attached to demonstrate the information that is being collected.

2013-2016 Findings:
Overall, the monitoring and surveys completed in 2013 show a continued increase in the public’s knowledge and compliance with existing travel management regulations across the Northern part of the Uncompahgre Plateau.

Travel Management - Daily Diary & Patrol Log

(Front Page) Track daily work accomplishments associated with the implementation of travel management plans.
(Back Page) Documentation of education & enforcement efforts (public contacts) and the responses received.

Daily Diary – Travel Implementation Accomplishments

Unit/General Location: Date: Personnel:

	Non System Routes (Level I - IV decommission)								System Routes							Other					
Specific Area (Area Description and/or Route #'s)	Total # of Routes Inspected	# of Routes that need Work to reduce impacts	# of Signs (Carsonites) Installed		# of Routes Obscured		# of Barriers Installed		# of System Route Sign Units Inspected	# of Route Signs Installed		# of Travel Mgmt (open to - Closed to) Signs / Placards		# of Devices (gates, posts, etc.) to implement restrictions		Travel Kiosks Installed		Kiosk Maps & Info		# of Incident Reports
			New N	Rplc R	New N	Rplc R	New N	Rplc R		New N	Rplc R	New N	Rplc R	New N	Rplc R	New N	Rplc R	New N	Rplc R	
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N = New R = Replaced or Repaired

Note: A parent map(s) should be kept on each unit to track the total routes/signs monitored to reduce double counting.

Protocol:

Spatial scale of the area under consideration

The Northern portion of the Uncompahgre Plateau encompassing approximately 250,000 ac of lands administered by the Grand Valley Ranger District.

General approach

Crews will inspect and document efforts involved in the signage and other on-ground travel management devices throughout the year. District personnel will also document visitor contacts to assess the public's awareness and opinions of existing travel regulations.

Locations to be assessed

All routes (system and non-system) across the Northern portion of the Uncompahgre Plateau.

Measurements to be taken at each location

Document existing conditions and efforts taken to correct any deficiencies, i.e., replaced sign, installed barrier, etc.

People engaged in measuring (agency, volunteers, etc.)

The district "OHV crew" are primarily responsible for the on-ground monitoring and correction of signs and other necessary work on routes. The entire district recreation staff are involved with conducting visitor contacts and documentation of those efforts.

Patrol Log – Field Contact Documentation

General Location: Date: Personnel:

Specific Location Route # - Mileage	Contact Type		Total # of PEOPLE	# PPL From:		Types & Number of Equipment							Was TM Info provided? (Discuss or handouts)		Were Person(s) previously aware of Travel Regs?				Did person(s) provide feedback to Travel Regs?		If Travel Mgmt feedback provided… Response to existing TM regulations		
	Camp	Field		CO	Out of State	Full Size Veh's	UTV	ATV	MO	MB	HO	Y	N	Y	N	Some what S	Not deter-mined ?	Y	N	Positive P	Negative N	Undecided or Neutral U
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Data management plans

Continue to review monitoring reports and provide an overall total of achievements such as the total number of routes inspected, number of signs replaced, and number of visitors contacted.

Data archiving plans

All data recorded throughout the year will be kept at the Grand Valley Ranger District Office.

Plan for communicating findings to collaborators, line officers

A summary of the information collected for each year will be provided as necessary.

Uncompahgre Mesas Monitoring Plots (Forest Condition Assessment)/Montrose High School Forestry Internship Program (FIP)

Leadership people:
Todd Gardiner (USDA Forest Service), Marin Chambers (Colorado Forest Restoration Institute), Lyle Motley (Montrose High School Forest Internship Program crew leader)

Other Leadership People:
Rusty George (Montrose High School)

Overall goals and objectives:

- Restore ecosystem structure, composition, and function. For ponderosa pine type forests, these goals include:
  - 20 to 90 ft^2/acre, often clumped (20-100 ft. radius) with mini-meadows; uneven-age structure, fostering old, large trees.
- For mixed-conifer type forests, these goals include:
  - 25 to 130 ft^2/acre basal areas; clumped in some places (20-100 ft. radius), but not everywhere; some mini-meadows (0.1 to 0.5 acres), uneven-age structure, favoring Douglas-fir, ponderosa pine, and aspen regeneration
- Create opportunities for high achieving high school students to gain vocational skills and provide experiences working in forestry, ecological science, and natural resources while gaining high qualitypre- and post-treatment data for forest condition assessments.

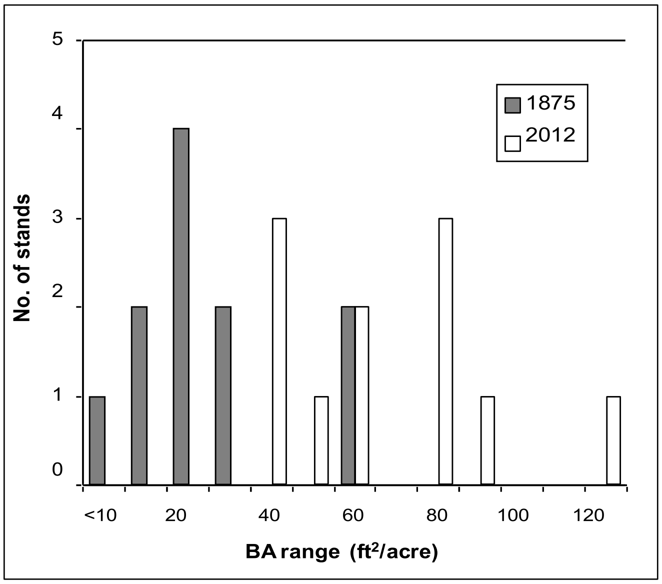
Key questions to be examined:

- Did treatments move the ecosystems toward the restoration goals?
- Were any unintended consequences important (such as invasive weeds)?
- How might the efficiency and effectiveness of the treatments be improved in the future?

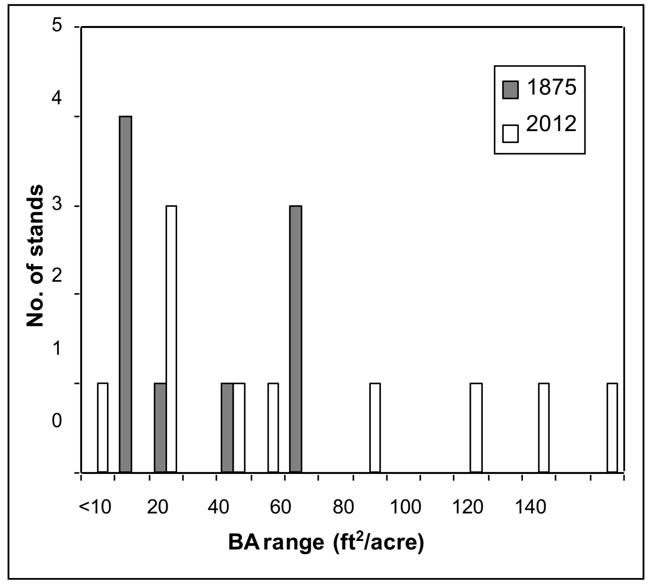
Objectives for 2013 monitoring:
The objectives for 2013 included continued use of the "forensic forestry" protocol from the historical reconstruction work to 1) assess the Unc Mesas treatments relative to historical forest structure, and 2) provide additional historical reconstructions to support the expansion in the Escalante Project. We also will assess the value and limitations of the rapid approach for multi-party assessments of historical stand structure by comparing the basic insights from the UP protocol with research-grade characterizations of plots undertaken by Peter Brown of the Rocky Mountain Tree Ring Laboratory.

2013 findings:
Additional rapid-assessment/forest forensic plots within the Escalante Project area showed similar results to plots from the Unc Mesas areas. Historical forests were characterized by much lower basal areas, with substantial areas in small meadows. The mechanical treatments in the Unc Mesas units recreated stand structures that were well within the historical ranges (see photos next page). Low basal area in mixed conifer stands in 2012 were all locations dominated by aspen, and we do not have away to reconstruct historical aspen basal area.

We sampled 18 stands in the Front Range of Colorado using our rapid-assessment/forest forensic protocol, centering each plot on a plot previously sampled by Peter Brown. Dr. Brown's research-gradeassessment included directly aging cores from living and dead trees, whereas the UP approach cores some trees and estimates others. Our comparison of methods will be completed early in 2014.



Distribution of conifer basal area in 1875 and 2012 in ponderosa pine stands.



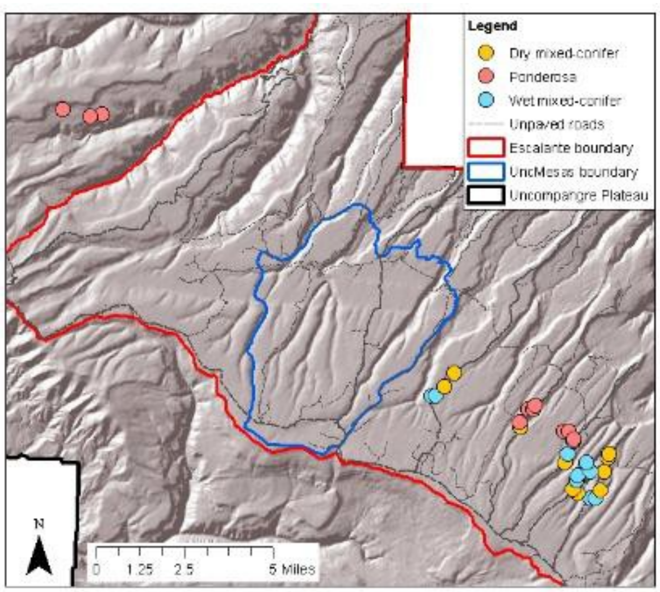
Distribution of conifer basal area 1875 and 2012 in dry-mixed conifer stands.

