Forests and Watersheds

A Newsletter for Decision-Makers

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New Mexico Forest and Watershed Restoration Institute

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RESTORATION INSTITUTE
AT NEW MEXICO HIGHLANDS UNIVERSITY

The Director's Thoughts

By Dr Kent Reid, NMFWRI

A new year brings new opportunities. This cliché usually means looking forward, and we should look forward. But we should also examine our performance, and learn from what we have done.

This issue of the newsletter of the New Mexico Forest and Watershed Restoration Institute has an emphasis on results. Two of the bright spots in restoration comes from efforts in the Sandia and Mazano mountains. Two different people working in that area have submitted articles for this issue. Krista Bonfantine is a consultant with Arid Land Innovation, and she reports on reducing the risk of wildfire in Sandia Park. Cody Stropki is a watershed scientist with SWCA environmental consultants, a group that has been following the effects of forest restoration on wildlife habitat, the water table, and a host of other factors for almost a decade. I have seen their Estancia Basin data and am excited by it. They are in the midst of publishing it, and Dr. Stropki gives us a glimpse of what they have found.

Dr Kent Reid

Within the Institute, three new hires during the last half of 2015 bring us to something approaching full staffing. We have always had strong GIS capabilities, but we have been short-handed in other areas for almost two years. These three new people have each contributed articles for this newsletter

The first person to start was Kathryn Mahan, who was hired as an ecological monitoring specialist, but has proved to be much more than that. She brings a strong interest in streamside restoration, and is diligently analyzing our backlog of upland monitoring data. Her article is on her work with the Greater Rio Grande Watershed Alliance.

We conducted a nation-wide search for the other two new staffers. Dr Rob Strahan is our Restoration Monitoring Program Manager. He is originally from Clovis, and comes to us from NAU in Flagstaff. He was hired for his expertise in woody plant measurements, but also brings a range management education from NMSU. When a forest or woodland is restored, a big part of what is restored is the grass-forb layer, and Dr. Strahan's background will help us understand and interpret these changes. His article is about work he did in Arizona with native species restoration.

Finally, Alan Barton is our new Collaboration Program Manager. The Institute does not work alone; everything we do is in collaboration with one or more partners. The search specified that the person have a background in community development. Dr Barton has this, and in addition is fluent in Spanish and has ties to the legal community in New Mexico. He will bring a unique perspective to landscape issues, as his article demonstrates. With these staff additions, we are in a good position as we work with others to catalyze the transition of the renewable resource-based economy of New Mexico.

Collaboration: The Human Dimension of Ecosystem Restoration

By Dr. Alan W. Barton
Collaboration Program Manager

As the emphasis in forestry has shifted from production to restoration, those engaged in the use and conservation of natural resources have become increasingly aware of the need to collaborate with others. In the past, landowners tended to focus on their own interests to maximize revenue. This focus produced competition with other landowners, and disputes with public land management agencies and environmental organizations. Today, however, landowners, resource managers, environmental organizations and policymakers increasingly are finding ways to work together to restore large landscapes that incorporate multiple ownerships. The task of restoration simply requires a collaborative landscape-level approach to be successful.

Landscape restoration requires more attention to watershed boundaries than to property boundaries. A landscape approach does not imply that property boundaries and rights will not be respected. Rather, the implication is that multiple owners within watersheds must work together on targeted interventions that enhance and speed up natural processes of regeneration and restoration of ecosystem health. This, however, is a huge task, requiring financing, expertise, local knowledge and working together. New Mexico's forests cover nearly 25 million acres, slightly less than one-third of the 77,666,400 total acres of land in the state. Restoring these forest ecosystems to a more natural and healthy condition can only happen through collaborative efforts.

Within any watershed in the state, landowners represent a wide variety of ownership categories.

