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Investigating CFRP's Ecological Legacy

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Highlights

After ten years of project data, here's what we know about CFRP: Some things are working, some things aren't. Program-wide, results are mixed.

2019 Walker Flats CFRP

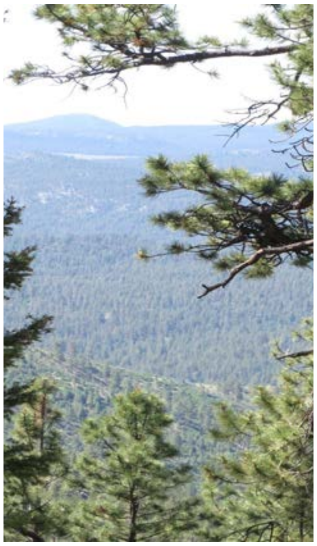
The New Mexico Forest and Watershed Restoration Institute (NMFWRI), which is located at New Mexico Highlands University, is a statewide effort that engages government agencies, academic and research institutions, land managers, and the interested public in the areas of forest and watershed management.

A View from the Ground

The NMFWRI monitoring crew hikes across rugged terrain with sledge hammers and GPS units in hand. On their backs they carry heavy loads of rebar, water, plant guides, datasheets, forestry equipment, first aid kits and personal gear. Passable roads and hiking trails are scarce, but the crew covers an average of seven miles a day, on foot. Their itinerary is simply to move from one randomly placed monitoring point to the next. "This has totally ruined regular on-trail hiking for me," says Louis Rymalowicz, a 2019 student intern. "I see so much more this way."

When they arrive at a point, the crew pounds in a piece of rebar to mark the plot's center and gets to work. NMFWRI's monitoring staff and NMHU student interns work together to measure parameters such as ground cover, surface fuels, understory composition, tree species, size, and condition. When one plot is completed, they hike to the next.

This process is repeated several times per project: before restoration treatment, immediately after treatment, and 5, 10, and (eventually) 15 years after. NMFWRI's Las Vegas office has a file cabinet on nearly every wall full of CFRP datasheets. Now that the 10-year data collection has occurred for many areas, the time has come to ask: What can all this data tell us?



2016 Ensenada CFRP

What is CFRP?

The Collaborative Forest Restoration Program is a forestry initiative managed by the US Forest Service in New Mexico since 2001. This unique program provides a framework for community groups to collaborate and propose restoration projects on public or tribal forested land. Projects are evaluated by a peer-led Technical Advisory Committee, and those that are selected can receive a grant of up to $360, 000 for four years.

CFRP projects fall into three broad categories: (1) planning (these grants support community outreach, initial data collection, NEPA clearance work, etc), (2) utilization (these grants support local forest industry capacity) and, (3) implementation (on-the-ground treatment).

Program Goals

1. **Wildfire threat reduction**
2. **Ecosystem restoration, including non-native species reduction**
3. **Reestablishment of historic fire regimes**
4. **Reforestation**
5. **Preservation of old and large trees**
6. Small diameter tree utilization
7. Creation of forest-related local employment
8. Stakeholder diversity

2016 Moon Mountain fire

Is CFRP Meeting Those Goals?

The short answer? Sort of.

NMFWRI conducted an analysis of 31 projects, which includes 1600 plots and represents around 25 percent of implementation projects shows that overall. This analysis looked at the ecological program goals (numbers 1 through 5 in bold in the list above) and found that results are mixed among forest types and objectives.

According to the US Forest Service, the CFRP program in New Mexico has restored over 33,000 acres with 200 projects involving 600 partners since 2001. This restoration occurs under the implementation grants. To understand the ecological legacy of CFRP, we need to take a closer look at these projects, and what it means to have a “restored” site.

What is "Restoration" ?

There are many different definitions of restoration! The law creating CFRP does not specify just one. NMFWRI's adaptation of the Society for Ecological Restoration's definition is: Restoration is a process of assisting the recovery of degraded, damaged, or destroyed ecosystems and increasing their resiliency to disturbance. In other words, restoration tries not only to "right past wrongs," but to help the system respond to future changes.

Why Do New Mexico's Forests need to be Restored?

From the Ground

Back at camp, NMFWRI crew boss Carmen Briones checks in with co-workers about the day's progress. "Honestly, I have never seen so many interesting trees. All kinds of diseases, deformities, weird shapes." After a day of working beneath spittlebug masses dripping down from the mistletoe in the ponderosa pine, the crews are sticky.

View from camp, June 2019 wildfire smoke

As they clean up, the smell of smoke gets their attention. A phone call confirms their safety: the fire is dozens of miles north. Nevertheless, the crew is on edge. "The Las Conchas Fire burned at an acre per second the first day," Raymundo Melendez explains. For the rest of the evening, the sky continues to darken.