Protocol:

Spatial scale of the area under consideration:

- Originally 17,000 acres for Unc Mesas, now expanded to over 135,000 acres for the Escalante Project.
- We have assessed forest structure in over 30 stands located within or nearby the Escalante Project area:

General approach:



Active restoration treatments envisioned for up to half (or more) of the Unc Mesas area (and expanding to the Escalante Project Area), substantially modifying landscape-scale structure and function (including fire hazard)

Locations assessed:
- 12 new plots were added in the Escalante Project area, giving us about 50 plots to inform us on historical stand structure.
- 18 plots were measured in the Front Range for the method comparison.

Measurements taken at each location:
- Stem-mapping of live post-treatment trees.
- Mapping of signs of historical (1875) forest structure for the historical condition plots.

People engaged in measuring (agency, volunteers, etc.)
Dan Binkley (CSU), Megan Matonis (CSU), Matt Tuten (USDA Forest Service), and UP collaborative volunteers.

Objectives for 2014-2015 monitoring:
- Used Rapid Assessment (RA) plots to assess changes in basal area and species composition, fuels and expected fire behavior, understory and forest floor cover following treatments.
- Integrated the Forest Internship Program (FIP) high school student crew as primary data collectors.
- Pre-treatment monitoring served as a baseline for change post-treatment.
- See overall objectives and key questions above; additionally, regeneration plots were added to the study design to better assess long-term forest resilience to treatments.

Objectives for 2016-2024 monitoring:
- Continued to use Rapid Assessment (RA) plots to assess changes in basal area and species composition, fuels and expected fire behavior, understory and forest floor cover following mechanical and prescribed burning treatments 5-10 years post-treatment.
- Utilized the Forest Internship Program (FIP) high school student crew as primary data collectors. Pre-treatment monitoring served as a baseline for change post-treatment.
- See overall objectives and key questions above; additionally, >200 regeneration plots were added to the study design to better assess long-term forest resilience to treatments.
- Photopoints were also added in six treatment areas to illustrate changes pre-, 1-yr, 5yr and 10 yr post-treatment when applicable.

Protocol:

Spatial scale of the area under consideration:
152,000 acres between Unc Mesas and Escalante Project.

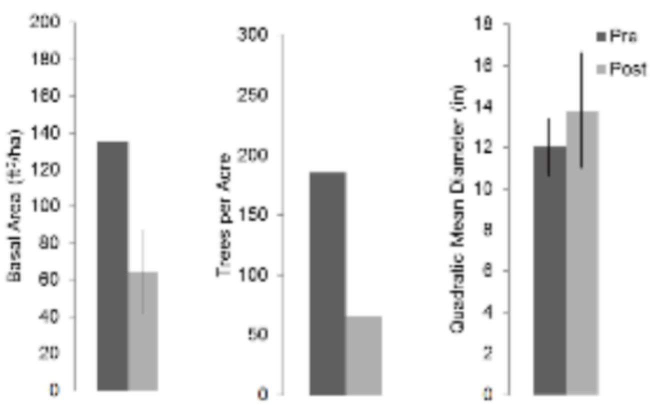
General approach:
- Used Rapid Assessment plots to measure variables.
- Regeneration plots were 1/100th acre in size, all regenerating tree species and heights were recorded.

Measurements taken at each location:

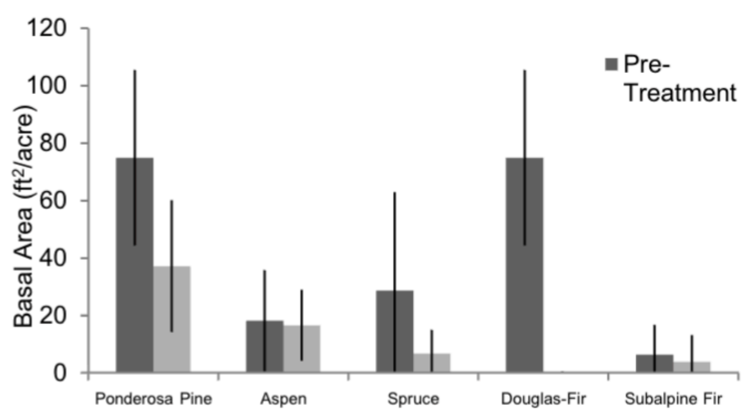
- Plot characteristics (slope, aspect, GPS coordinates).
- Tree (species, status, DBH, CBH class, standing class).
- Regeneration data (species, size classes, counts).
- Fuel loadings (1, 10, 100, 1000 hr, litter and duffdepths, shrub type, heights, and widths along transect).
- Aerial cover of graminoids, forbs, shrubs, and other forest floor variables in Daubenmire plots.

People engaged in measuring (agency, volunteers, etc.):
Kristen Pelz (CFRI), Marin Chambers (CFRI), Rusty George (Montrose High School), Collen Trout (Montrose High School), Lyle Motley (Montrose High School Internship Program crew leader), Todd Gardiner (GMUG), numerous Montrose High School interns.

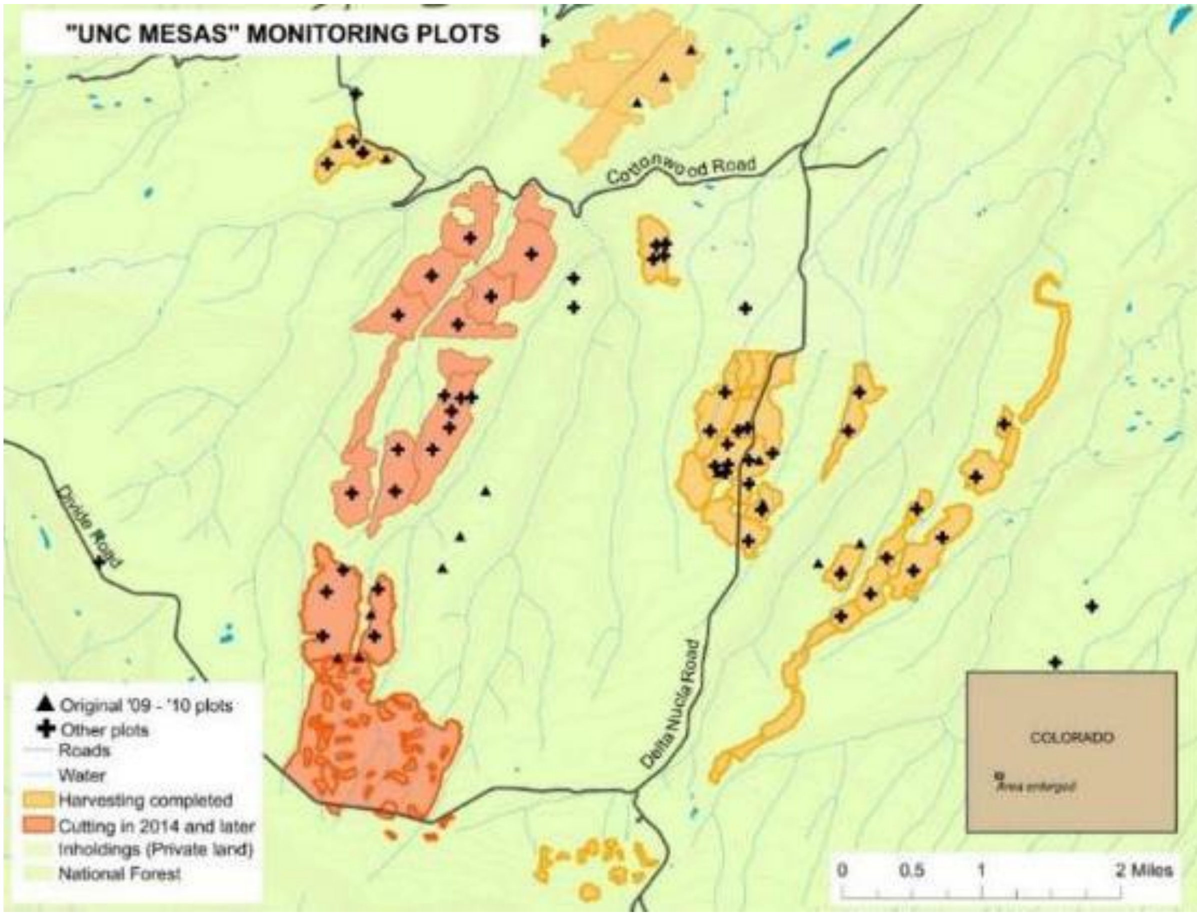
2014-2015 findings:
Treatments have reduced the basal area and trees per acre and have increased the quadratic mean diameter slightly. Stands also met the objective of retaining ponderosa pine and aspen, while removing non-pine conifer basal area. The reduction in basal area and removal of the more shade-tolerant conifers led to more open stand conditions, which will provide more light for understory plants and shade-intolerant tree regeneration. Canopy fire hazard has been reduced in treated stands. Ladder and canopy fuels were reduced, and surface fire is predicted to burn in all monitored stands (under 90th percentile weather conditions). Torching, and particularly Crowning, Indices increased suggesting active crown fire is much less likely in these stands now than before treatment. (Torching and Crowning indices are the wind speeds needed to sustain canopy fire; the higher the wind speed, the less likely crown fire is to occur. "Torching" is used to describe fire that moves from the surface into the crown of a single tree. Fire that moves from tree crown to tree crown is called "crowning" fire.) Despite the reduction in canopy fire hazard, woody surface fuels doubled following treatment. Prescribed fires are planned to help reduce surface fuel loads.