- Over 34 percent of the state's land is owned by the federal government and managed by agencies such as the Bureau of Land Management, the Bureau of Reclamation, the Forest Service, the Fish & Wildlife Service, the National Park Service, the Department of Energy, and the Department of Defense. Each of these agencies has its own management objectives, culture, and administrative procedures.
- The Forest Service manages about 7.8 million acres, or 31 percent of the state's forest land.
- State agencies manage land for recreation and habitat protection. New Mexico State Parks manages over 91,000 acres, and the State Game Commission controls about 175,000 acres of Wildlife and Waterfowl Management Areas.
- The State Land Office manages the state's trust lands, which fund education and other public services. State trust lands comprise 11.6 percent of the land in New Mexico.
- Tribal lands cover over 10 percent of the state's land.
- About 44 percent of the state's land is privately owned, including 10.8 million acres of forest land. Private landholdings represent diverse management objectives, ranging from production through agriculture and grazing to conservation and protection of natural amenities.
- Private land trusts own land to conserve nature and to ensure agriculture remains a viable industry in the state. Land trusts also hold conservation easements on private lands, precluding development of these lands in perpetuity. The New Mexico Land Conservancy owns 147,000 acres, the Santa Fe Conservation Trust owns 36,000 acres, and the Nature Conservancy owns 20,490 acres in New Mexico.

When lands owned by different government entities, private organizations and families share boundaries within watersheds, there is substantial potential for conflict, given the diverse interests and objectives involved. Conflict may arise between two federal agencies with different mandates, between federal and state agencies over sovereignty issues, or between private landowners and government land managers over who is more deserving to utilize natural resources. Behind these conflicts are rules and incentive structures that fail to instill collaboration as a value. For example, in the absence of policies or directives to the contrary, Forest Service personnel who are hired to manage a national forest may consider collaboration with other agencies outside their forest's property a misallocation of their time. Private landowners may be hesitant to work with environmental groups if doing so might lead to lawsuits or increased regulation. Policymakers play a key role in setting the structures that motivate collaborative work and decision-making.

Most state and federal agencies managing land in New Mexico have expressed a commitment to a collaborative approach. And many are carrying out collaborative activities through their planning processes, or through programs such as the Collaborative Forest Restoration Program (CFRP). Yet many public agents face significant challenges in collaborating with local groups and residents opposed to government land ownership and management policies. Keeping open communication channels, listening carefully to concerns, and explaining policy and management decisions to the public are crucial to effective collaboration. Policymakers, resource managers and organizational spokespersons should always look for ways to build bridges and to keep the focus on the common good, avoiding language that is divisive or that represents specific interests.

Collaboration requires a multi-layered approach and an inclusive perspective by all parties. Incorporating many stakeholders into decision-making processes and establishing ongoing partnerships with a wide variety of organizations opens up new ideas and perspectives and has the potential to greatly enhance restoration efforts while reducing conflict. Building collaborative partnerships is rooted in valuing both expert and local knowledge. Communities may resist federal or state actions, perceiving them as contrary to local

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Tree-of-heaven (right), as well as cocklebur, Russian thistle and kochia are among the non-native species present following a fire on Sandia Pueblo.

Why GRGWA is Great

By Kathryn Mahan,
Ecological Monitoring Specialist

I was hired on with the New Mexico Forest and Watershed Restoration Institute this past year as an ecological monitoring specialist with a focus on riparian systems. My good fortune aside, this was an opportune move by the Institute, because neither the challenges nor the importance of working in riparian areas in New Mexico today should be underestimated. According to the New Mexico Game and Fish Conservation Division, wetlands and riparian areas comprise approximately 0.6 percent of all land in New Mexico. Despite this small percentage, estimates of New Mexican vertebrate species depending on wetland and riparian habitat for their survival ranges from 55% to 80%. These areas also provide flood mitigation, filtration of sediment and pollutants, water for a variety of purposes, and groundwater recharge.

These areas are disproportionately important to ecosystems and human communities, but they are also disproportionately impacted by disturbance. Anthropogenic impacts with major consequences for our riparian areas include dams, reservoirs, levees, channelization, acequias and ditches, jetty jacks, riprap and gabion baskets, urbanization, removal of native phreatophytes, grazing by domestic livestock, excessive grazing pressure by native ungulate populations absent natural predation cycles, beaver removal, logging, mining, recreation, transportation, introduction and spread of invasive exotic species, and climate change. Statewide, it is estimated that as much as 90% of our historical riparian areas have been lost, and approximately 39% of our remaining perennial stream miles are impaired.