Birds-Eye View

A legacy of fire suppression, logging, and overgrazing in New Mexico has left some forest-reliant communities with the following problems:

2011 view from Elk Mountain. The Viveash fire burned this area in 2000.

- Biodiversity and habitat quality decline
- Insect and pest epidemics
- Large, severe wildfires
- Decreased resilience to disturbance
- Decreased ability to provide ecosystem services (clean air, water, climate regulation, etc.)
- Economic impacts on local communities (mills, timber market, fuelwood harvesting, grazing)
- Sense of animosity between the public and government agencies such as US Forest Service

As climate change exacerbates stresses on ecosystems, the importance of effective restoration work increases.

What Restoration Methods are Used?

In New Mexico, some forest restoration methods include harvesting trees for timber, firewood, and wood products, prescribed fire, and planting of trees and site rehabilitation after catastrophic wildfire. Harvesting, also called thinning, is the most common. Harvesting be done by hand with a chainsaw or with specialized heavy equipment such as feller-bunchers, harvesters and forwarders, skidders, or sometimes even by cable or helicopter. One of the aims of thinning is to reduce fuel levels enough to allow safe re-introduction of fire.

Prescribed fire (a fire lit under controlled conditions) is usually introduced after a restoration thin to safely reduce the fuel load and encourage natural nutrient recycling. It can occur as pile or jackpot burns (burning caches of material) or a broadcast burn which covers the landscape in a mosaic like a natural wildfire.

Hand crews working with chainsaws near San Ignacio in 2014

Mechanical harvesting equipment in a "dog hair" stand" near Tierra Amarilla in 2016

A "drop point" where material is cached during harvest for later removal as firewood or in a pile burn, near Chama, 2017

Prescribed Broadcast burn near Las Dispensas, 2016

How Do You Know If Restoration is Effective?

In a word: **Monitoring!**

Among the unique features of the CFRP is the monitoring mandate included in the law. All grantees must use a multiparty monitoring team to do the following: monitor short- and long- term ecological effects of the restoration treatments for at least 15 years (individual grantees must monitor pre-treatment and immediate post-treatment); use collected ecological data to identify the existing and desired future ecological conditions of the project area; and report on the impacts and effectiveness of their project and assess how effectively the project's stated goals are being met.

Monitoring on the Carson National Forest, 2017

What Monitoring Data is Collected?

Measuring ecosystem function can be challenging, and restoration effectiveness is an evolving field. Most monitoring programs use proxies or metrics to document change over time, rather than trying to measure a whole process. This is much like a doctor doing a blood test to look for signs of a sickness rather than trying to image an entire body and measure all responses.

The metrics used in ecological monitoring of CFRP projects include the following:

Recording fuels near Chama, 2016

Overstory canopy cover : Overstory canopy cover is an estimate of cover by tall trees. This cover can tell us about wildfire risk and plant and animal habitat.

Understory cover : Understory cover documents ground and understory vegetation cover by category and percentage. This can tell us about wildfire risk, native plants, soil resources and erosion risk, wildlife and microorganism habitats.

Surface fuels : Surface fuels, or the amount of woody debris on or near the forest floor, are measured in tons per acre. Measuring surface fuels tell us about wildfire risk, fire regime and erosion potential.

Stand composition and structure : Stand composition is the mix of species in a forest and the condition of those species. Stand structure is the mix of age and height classes of trees and other vegetation. These metrics can tell us about vegetation community health and timber resources, as well as habitat (e.g. snags) and wildfire risk (density of trees).

Tree live crown base height : Live crown base height is a measure from the forest floor to the lowest point of live growth on a tree. This metric tells us about wildfire risk.

Common Forest Types

Most implementation CFRP projects can be divided into four main forest types, pictured below: piñon-juniper, ponderosa pine, dry mixed-conifer and wet mixed-conifer. Note: riparian projects are also part of CFRP, but the historic disturbance regime in riparian areas is flooding, not fire, so they are not included in this analysis.