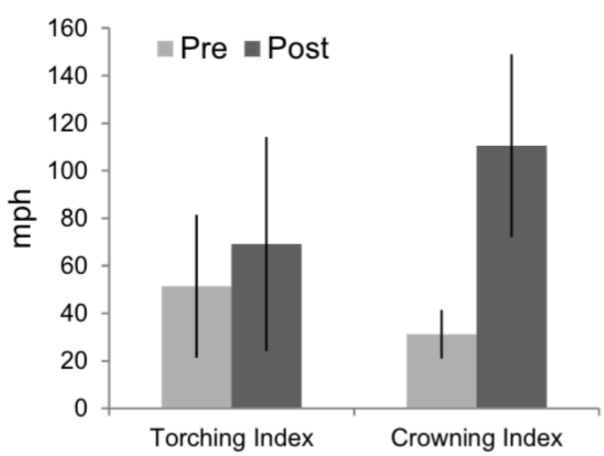


Mean (± standard deviation) basal area, trees per acre, and quadratic mean diameter before and after treatment.

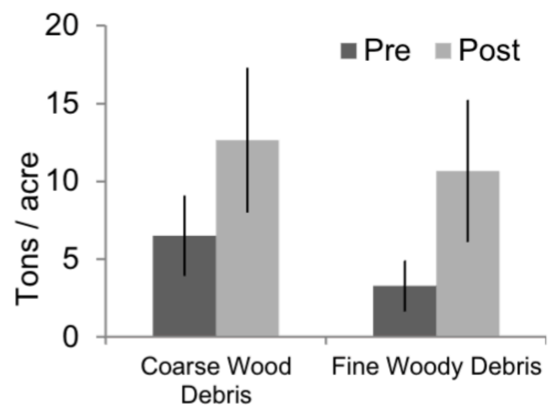


Mean (± standard deviation) of basal area by species before and after mechanical treatment.

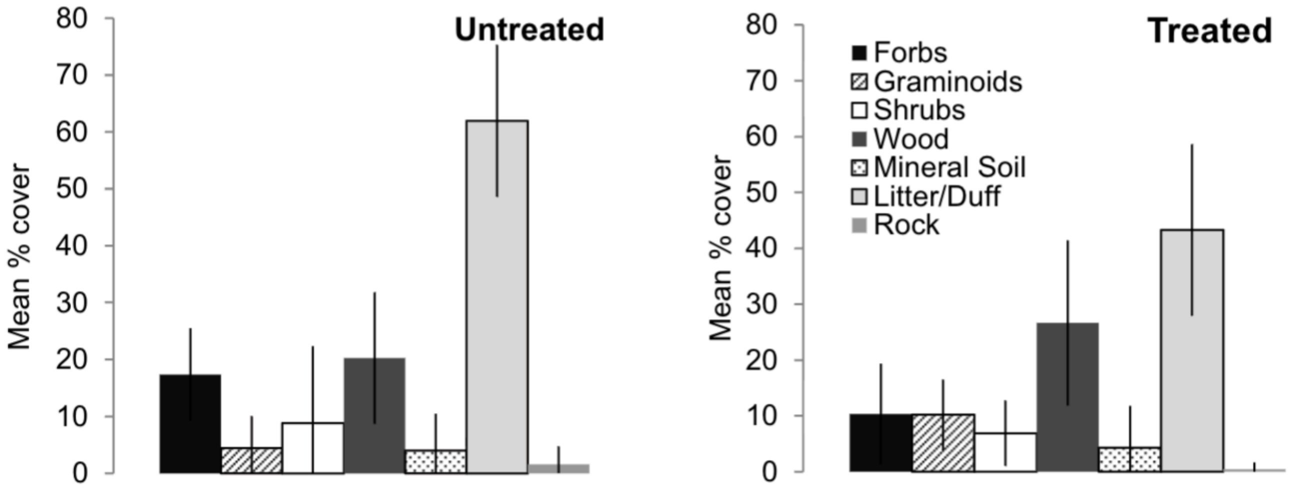




Mean (± standard deviation) Torching and Crowning Indices before and after treatment.

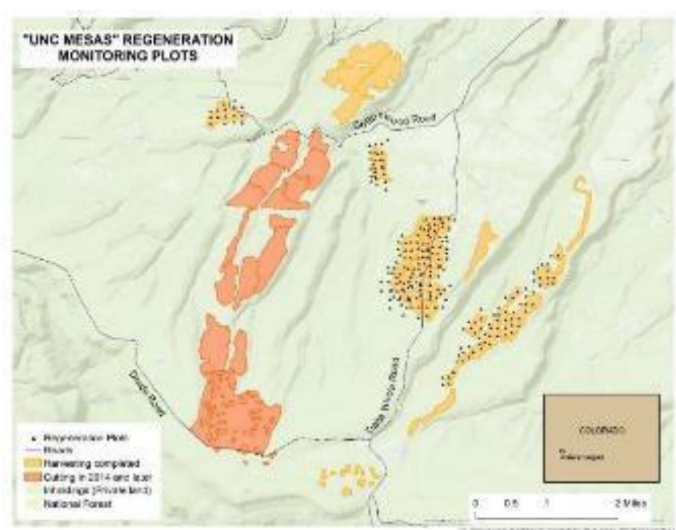


Mean (± standard deviation) coarse and fine woody debris in stands before and after treatment. Coarse woody debris is > 3 inches in diameter. Fine woody debris all smaller dead woody material.



Mean cover (± standard deviation) of forest floor in treated and untreated areas measured in 2014. Litter, duff, and woody material are the dominant substrate following harvest. There was concern thattreatments would lead to too much soil disturbance; however, mineral soil is about 5% cover in both treated and untreated units. Forbs, graminoids (grasses and sedges), and shrubs cover less area in treated than untreated stands, but plant cover will likely increase with time since treatment.

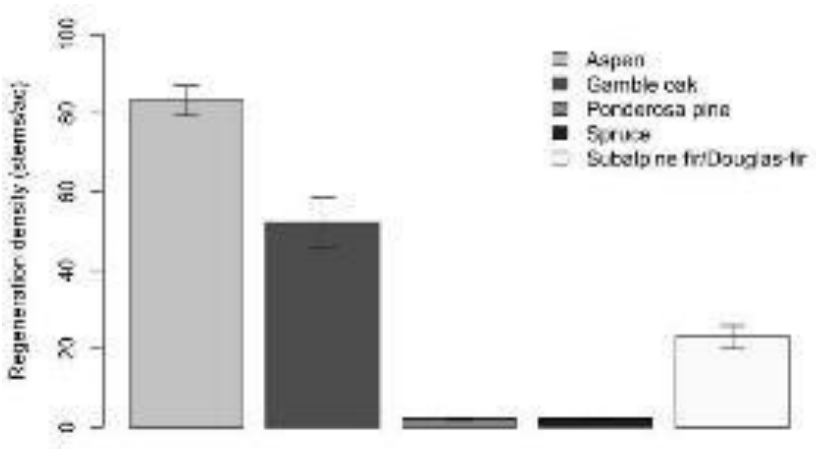
Tree regeneration is occurring and is dominated by aspen and oak, both species that can reproduce through re-sprouting. Subalpine fir/ Douglas-fir seedlings were present at low densities (<25 stems / acre), some of which may have been present prior to mechanical harvesting. Ponderosa pine and spruce species were regenerating at very low (<5 stems/ac) densities. Figure 5 (below) shows mean (± standard error) regeneration densities by species averaged across monitoring area. Tree regeneration was measured in 1) uncut- and-unburned (untreated) areas, and 2) cut; 3)cut-and-burned; 4) uncut-and-burned treatment areas.



Untreated areas were dominated by aspen, Gambel oak and subalpine fir/Douglas-fir with very little pine or spruce regeneration. Cut areas were dominated by high densities of regenerating aspen and Gambel oak, with verylow densities of regenerating pine and spruce. In 2015, Gambel oak was the dominant regenerating species in cut-and-burned areas.

However, further monitoring is needed to make meaningful inferences as only 5% of plots were located in cut-and-burned areas, and 1% of plots occurred in uncut-and-burned areas. Most plots were located in cut (62%) and uncut-and- unburned (untreated) (32%) areas. Therefore, remeasuring or adding plots following prescribed burning in 2016 will further inform regeneration across different treatment types.

On the one hand, the increase in aspen and Gambel oak addsplant diversity in the project area and across the landscape which, in turn, adds diversity of habitat for wildlife. On the other hand, this increase could inhibit the development of Ponderosa pine stands or meadows; Gambel oak may also increase fire hazard. Monitoring the effect of fire on aspen and Gambel oak across the project area will inform what might be expected with future forest conditions.



Mean (± standard error) regeneration density by species.

Right: photos ofthe pre- (at left)and post-treatment (at right) conditionsof a monitored stand. Larger conifer trees and aspen were retained.