New Mexico is fortunate enough to have the Middle Rio Grande Bosque, the largest remaining bosque in the Southwest. However, the number of fires in the bosque has been increasing over the past two decades. Historically, the primary disturbance regime in the bosque has been flooding, not fire, which means the system is not fire-adapted. In fact, native species like cottonwood resprout from their roots after floods and need wet soils to germinate from seed. Flooding also promotes decomposition of organic material and keeps the soil moist which reduces the likelihood of fire. Today, overbank flow is uncommon in many areas of the Rio Grande due to the heavy alteration of the channel and flow regimes. This has led to low fuel moisture content and high fuel loads, as well as increased human presence in the riparian area. As a result, bosque fires are more common and more severe: they kill cottonwoods and other native species, creating spaces which are filled by non-native species such as salt cedar, Russian olive, Siberian elm, and Tree-of-Heaven. We are constantly learning more about how these species can exploit and encourage a riparian fire regime, in addition to many other changes they bring to ecosystems.

There are many programs in the state working to address the challenges we face in our riparian areas. Some are more successful than others. One such effort is the Greater Rio Grande Watershed Alliance (GRGWA). GRGWA is a collaboration of soil and water conservation districts (SWCDs), Pueblos, agencies and stakeholders along the Middle Rio Grande Watershed working on landscape-scale watershed restoration, with a focus on non-native phreatophyte removal from the bosque. They use a variety of techniques including extraction, mastication, aerial, basal, foliar and cut-stump herbicide applications and planting grass, shrubs and trees. They follow community, statewide and national management and conservation plans, and also seek to monitor the effectiveness of their restoration efforts. This type of coordinated resource management strategy, which brings together diverse groups to address challenges, has seen greater success than other methods because

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Estancia Basin Forest Watershed Health, Restoration and Monitoring Project

By Dr. Cody Stropki,
SWCA Environmental Consultants

Concerns over the poor management of forests and watersheds throughout the western United States, along with increased frequency of catastrophic wildfires have highlighted the needs for restoring or rehabilitating western mountain forests and watersheds. Most of New Mexico's sustainable water for human and ecosystem needs comes from mountain forest watersheds. Recently there have been nationally and locally funded initiatives to better manage and to restore New Mexico's mountain forest watersheds and their hydrological functions. Such restoration efforts have the objectives of reducing catastrophic wildfires while at the same time improving forest watershed function and increasing watershed yield. Although there is growing political and public support for the need to restore and properly manage forest watersheds, there also is concern that restoration treatments may not be effective to benefit forests, watershed health and watershed yield. Forest restoration effectiveness monitoring is the best way to ensure that forest watershed restoration treatments are effective at meeting their intended objectives.

The New Mexico Forest and Watershed Restoration Institute is overseeing the Estancia Basin Watershed Health, Restoration and Monitoring Steering Committee's (Steering Committee) forest thinning projects, and monitoring to evaluate the effectiveness of those forest thinning projects in the Manzano Mountains and Estancia Basin of central New Mexico. The primary goals of the Steering Committee's program are to improve forest watershed health and to create defensible space from wildfire by thinning overstocked forests in order to protect rural communities from catastrophic wildfire. Funding for this program has been provided by the New Mexico Water Trust Board. The Steering Committee has provided support for forest thinning projects on private lands, improving watershed function and reducing catastrophic wildfire threats on over 8,000 acres of formerly overgrown forest lands.

A forest thinning monitoring project was initiated in 2007 to evaluate the effectiveness of the Steering Committee's thinning treatment methods. A comprehensive monitoring plan was completed in the spring of 2008 - available online at the New Mexico Forest and Watershed Restoration Institute's website (http://www.nmfwri.org/ images/stories/pdfs/Estancia_Basin_Monitoring/EstanciaBasinMonitoring.pdf - that provided background information, research questions, and a discussion of methods relative to evaluating the effectiveness of forest thinning treatments. Monitoring began in 2008 and provided three years of pre-thinning baseline data, and has continued since thinning treatments were imposed on the monitoring sites in 2011 to determine how thinning treatments affect soils, hydrology, vegetation and wildlife. The monitoring is being conducted in both ponderosa pine forest and piñon-juniper woodland sites. Each monitoring site has paired watersheds, one treated and one left untreated as a control. Results from the 2008 through 2014 monitoring seasons have been compiled annually into reports, which can be found on the New Mexico Forest and Watershed Restoration Institute's website.