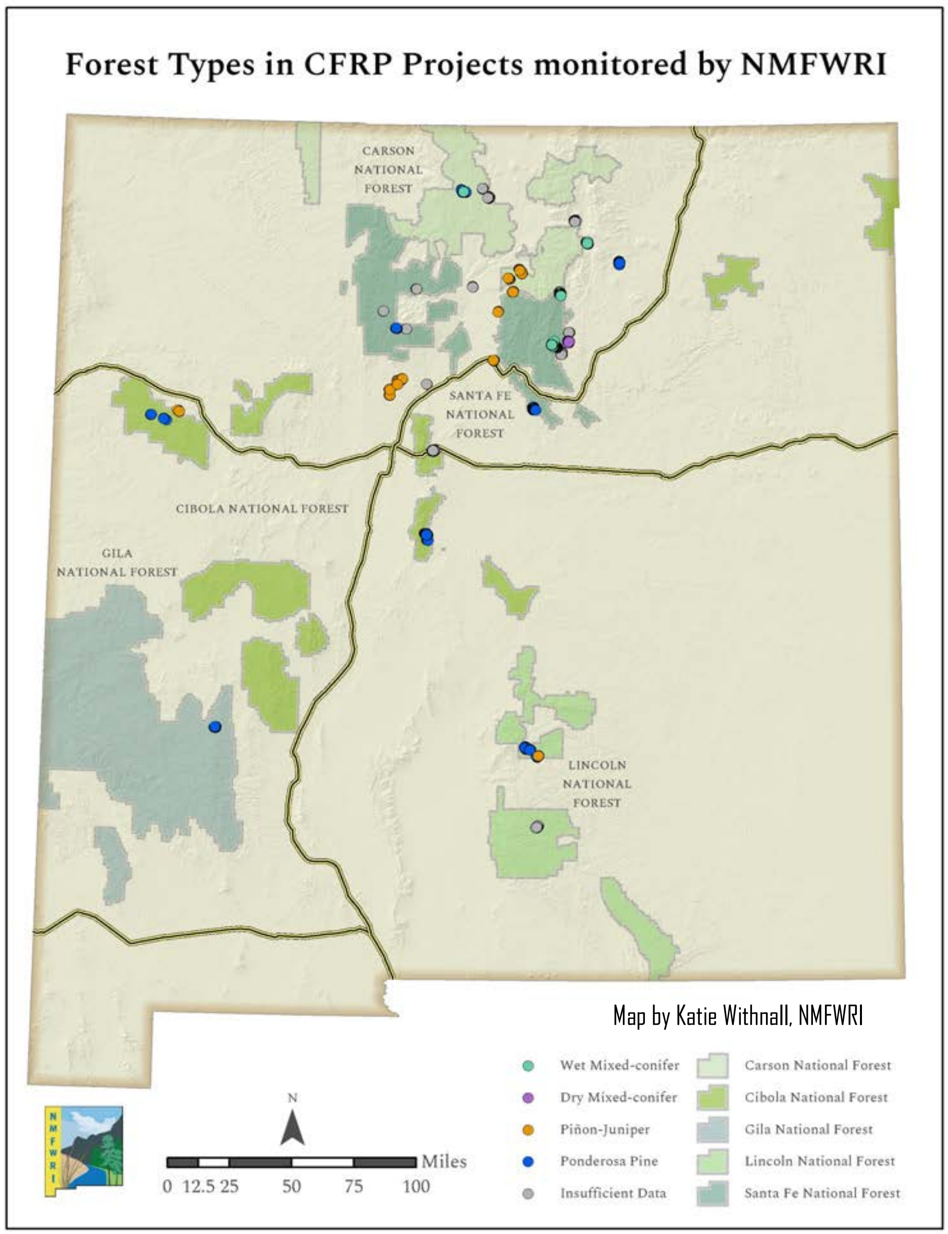
Understanding the forest type is critical to evaluating project success, since different forest types respond in different ways to treatment. For instance, ponderosa pine is a frequent-fire forest type, meaning wildfire naturally occurs in the system every few years. Wet mixed-conifer, on the other hand, naturally sees fire every 200-300 years.

Piñon-Juniper

Ponderosa Pine

Dry Mixed-Conifer

Wet Mixed-Conifer



Is CFRP Meeting its Goals? (Details)

NMFWRI compared pre-treatment, immediate post-treatment, 5-year-post-treatment and 10-year-post-treatment results for the monitoring metrics discussed on page 4. We wanted to know how the projects responded to restoration treatment and how long the effect of the treatment persisted.

In this initial evaluation, we looked at statistically significant differences for the four main forest types (see box, below, for more on what we mean by this term).

There is much more work that can be done to investigate the potential causes of these differences and how they show up on specific sites, but the following pages detail what we know so far!

Want to Get Technical? Learn More About Statistical Significance

When used in research "statistically significant differences" means that differences reported are unlikely to be due to chance. In other words, we can be sure that a difference we report has not just appeared because of random chance; our statistical analyses show the difference actually exists at the program level.

That said, 100% certainty is never an option. For instance, the number of projects available to us in this study varies greatly by measurement period and forest type. Larger sample sizes are generally associated with more confidence in the result. Flukes are harder to detect in smaller samples.