<u>2016-2018 Findings:</u>

The 2018 FIP crew progress included collecting post-treatment data in the Lockhart mechanical treatment area, collecting data in post-prescribed burn areas in Cottonwood Mesa and Sawmill Mesa, and collecting 2–3-year post-mechanical treatment and 50% of the plot had evidence of recent burn.

Mechanical treatments have reduced basal area and trees per acre, as expected, but have also reduced the quadratic mean diameter slightly (Figure 3). Basal area and trees per acre were also reduced slightly in prescribed burn areas, while quadratic mean diameter in these areas remained the same (Figure 3). One of the goals of mechanical treatment in the Lockhart treatment area was to reduce tree density, which was achieved, while one of the goals of prescribed burning in Cottonwood and Sawmill Mesa was to introduce some tree mortality, which was also achieved as indicated by the reduction in basal area and trees per acre.

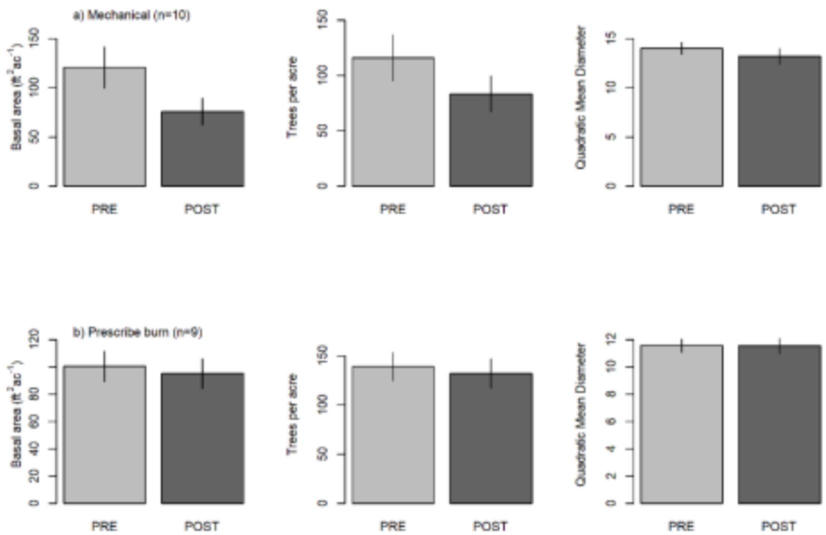


Figure 3: Mean (± standard error) basal area, trees per acre, and quadratic mean diameter before and after treatment within a) mechanical treatment areas and b) prescribed burn areas.

Within mechanical treatment areas, stands met the objective of retaining ponderosa pine and aspen, while removing larger proportions of non-pine conifer basal area (Figure 4a). The reduction in basal area and removal of the more shade-tolerant conifers within mechanical treatment areas has led to more open stand conditions, which will provide more light for understory plants (see page 5 for data on understory conditions) and shade-intolerant tree regeneration, such as spruce and fir species. Within prescribe burn areas, ponderosa pine and aspen basal area decreased slightly, while spruce basal area remained constant (Figure 4b).

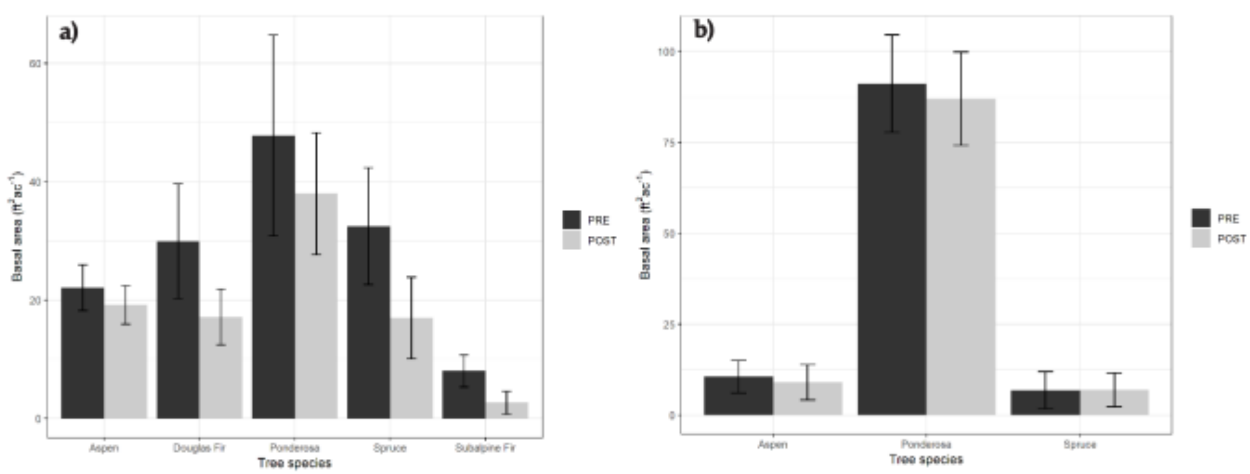


Figure 4: Mean (± standard error) basal area by species before and after treatment within a) mechanical treatment areas and b) prescribed burn areas.

Within mechanical treatment areas, fine and coarse surface fuel loadings doubled following treatment (Figure 5, Figure 6a). Prescribed fires have been planned to reduce these surface fuel loadings following mechanical treatment, and several recent prescribed burns have taken place in areas where mechanical treatments have and have not taken place. Results from data collected within these recent prescribed burn areas illustrate that prescribed burning was successful in reducing surface fuel loadings by at least 30% of what loadings were before burning (Figure 8, Figure 6b).

Figure 5: Comparison photo-points in the Lockhart mechanical treatment area. Pre-treatment (right), post-treatment (left). Photo illustrates the reduction of tree density, while retaining ponderosa pine and aspen, and reducing the proportion of shade tolerant and fire intolerant species such as spruce and subalpine/Douglas fir.

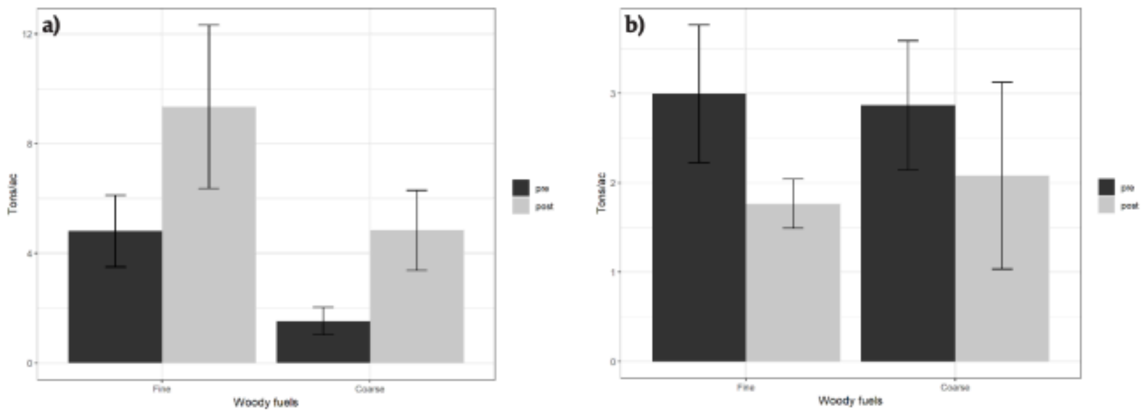


Figure 6: Mean (± standard error) tons per acre of fine (<3 cm diameter) and coarse (>3 cm diameter) wood before and after treatment within a) mechanical treatment areas and b) prescribed burn areas.

Due to the changes in surface and canopy fuel loadings, canopy fire hazard under 90th percentile weather conditions has been reduced in both mechanical and prescribed burn treatment areas, as illustrated by Crown Index (Figure 7a, b). Crown Index is the wind speed needed to sustain a crown fire, where fire moves from tree crown to tree crown. When evaluating Crown Index, the higher the wind speed, the less likely crown fire is to occur. Similarly, Torch Index is the wind speed needed to move fire from the surface of the forest floor into the crown of a single tree; higher Torch Index wind speeds indicate a lower likelihood that surface fire can move into the crown of a tree. Torch and Crown Index were modeled in FFEFVS using all default options. Within mechanical treatment areas (Figure 7a), results indicate that lower wind speeds are necessary to move a fire from the forest floor into the crown of a single tree following treatment, likely due to the increase of fine and coarse surface fuels within 1-3 years of mechanical treatment. However, wind speeds of over 40 mph are necessary to carry fire from crown to crown following mechanical treatment. Following prescribed burning, Torch and Crown Index both increased (Figure 7b), indicating that surface fuel loading had been reduced following burning, and that some tree mortality had decreased the connectivity of tree crowns following burning, resulting in a lower hazard of surface or crown fire.

In both mechanical and prescribed burn areas, changes in understory and forest floor cover generally reduced graminoids, forbs, and shrubs (Figure 9a, b). Forb and graminoid cover were slightly higher pre-treatment in mechanically treated areas than in prescribed burn areas, while prior to treatment, shrubs were nearly double in prescribed burn areas relative to mechanically treated areas. Following both mechanical treatment and prescribed burning, graminoids, forbs, and shrubs were less than half what they were prior to treatment or burning. However, post-treatment data were collected and branches on the ground. Within prescribed burn areas, soil cover increased slightly, while cover of fine and coarse wood remained unchanged, likely due to some fine fuels being consumed during the fire, and then additional fine fuels falling from dead branches following fire.