Significant results from the four years of post-treatment monitoring include:

- Tree and woody vegetation structure was greatly changed from the thinning treatments, resulting in more open forest stands on the treated watersheds, fulfilling the restoration objectives for wildfire fuels reduction. The control watersheds had a larger number of small sized trees, with less range in tree size as compared to the treatment watersheds that were dominated by large trees along with a broad range of tree sizes which is more characteristic of natural conditions in these forest and woodland types.
- For three years following treatments, run-off from rainfall events has been higher on treatment watersheds as compared to control watersheds. 2014 was the first year where runoff was higher on control watersheds than on the treatment watershed. Additional monitoring is needed to determine if this new trend persists into the future or if this was merely a product of unusual monsoon rainfall patterns.
- Soil moisture was higher on all treated watersheds compared to control watersheds, especially during dry periods following rainfall events, demonstrating that moisture is retained more on sites where trees were thinned.
- The cover of grasses and forbs was significantly higher at almost all treated watersheds as compared to the control watersheds where tree density was higher and supported lower canopy cover of herbaceous understory vegetation.
- Bird densities and diversity tended to be higher on treated watersheds than control watersheds, especially at piñon-juniper woodlands during fall migration period.
- Rodent densities have remained lower on most of the treatment watersheds than on control watersheds, with shifts in species composition relative to stand structure.
- Native large animals recorded from remote wildlife cameras such as mule deer, elk, and rab-

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Fire Adaptation Starts with a Spark

By Krista Bonfantine,
Arid Land Innovation LLC

*Al*though massive wildfires have impacted wildland urban interface (WUI) communities from Ruidoso to Los Alamos, New Mexico's largest WUI has so far been spared. Generally referred to as the "East Mountains," 20,000 people live in the wooded foothills east of the Sandia Mountains. The density of trees and houses in the area coalesce to generate high fire hazard rankings and assign many local communities dubious distinction as New Mexico Communities at Risk. One of these communities at high risk from wildfire is Sandia Park. Established in the 1920's, Sandia Park is a forested neighborhood located along the U.S. Forest Service National Scenic Byway that carries visitors to Sandia Crest.

Despite hazardous WUI conditions, in 2012 local officials championed the establishment of a new campground within the neighborhood complete with hundreds of campers and several fire pits. Fire agency disregard for local conditions galvanized the neighbors and motivated them to take action. In order to raise wildfire awareness and preparedness, Sandia Park Scenic Byway Neighborhood sought and received designation under the National Fire Protection Association's Firewise Communities Program (www.firewise.org). A decade ago, a Sandia Park Firewise Community would have been a hard sell but years of drought and megafires in the news have transformed local perceptions of wildfire. The Sandia Park Scenic Byway Firewise Community is now hosting regular events to encourage fire preparedness and help spread the word about the collective benefits of forest thinning and defensible space.

As residents are scrutinizing conditions across fence lines, the U.S. Forest Service is proving to be a good neighbor. The U.S. Forest Service recently completed a thinning project to reduce tree density and fuel loading on federal land adjacent to the neighborhood. The thinned forest demonstrates healthy tree densities and provides a strong contrast to other areas on public and private land that have not been treated. The site is also serving to educate the community as children from local schools visit the thinning project and learn about fire and forest ecology. The frequent hum of chainsaws in the neighborhood implies that people are getting the message.

Several neighbors now share a fence line with the new private campground and its unlimited number of campers. As they smell smoke from the campfires at least they can rest easier knowing that they have taken action to reduce wildfire risk on their side of the fence.

Through their own actions and the actions of partner agencies, local businesses, and outreach organizations, the historic community of Sandia Park is increasingly fire-adapted. If New Mexico can invest in a robust and active Firewise Program, as they have in Southwest Colorado (http://www.southwestcoloradofires.org/), other WUI communities throughout the state may soon progress along the fire-adapted path. Investments in these communities will bear fruit over many years as neighbors help neighbors, stretching limited public dollars to effectively prepare New Mexico communities for the next big one.

This newsletter is intended as a source of information for decision makers. As part of this service, we will print contributions by people associated with a wide variety of agencies, NGOs, and citizen groups. So that our readers may be able to fully understand what these groups do and how they think, we do not edit these contributions. We may not agree with all the details expressed by the contributors, and may envy their budgets, but we all want to work together to have a healthy landscape and healthy communities. – Kent Reid

Native grasses in restored ponderosa pine

By Dr. Robert T. Strahan, Restoration Monitoring Program Manager

For more than a century, ecosystems around the world have experienced an increase in the dominance of woody species. In many cases, these are native species that were historically present at lower densities and are currently at densities outside of their natural range of variability. Natural variability represents the range of spatial and temporal conditions under which the ecological and evolutionary conditions of a system are sustained. For that reason, natural (or historical) range of variability can be used as a reference to guide restoration efforts, determine site potential, and evaluate targets. Therefore, quantifying the natural range of variability is not only fundamental to restoring ecological integrity but instrumental to assessing ecological changes and developing reference conditions that can be used to guide restoration projects.

In the case of ponderosa pine forests, early studies and historical accounts describe open, park-like stands consisting of large trees interspersed among openings of a diverse and productive, grass-dominated understory. These historical conditions were maintained primarily by frequent, low-intensity surface fires that acted to regulate the competitive balance between overstory and understory communities. Over the last 150 years, a number of factors including grazing, logging, and fire suppression have combined to favor pine establishment at the expense of understory diversity and productivity. As a consequence, contemporary forests often contain uncharacteristically high tree densities with closed canopies, lower light availability, and deeper forest floor litter and duff layers. A major consequence of this has been the degradation of understory integrity, including declines in understory cover, productivity, and diversity. While often overlooked, the understory plant community is an integral component of structure and function in ponderosa pine ecosystems, influencing nutrient turnover rates, watershed function, wildlife habitat, and providing fuel for frequent surface fires.

How best to move from current conditions to proper structure and function? Scientific studies assessing treatment success have shown that a combination of mechanical thinning plus prescribed fire is most successful at meeting overstory restoration targets. These management interventions restore the key feedback interactions between pattern and process under which these forests evolved, enhance ecological integrity, and increase resilience to disturbance. However, despite agreement on overstory restoration and agreement on the need to increase cover and diversity of native understory vegetation, a clear consensus on how to meet understory objectives does not exist.

Understory response to restoration takes place over time and monitoring over multiple years is required to determine changes in understory communities following treatments. With a long-term study, data on understory response can be combined from multiple sites across a common ecosystem. Just before joining FWRI, I worked on this topic in Arizona for the counterpart Institute there. In that study, we evaluated whether this objective was met five years after two alternative restoration treatments in the Mineral Ecosystem Management Area (Mineral) located in the White Mountains in east-central Arizona and part of Northern Arizona University Ecological Restoration Institute's Long-term Ecological Assessment and Restoration Network (LEARN). We then compared our results with those of three other LEARN sites, which provided a valuable opportunity to combine data from within an ecological system, across different sites, to compare and evaluate the consistency of responses.

Research findings

- Understory community response at Mineral. Post-treatment sampling at Mineral showed understory cover and species richness increased within five years of treatment with a combination of mechanical tree thinning and prescribed burning (see Figure 1). In general, burn-only treatments were less successful in meeting this objective. Compared to the untreated control, burn-only treatments were only successful at increasing understory forb richness, in particular the number of annual-biennial species. The thin-plus-burn units demonstrated greater increases in species richness.
- Comparison across LEARN sites. Including our results from Mineral, species richness increased in thin-plus-burn treatments relative to untreated units at three of the four LEARN sites. Pretreatment species richness values at Mineral were within the range of response values observed post-treatment across the comparison LEARN sites. The increase in species richness values in thin-plus-burn units at Mineral exceeded those observed in the same treatment units at the LEARN comparison sites.