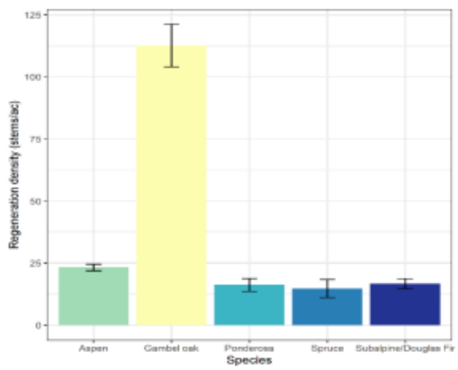


Figure 10: Mean (± standard error) density (stems/ac) of tree regeneration occurring across the entire Escalanted and Unc Mesas treatment areas in uncut, cut, and cut and burned plots.

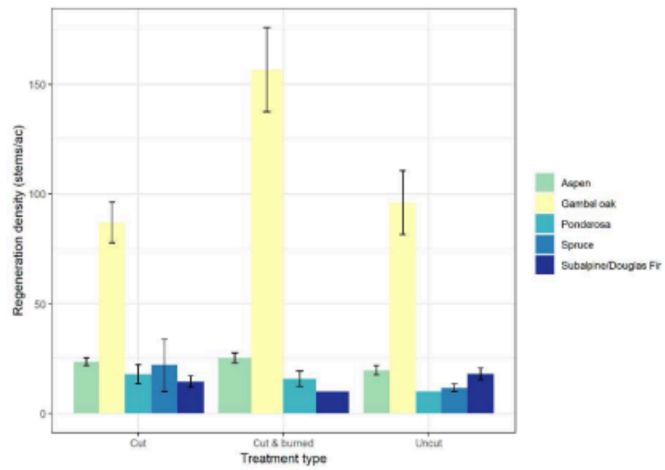


Figure 11: Mean (± standard error) density (stems/ac) of tree regeneration within uncut, cut, and cut and burned plots in the Unc Mesas treatment areas.

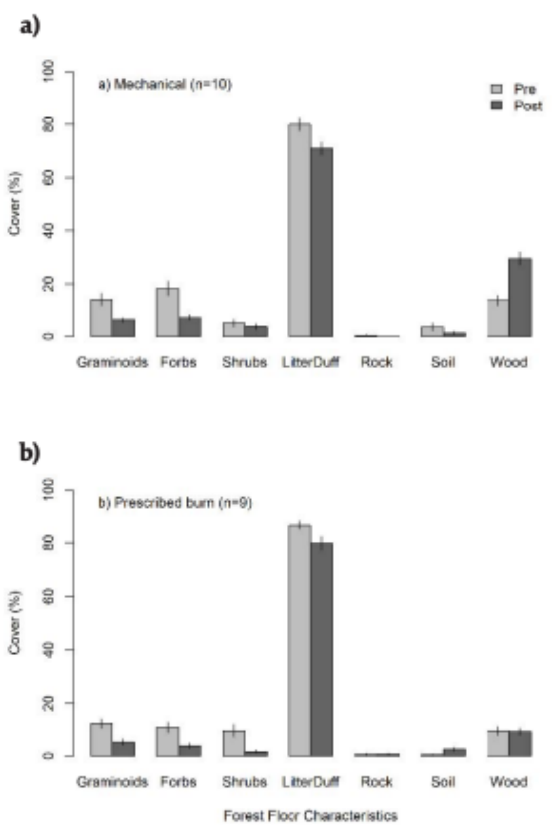


Figure 9: Mean (± standard error) percent cover before and after treatment within a) mechanical treatment areas and b) prescribed burn areas. Cover was ocularly estimated within Daubenmire plots to the nearest 1%.

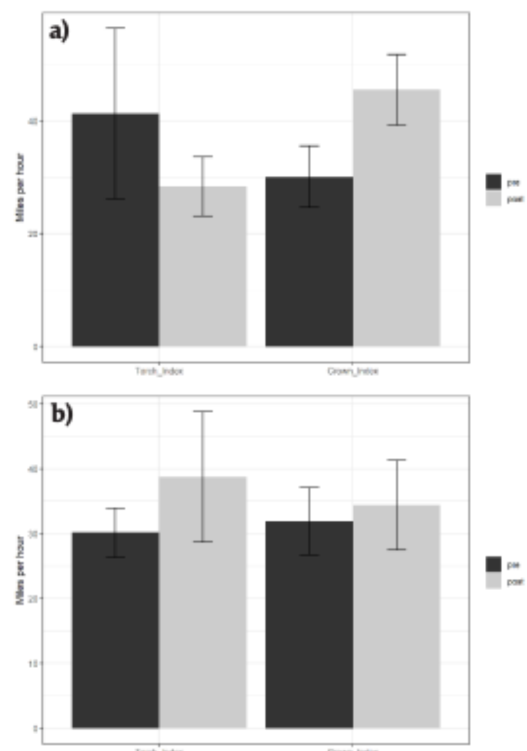


Figure 7: Mean (+- standard error) miles per hour for torching and crowning indexes before and after treatment within a) mechanical treatment areas and b) prescribed burn areas. Torch Index is the wind speeds necessary to move a fire from the surface of a forest floor into the crown of a single tree; Crown Index is the wind speeds necessary to sustain a crown fire.

In 2016, the FIP interns established 240 plots across the Escalante and Uncompahgre Mesas treatment area, where mechanical and prescribed burning were planned to occur. In 2018, the FIP interns remeasured a subset of these plots (n=96) across uncut, cut, and cut and burned areas. The result of the 2018 data collection demonstrates that tree regeneration is occurring and is dominated by Gambel oak. Other species regenerating included aspen, ponderosa pine, Engelmann and blue spruce, and subalpine and Douglas fir. Gambel oak dominated tree regeneration across all treatment types and was very high within cut and burned areas relative to cut or uncut areas. Ponderosa pine, a focal species for regeneration in these areas, is regenerating, and had nearly double the regeneration within cut areas as uncut areas. Also notable, within cut and burned areas, subalpine or Douglas fir regeneration was not present.

For more details and to see the full monitoring report, visit: https://cfri.colostate.edu/wp-content/uploads/sites/22/2019/08/Chambers_UPCFLRP-Report.pdf

2023-2024 Findings:
While FIP monitoring began in 2013 and lasted through 2024, this final monitoring provides insights into forest responses to treatments (e.g., mechanical and prescribed burning) pre-, one-year post, and 4-6 years post-treatment (hereafter "5 years post-treatment"). While many plots were monitored 8-10 years post-treatment, we discovered inconsistencies in data collection during pre-treatment years that were unrecoverable for data analysis and reporting. For the purpose of this report, data used for analysis and summaries of changes in basal area, trees per acre, quadratic mean diameter, tree species composition, and expected fire behavior (e.g., all overstory tree data) only included live trees ≥8 in diameter at breast height to reduce the confounding effect of smaller trees continuing to grow five years post-treatment.

Changes in basal area, trees per acre, and quadratic mean diameter
Average basal area and trees per acre generally decreased immediately following both mechanical and prescribed burn treatments (Figure 3). These results illustrate that mechanical treatments achieved the goal of reducing basal area and trees per acre immediately post- and five-years post-treatment. Average quadratic mean diameter (QMD) increased over the course of monitoring; indicating that the average size of the trees in these stands increased and small diameter trees were reduced in these stands immediately following and five years post-treatment.

Within the prescribed burn treatment areas, basal area and trees per acre had a slight decrease between pre-treatment and one-year post-burning, with a larger decrease five-years post-treatment, while QMD increased slightly one- and five-years post-treatment relative to pre-treatment levels. These results illustrate that between pre- and one-year post-prescribed burning, basal area and trees per acre had a slight decrease due to small amount of mortality relating to the prescribed burning. The larger decrease in average basal area and trees per acre five-years post-treatment indicates that more trees died in that time frame, either due to natural mortality or potentially delayed effects of the prescribed burn, and based on the QMD results, smaller trees experienced mortality, while larger trees were retained.

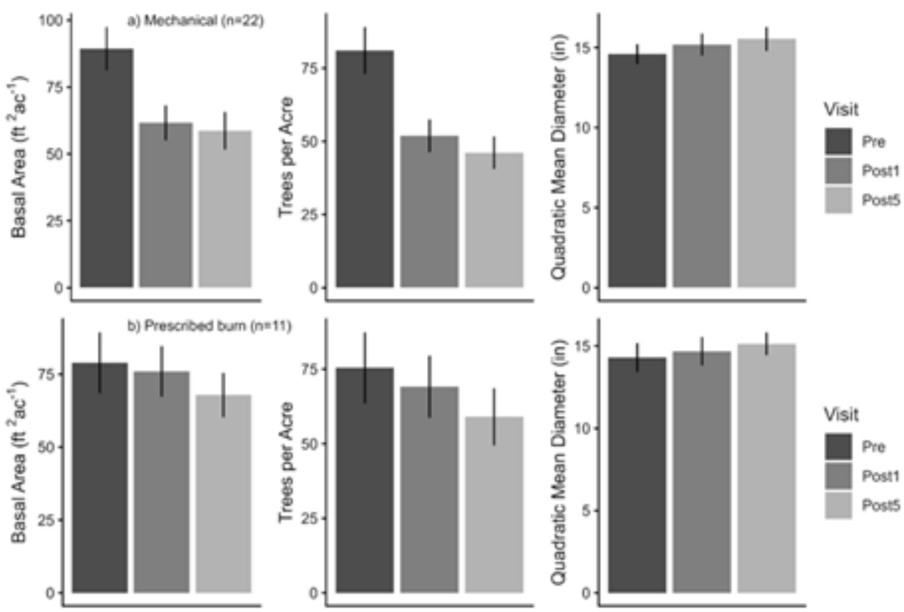


Figure 3. Mean (± standard error) basal area, trees per acre, and quadratic mean diameter pre-, one-year post, and five-years post-treatment within (a) mechanical and (b) prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates 4-6-years post-treatment monitoring.