In contrast to species richness, we did find evidence for a consistent understory response for total and native plant cover following the full thin-plus-prescribed-burning treatments across the LEARN sites (Figure 1). Total plant cover five years after thinning-plus-burning treatments ranged from an average of 7.2% to 13.1% across the comparison LEARN sites. Total plant cover in the full restoration treatments at Mineral fell within this range. Native plant cover across the comparison LEARN sites ranged from 6.1% to 9.2%. Average native plant cover in thin-plus-burn at Mineral fell just above these values, at 9.6%.

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Collaboration from Page 4

interests and carried out by remote and hierarchical entities. Changing economic conditions, including less opportunity to use nearby natural resources, exacerbates the tensions between communities and government. But the burden for building trust between government and communities often falls on the government officials. Many agencies now appreciate that merely applying their expertise to resource management is not enough, that they must consider social and economic factors in their decision-making, and must carefully explain their decisions to community members. Policymakers should seek input from various stakeholders as well before making crucial decisions that will affect the structural conditions that shape restoration.

The FWRI has contributed to collaborative restoration efforts by contributing its expertise in facilitation and relationship-building to create and strengthen partnerships among public agencies, private organizations, and stakeholders in natural resource management around New Mexico. FWRI personnel have created, facilitated and enhanced watershed alliances, regular cross-agency meetings, and funding mechanisms such as CFRP or the Nature Conservancy's Rio Grande Water Fund. The FWRI will continue to build partnerships across the state with public agencies, tribal leaders, non-governmental organizations (NGOs), municipalities, soil & water conservation districts, land grants, and other groups engaged in forest and watershed restoration initiatives. These collaborative partnerships are the backbone of sustainable community development and healthy ecosystems.

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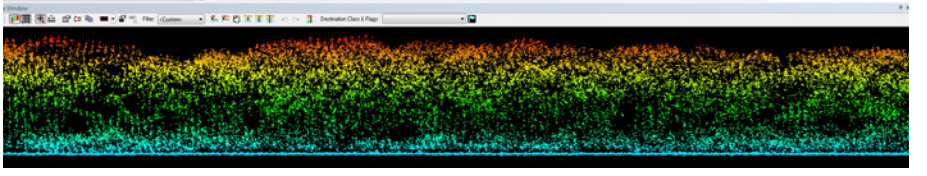
individuals make connections with one another and the landscape, develop alternative behavior strategies to allow for sustainable long-term solutions, and gain a lasting understanding of how technical advice functions on the ground.

GRGWA's partners and collaborators include or have included: Claunch-Pinto, Ciudad, Coronado, Cuba, East Rio Arriba, Estancia, Lava, McKinley, Santa Fe-Pojoaque, Socorro and Valencia Soil and Water Conservation Districts (SWCDs); Pueblos of Kewa, Santa Ana, and Sandia; EMNRD Forestry Division; New Mexico Department of Game and Fish; New Mexico Department of Agriculture; New Mexico Environment Department; the State Land Office; Middle Rio Grande Conservancy District; Natural Resources Conservation Service; U.S. Army Corps of Engineers; and the New Mexico Forest and Watershed Restoration Institute, as well as businesses and non-profits working in bosque ecology and watershed restoration.

NMFWRI has been working with the Greater Rio Grande Watershed Alliance since 2013 when we took over the formal monitoring and began constructing a geodatabse for GRGWA's non-native phreatophyte removal projects. NMFWRI has collected data on 27 sites where land managers are willing to participate, using an adapted version of the biotic portion of the New Mexico Rapid Assessment Method as a part of a standard, low-intensity monitoring protocol, as well as an adaptation of the Bosque Ecosystem Monitoring Program's Vegetation Monitoring Plots and Brown's transects as part of a high-intensity monitoring program.