Changes in tree species composition

Both mechanical and prescribed burning treatments generally achieved the goal of retaining fire-resilient species (e.g., ponderosa pine and aspen), with varying results for less fire-resilient species (Figure 4, 5 and 8). Within mechanical treatment areas, average basal area of ponderosa pine was 33 ft^2ac^{-1} pre-treatment, decreased slightly one-year post-treatment from pre-treatment levels, and increased five-years post-treatment, likely due to maturation of saplings over that time period. Average aspen basal area decreased each monitoring visit. This decline in aspen is not expected five years post-treatment given that aspen is a sprouting species but may be related to a spring frost occurring in 2023 which impaired aspen growth throughout that year. Pre-treatment, spruce species had variable basal areas, with Engelmann spruce, blue spruce, and unidentified spruce (e.g., trees that were identified as a spruce (*Picea sp.*), but could not be verified to the species level) having relatively high basal area values, while subalpine fir and Douglas-fir had relatively smaller basal area values pre-treatment. One year following mechanical treatment, average basal area of spruce species was reduced by over 50%, while average subalpine fir and Douglas-fir were reduced. Five-years post-treatment, average basal area of the spruce and fir species decreased. These results illustrate that the goals of retaining fire tolerate species (e.g., ponderosa pine and aspen) while reducing the presence of fire-intolerant species (e.g., spruce and fir species) were generally achieved (Figure 5). While Douglas-fir was reduced, it still represented a relatively large amount of basal area in these stands post-treatment and may be a candidate for further reduction in future treatments.

In the prescribed burn areas, fire intolerant species (i.e., fir and spruce species) showed trends of absence or reduction in average basal area relative to the more fire-tolerant species (e.g., ponderosa pine and aspen). Subalpine fir and Douglas-fir were absent from prescribed burn areas pre- and post-treatment, while spruce species experienced low average basal area pre-burning and reductions in average basal area post-treatment. Average ponderosa pine basal area decreased slightly one- and five-year post-burning from pre-burning values, indicating that a small portion of ponderosa pine trees experienced mortality after burning. Average aspen basal area remained constant pre-burning and one-year post-burning and decreased five-years post-treatment. Like mechanical treatment areas, this unexpected decrease in aspen may be the result of the extreme spring frost in 2023. Douglas-fir was absent from these stands pre- and post-burning.

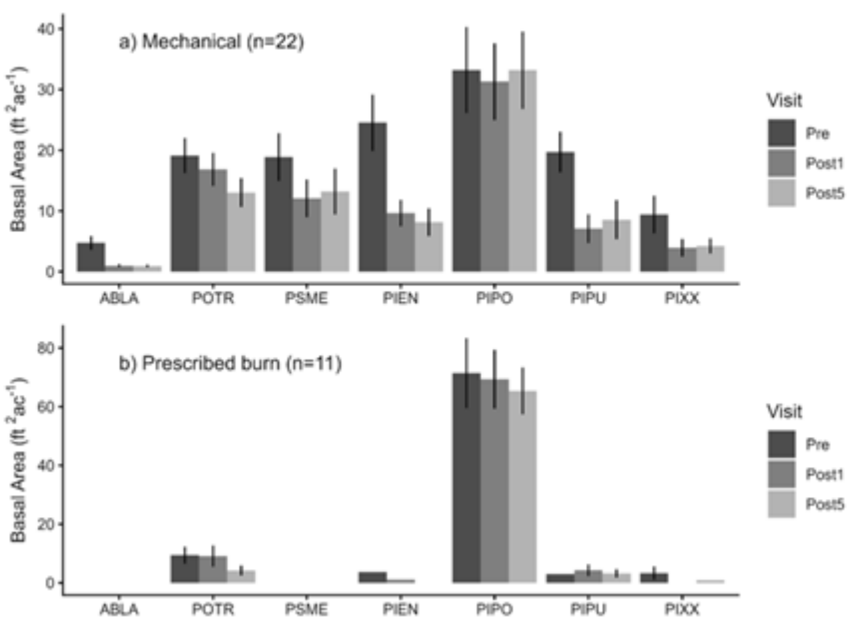


Figure 4. Mean (± standard error) basal area by species within (a) mechanical and (b) prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates four to six-years post treatment or burning monitoring. "ABLA" = Subalpine fir; "PIEN" = Englemann spruce; "PIPO" = Ponderosa pine; "PIPU" = blue spruce; "PIXX" = unknown spruce species; "POTR" = quaking aspen; "PSME" = Douglas-fir. "Unknown spruce species" includes Engelmann and blue spruce species that were unable to be identified to the species level.

Changes in expected fire behavior

Both mechanical treatment and prescribed burning resulted in little change to surface fire risk and while mechanical treatments resulted in a decrease in crown fire risk, crown fire risk in prescribed burn areas remained unchanged (Figure 6). Crown fire risk in mechanical treatment areas decreased, most likely due to the amount of basal area reduction (Figure 3) that occurred in these treatment areas, since wind speeds necessary to move fire from tree crown to crown increased far above average and highest wind speeds for this area.

The torching and crowning indices for the prescribed burn areas did not illustrate strong trends. Modeled torching index values increased slightly from 24 mph pre-burning to 25 mph one-year post-burning and to 26 mph five-years post-burning, respectively. Modeled crowning index was similar pre-, one-year and five-years post-burning (86 mph, 83 mph, and 82 mph, respectively). Low fine fuel loading in these prescribed burn areas pre-, one-, and five-years post-burning (Figure 7) may indicate a consistent surface fire risk (torching index). A small amount of tree mortality (Figure 3) and coarse fuel consumption (Figure 7) may contribute to lowered crown fire risk in prescribed burn areas between pre-, one-, and five-years post-burning.

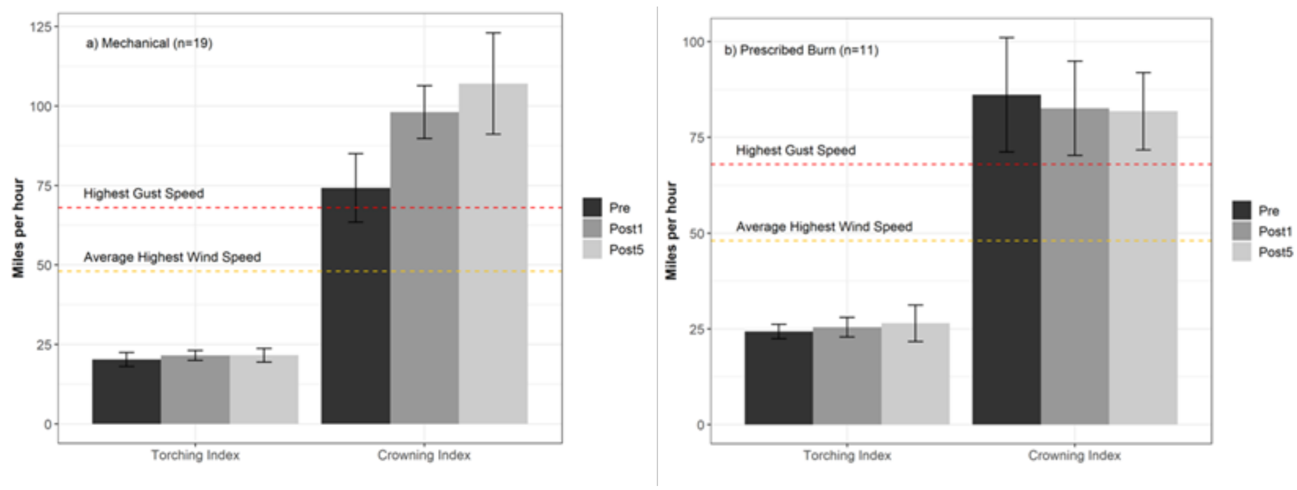


Figure 6. Mean (± standard error) of FVS generated torching and crowning indices within mechanical and prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates four-to-six-years post treatment or burning monitoring. "Torching Index" indicates the wind speed needed to move fire from the surface of the forest floor into the crown of a single tree (a proxy for surface fire risk), while "Crowning Index" indicates the wind speed needed to move fire from one tree crown to another (a proxy for crown fire risk). Average highest wind speed and highest gust speeds are derived from Remote Automatic Weather Stations (RAWS) 97th percentile conditions for fire weather conditions.

Changes in surface fuels

The data collected by the FIP crew in the Lockhart, Cottonwood, Monitor, and Sawmill treatment areas illustrates a trend of stable or increasing fine and coarse woody fuel loading in mechanical treatment areas, while in prescribed burn areas, average fine and coarse wood both decreased following burning (Figure 7).