NMFWRI is also utilizing LiDAR where available (areas along the immediate Rio Grande corridor). LiDAR, light detecting and ranging, provides elevation data which we use to analyze vegetation and canopy structure in detail as a supplement to field monitoring data. The image above shows the 3-D canopy representation used to identify understory vegetation at a site in Belen.

Preliminary comparisons of pre- and post- treatment indicate that, as expected, the presence of exotic invasive plants are reduced, improving the relative native plant community composition. However, increases in native riparian tree regeneration have not been observed and both soil surface condition and surface fuels have seen mixed results; horizontal and vertical structure tend to be negatively impacted, presumably by the disturbance of the treatment. We expect the structure to recover over time.

After working through many challenges, we believe we now have a system that will allow for a good feedback loop based on comparison of the results of our pre- and post-treatment data. NMFWRI plans to re-collect data in five year intervals; Claunch-Pinto's re-spray field crew has also expressed their intention to collect photos at the points placed in NMFWRI's pre-treatment assessment on the various projects as they re-visit, which provides additional data at essentially no additional cost. Some SWCDs have also expressed interest in continuing a photo-based monitoring program using NMFWRI's points during the 5-year interval, which NMFWRI strongly supports.

Many challenges remain, and lots of work remains to be done. However, one of the most rewarding elements of working in riparian systems is their innate resilience. Almost any effort that alleviates a stressor in the system will result in an improvement in function. Based on the information in our geodatabase, GRGWA's efforts have resulted in over 3,400 treated acres across 50 projects, including 12 ongoing at the time of this article. We are excited to be a part of it.

Basin from Page 6

bits were most abundant on control watersheds, while domestic livestock were far more abundant on treated watersheds at both piñon-juniper and ponderosa pine sites.

- The post treatment monitoring has been conducted over a period of prolonged drought so some parameter responses may have been dampened by a lack of rainfall.

Publications stemming from this research will enhance the knowledge of the scientific community, natural resource management agencies, and the general public about the effects of forest thinning in New Mexico and across the Southwest. Understanding the impacts of restoration treatments on forest and watershed health, translates into restoration that is ecologically appropriate and scientifically sounds. Like many other forest restoration projects, the ultimate goal of restoration in the Manzano Mountains is to improve forest health and to protect watershed values from catastrophic wildfire by attempting to return forest structure to a more natural and healthy condition. Successful forest restoration efforts should in turn help to alleviate the huge economic costs from unnaturally catastrophic wildfires, and should enhance forest watershed water yield and quality.

Native from Page 8

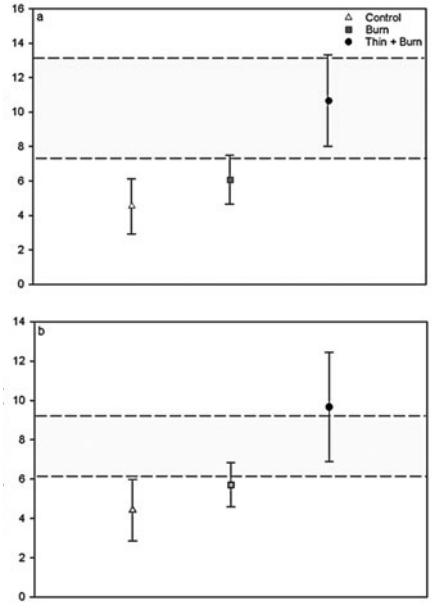


Figure 1. Average total (a) and native (b) species cover five years post-treatment (2013) at Mineral relative to the range of variability across three LEARN sites. Dashed lines represent the lower and upper average values from across three LEARN sites.

Conclusions

Our findings highlight that managers can expect understory plant communities to respond positively following restoration treatments that combined mechanical thinning and prescribed fire. Our primary objective to increase native understory cover and diversity was met with treatments that combined mechanical thinning and prescribed fire. In future studies, patterns of recovery might be revealed if we evaluate the rate of change for understory cover and richness. This would mean that for understory cover, defining more specific goals and objectives to assess restoration success is realistic. Further monitoring at these and other new sites will continue to provide insight into what responses we can expect from understory plant communities.

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