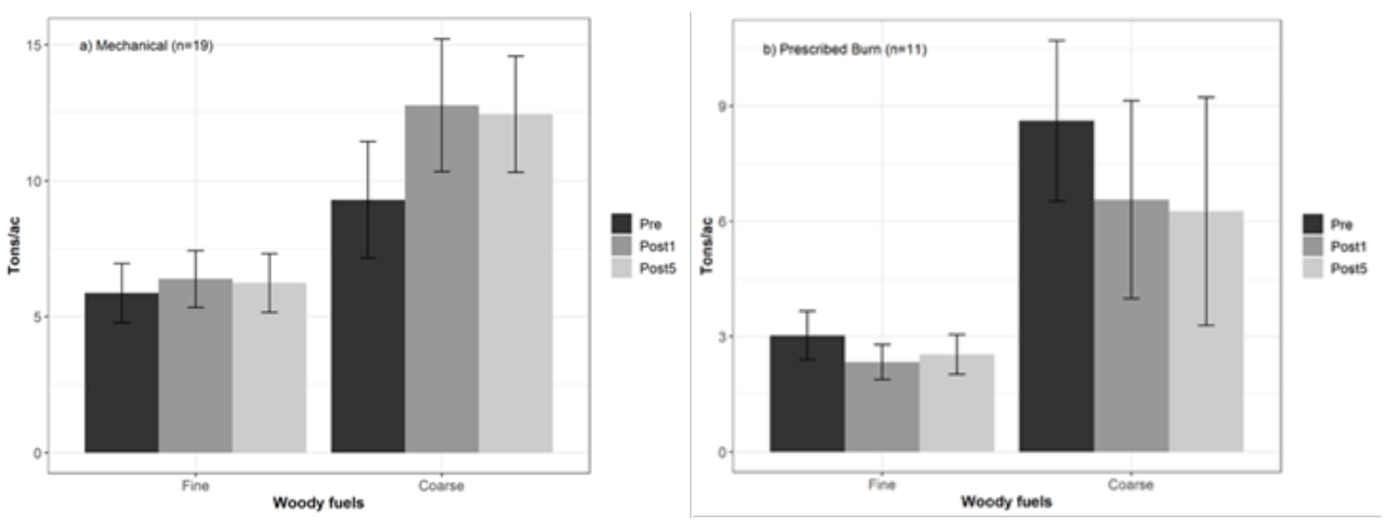


Figure 7. Mean (± standard error) tons per acre of fine (<3.0 inches diameter) and coarse (>3.0 inches diameter) wood within mechanical treatment and prescribed burn areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates four-to-six-year post-treatment or post-burning monitoring.

Changes in forest floor characteristics

Across both mechanical and prescribed burn treatments, our data illustrates the recovery of understory vegetation five-years post-mechanical treatment or post-burning relative to pre-treatment levels, with varying results for other forest floor characteristics (Figure 9). Between 2013 and 2024, forest floor composition of 25 mechanical treatment plots and 13 prescribed burn plots was collected in the Lockhart, Cottonwood, Sawmill, Monitor, 7N, and 25 Mesa treatment areas. Thirty-three total Daubenmire subplots (7 subplots normally completed for each plot) were dropped from the understory analysis due to human error. During data quality checks, some subplots were found to have ground cover observations that did not sum to 100%. The subplots with a sum exceeding 110% or less than 90% were dropped. Dropped subplots account for less than 4% of total ground cover data.

In both treatment types, average forb and shrub cover (%) decreased one-year post-treatment and then increased again to or nearly to pre-treatment levels five years post-treatment. Average graminoid cover (%) followed a similar pattern in prescribed burn plots, while graminoid cover remained consistent in mechanical treatment areas pre- and one-year post-treatment and increased five years post-treatment. Average litter/duff cover (%) increased over all treatment visits in both mechanical and prescribed burn treatment areas. Average rock cover (%) made up a very small percentage of forest floor cover in both treatment types and did not show appreciable changes over the monitoring period. Soil cover (%) increased immediately following treatment, then decreased five years post-treatment in both mechanical and prescribed burn plots. Average wood cover (%) measurements in this figure include both fine and coarse wood cover collected in seven Daubenmire plots per plot, while the fuel loading measurements shown in Figure 7 were collected using Brown's transects. The trends in wood cover/amount shown in these two figures are similar. Average wood cover (%) in mechanically treatment plots increased one-year post-treatment, then decreased five years post-treatment while wood cover decreased immediately following treatment and then remained constant five years post-treatment in prescribed burn areas.

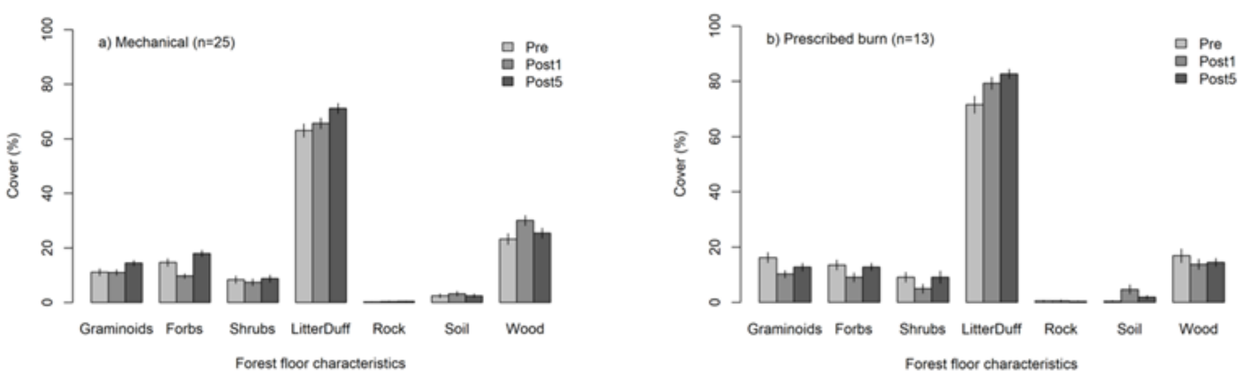


Figure 9. Mean (± standard error) percent cover of forest floor characteristics in (a) mechanical and (b) prescribed burn treatment areas. Cover was ocularly estimated within Daubenmire plots to the nearest 1%. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates four- to six-year post treatment or burning monitoring.

Changes in tree regeneration

Across the Uncompahgre Mesas and Escalante treatment areas, we observed that sprouting species dominated regeneration with a lower establishment of conifers, specifically ponderosa pine. In 2023 and 2024, 107 of the established 258 regeneration plots were re-measured in the 25 Mesa, Cottonwood, Monitor and Sawmill treatment areas. Regeneration density was dominated by Gambel oak seedlings (812 stems/acre), followed by aspen (689 stems/ac). Subalpine fir/Douglas-fir, spruce and ponderosa pine regeneration was much lower at 86, 35 and 28 stems/ac, respectively (Figure 10).

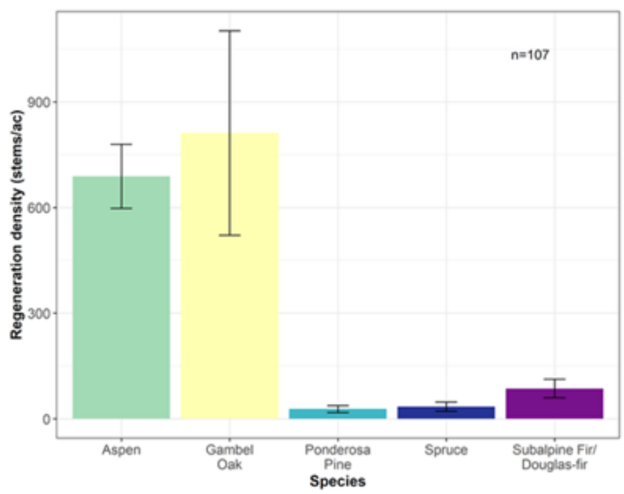


Figure 10. Mean (± standard error) tree regeneration density by species of data collected in the Uncompahgre Plateau/Grand Mesas area in 2023-2024.

Regeneration densities of the 107 plots measured in 2023 and 2024 were also summarized based on treatment type (Figure 11). Of these 107 plots, 44 were located in mechanical treatment areas (e.g. "cut"), 19 located in areas that experienced both mechanical and prescribed burning treatments (e.g., "cut & burned"), and 41 located in areas that had no mechanical or prescribed burning (e.g., "untreated").

Across all three treatment types, Gambel oak and aspen comprised most of the regeneration. Gambel oak regeneration was similar in the cut-only and untreated areas, but much higher in the cut & burned treatment area. Conversely, aspen regeneration was slightly greater in the cut-only and untreated areas than in the cut & burned plots.

Subalpine fir/Douglas-fir, spruce, and ponderosa pine occurred at much lower densities than Gambel oak and aspen across all three treatment areas. Subalpine fir/Douglas-fir regeneration was greatest in the untreated plots, slightly lower in the cut-only treatment area and absent from the cut & burned plots. The same trend was observed for spruce regeneration, where untreated plots had variable densities while and cut & burned areas had no spruce regeneration. Ponderosa pine regeneration was greatest in the cut & burned treatment area, followed by the cut-only and then untreated plots.

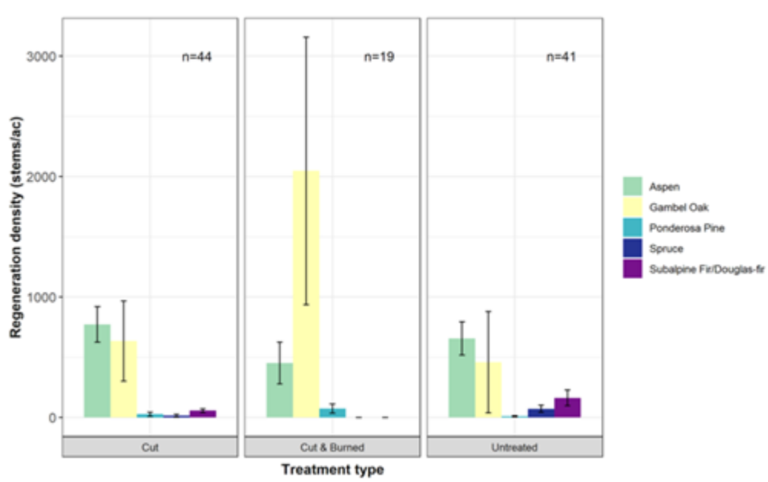


Figure 11. Mean (± standard error) density (stems/ac) of tree regeneration by species and treatment type within untreated, cut, and cut & burned plots in the Uncompahgre Mesas and Escalante treatment areas in 2023 and 2024.

Discussion and management implications

The Uncompahgre and Escalante Forest restoration treatments largely achieved the original goals aiming to reduce forest density, retain fire resilient tree species, lower crown fire risk, and maintain or promote diversity of understory species in the project area. Within mechanical treatment areas and prescribed burn areas, basal area and trees per acre were reduced while increasing QMD (Figure 3, 5 and 8). In mechanical treatment areas in particular, crown fire risk was reduced (Figure 6), likely directly because of the reduction in basal area in these treatments, while surface fuels (Figure 7) and torching index (Figure 6) remained relatively the same pre- vs. post-treatment. Prescribed burn areas generally achieved the goals of continuing to reduce crown fire risk (Figure 6) and reducing average surface fuels (Figure 7), while surface fire risk remained relatively unchanged pre- vs. post-treatment (Figure 6). This may be due to prescribed fire application resulting in a "cooler" fire with forest floor coverage that was not contiguous (based on FIP crew field observations). Treatments largely retained ponderosa pine and aspen, while reducing spruce and fir species; basal area of Douglas-fir was reduced but remained relatively high in mechanical treatment areas and may be a candidate species for reduction if further promotion of fire resilient species is desired in the future. While we did not explicitly perform botanical surveys of understory species in FIP monitoring, our results indicate that five years post-treatment, graminoids, forbs, and shrubs were nearly recovering to pre-treatment average cover (%) values (Figures 5, 8 and 9). Our results also indicate that the deciduous sprouting species (Gambel oak and aspen) dominated tree regeneration across areas monitored, with much lower regeneration of conifers, specifically ponderosa. Across treatments, areas that had been cut and burned had the lowest density of fire-intolerant species (e.g., spruce and fir) and highest densities of ponderosa pine and Gambel oak, while untreated areas had highest densities of spruce and fir and lowest densities of ponderosa. While sprouting species seem to illustrate high resilience across treatments, Gambel oak densities were highest in cut and burned areas, indicating that at least in these areas at this time, Gambel oak may be promoted by the two disturbances, however, ponderosa pine regeneration densities were highest under these conditions. Further observation would be beneficial to better understand long-term establishment of these species as managers weigh regeneration dynamics with actions to promote long-term forest resilience.

Future actions

At the time of the writing of this document, funding to continue to support this monitoring is not available; however, the data collected in the Escalante and Uncompahgre treatment areas on the Uncompahgre Plateau serve as an important long-term study to understand the longer term ecological impacts of forest restoration treatments in dry- and mixed-conifer forest in Colorado and across the broader Southwestern USA. Additionally, at the time of writing, a mountain pine beetle (*Dendroctonus ponderosae*) outbreak is impacting some of the same forests in this study area (Colorado State Forest Service, 2026). If additional funding becomes available, there is opportunity to better understand how forest restoration treatments in this study area may/may not create resilience to current and future forest disturbances.

For more details and to see the full monitoring report, visit: https://cfri.colostate.edu/wp-content/uploads/sites/22/2026/02/Uncompahgre-Plateau-Collaborative-Forest-Landscape-Restoration-Program-Forestry-Internship-Program-Final-Monitoring-Report-2013-2024.pdf

For a complimentary Forestry Internship Program photoseries document, visit: https://cfri.colostate.edu/wp-content/uploads/sites/22/2026/02/Uncompahgre-Plateau-Collaborative-Landscape-Restoration-Program_Forestry-Internship-Program-Photoseries.pdf

Data management plans:

Data are stored as Excel files and .jpg photo files at Colorado Forest Restoration Institute.

Data archiving plans:
Data will be archived at CFRI.

Plan for communicating findings to collaborators, line officers:

Findings were presented to collaborators and line officers during field trips on the Plateau, and during meetings.

Wildlife Cameras

Leadership people:
Luke Holguin (USFS Norwood and Ouray Ranger District)

Overall goals and objectives:
The goal is to measure wildlife densities and diversity within ourrestoration areas. Objectives are to continue the camera monitoring within the Escalante Restoration area on the Ouray Ranger District and identify new areas where we can gather wildlife data with the trail cameras.

Key questions to be examined:
How restoration activities affect the presence of wildlife preand post treatment.

Objectives for [2016] monitoring (multi-year monitoring project):

- Cameras were deployedwithin the Escalante Restoration area on the Uncompahgre Plateau.
- Cameras are directly tied to our Norwood High School Internship Program bird monitoring using the Integrated Monitoring in Bird Conservation Regions protocol.

Objectives for [2017] monitoring (multi-year monitoring project):

- Continue with our 2016 objectives.
- We also deployed the cameras in January on Dry Mesa to begin gathering data onwildlife in our mule deer habitat restoration activities.

Objectives for [2018] monitoring (multi-year monitoring project):

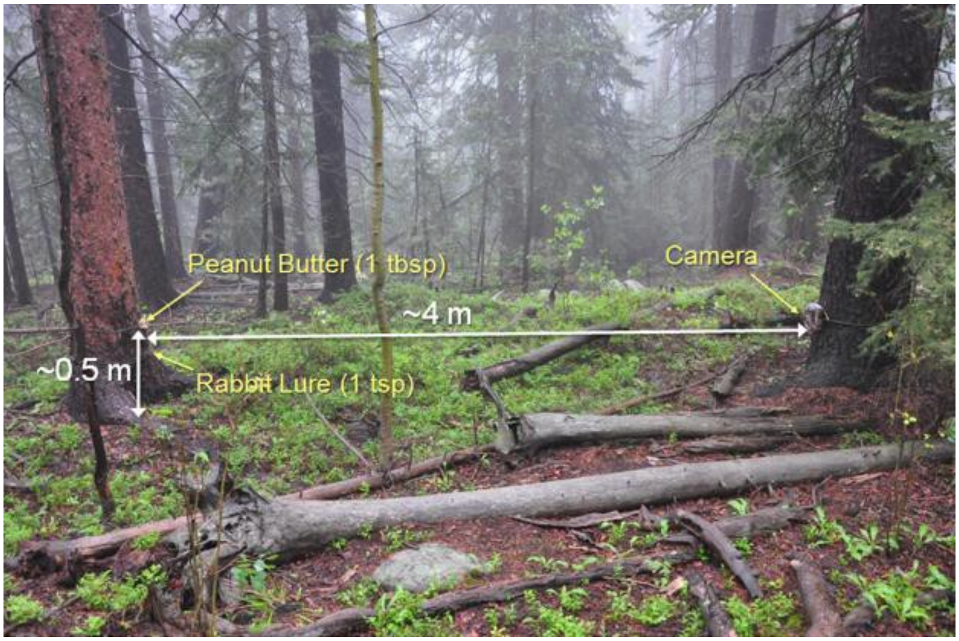
- Continue with 2016 and 2017efforts.
- Identify new areas in which to use the cameras to monitor wildlife.

Objectives for 2025 monitoring (multi-year monitoring project):
Continue bird monitoring through 2027 and continue camera monitoring during this same period. We will make a decision between now and 2027 if we will continue the camera monitoring beyond 2027.
**PLEASE CONTACT LUKE **

Protocol:

Spatial scale of the area under consideration:
Our focus is in the Escalante RestorationArea on the Uncompahgre Plateau.

General approach:
We follow a protocol developed by Jake Ivan who used the cameras and birding data to identify changes in bird and mammal diversity and densities related to the spruce beetle epidemic. Cameras are set out for at least 6 weeks. Peanut butter and rabbit lureare used to attract wildlife in the vicinity of the cameras to investigate and get their picture taken.



Locations to be assessed:

Lockhart1, Lockhart 2, Unc Mesas, and Dry Mesa.

Measurements to be taken at each location:

None. The cameras will do the work.

People engaged in measuring (agency, volunteers, etc.):

Norwood High School Interns, LukeHolguin, Bird Conservancy of the Rockies (BCR)

Data archiving plans:

All data are stored on server drives and uploaded to appropriatecorporate databases.

Plan for communicating findings to collaborators, line officers:

Students will present their findings toUSFS personnel and CFLRP stakeholders at the conclusion of each year's internship (July).

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