If you were to plot all our data points on a graph, you might see trends or visual changes that are not reported here. This is because this study only considers statistically significant differences, or data points with differences that our statistical analyses show are not due to random noise. On a graph, you may see that differences appear between other data points, but since we cannot be sure if those differences appeared by chance, we will not include them here. Because we are choosing to deal only with statistical differences, we may be ignoring differences that show up as large on a graph, and may be large when we visit a project. In dealing with this (or any) data set, if the number of treated sites is small (say, fewer than 6) and the variability among projects is large (say, the pre-treatment quadratic mean diameter (QMD) on one project is only slightly smaller than the post-treatment QMD on another project), the treatment won't show up as statistically significant across projects, even though the difference in pre- and post-treatment for any one project might reduce the risk of catastrophic fire to a level that the land manager considers it to be meaningful. The best example of this phenomena is the wet mixed-conifer treatments in these data; despite removing a lot of trees from these projects, no indicator is significantly different. Once again, this is because this study looks at program-wide results (i.e. averages) rather than individual project success.

Finally, while we can be sure a statistically significant difference exists, we have to do more work to determine what this difference means for management. For example, let's imagine that the average seedlings per acre are significantly different when comparing pre-treatment and immediate-post-treatment for a certain forest type. Next, we would use additional analyses to tell us the direction of difference, or whether the average seedling per acre estimate was larger before or after treatment. Let's say it was larger before treatment. We still don't know what this means. Why is it different? Is it telling us something important? This may be an indicator that seedlings were removed during treatment as part of the prescription. It might be caused by site disturbance during treatment that killed small trees. Maybe the restoration treatment used prescribed fire, or a wildfire burned through the area and this killed the seedlings. Maybe all the seedlings outgrew the "seedling" class and were counted as "saplings" by the time the post-treatment measurement happened, and no new seedlings grew in. There are lots of possibilities.

What's Not Working?

Aspen regeneration in a Wet Mixed-Conifer project, 2015

Wet Mixed-Conifer

Overall, metrics on **wet mixed-conifer** projects showed no significant differences from pre-treatment to post-treatment measures. This suggests that treatments in wet mixed-conifer may not be producing the desired effect. Field crew observations do document aspen regeneration.

Dry Mixed-Conifer

In the **dry mixed-conifer forest type**, the number of trees per acre dropped post-treatment and remained significantly lower at the 5-year mark. This is what we would expect from effective restoration: since most New Mexico forests are overstocked, a successful restoration effort could be expected to reduce the trees per acre. However, in dry mixed-conifer, average trees per acre at 10 years is not significantly different from the average pre-treatment. Based on field crew observations, this is heavily influenced by aspen regeneration and growth, suggesting that while the number of trees per acre may not be different, the species mix may be. We speculate that the rapid growth and high variability associated with aspen also affects other dry mixed-conifer metrics, including basal area, quadratic mean diameter, height of live trees, live crown base height, and overstory canopy cover. Our findings suggest that at some point no later than between the 5 and the 10 year marks, dry mixed-conifer needs additional disturbance to achieve CFRP's restoration goals. This disturbance could take many forms, for instance, reentry of thinning, fuelwood harvesting, or return of a natural fire regime.

No significant changes were detected for several metrics, including tree regeneration, understory shrubs, sick trees and snags and surface fuels.

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Photos from 5 years (top) and 10 years (bottom) post-treatment. The drastic changes over time represent a common challenge in CFRP data analysis.

What's Not Working? (continued from page 8)

Ponderosa Pine

In **ponderosa pine**, a return to pre-treatment levels was seen with overstory canopy cover by 5 years post-treatment.

Interestingly, large surface fuels (logs) were detected at significantly higher levels immediately post-treatment than pre-treatment. This could be explained by a restoration method that included dropping and leaving woody material on the ground, but it does suggest that post-treatment sites may have higher fuel loads than desirable. At 5 and 10 years post-treatment, the surface fuels were not significantly different from the pre-treatment levels.

The number of seedlings per acre (tree regeneration) decreased after treatment and had not returned to pre-treatment levels by 10 years post-treatment. This suggests that natural restocking may not be occurring at sustainable levels.

Finally, just as in other forest types, no significant changes were detected for several metrics, including quadratic mean diameter, live crown base height, understory shrubs, sick trees and snags per acre.

Mistletoe in ponderosa pine, 2018

Piñon-Juniper

In **piñon-juniper**, significant differences in metrics were generally in the direction expected for successful restoration treatments. The main concerning finding was a lower number of saplings per acre post-treatment, which suggests that restoration treatment removed or killed saplings that were not replaced within the stand.

There were several metrics which showed no significant impact of treatment, including tree height, live crown base, seedlings, shrubs, sick trees per acre, and surface fuels.

Wet Mixed-Conifer

Study Findings

- Little or no significant impacts of treatment

Recommendations

- Re-evaluate treatment methods

Trends

Dry Mixed-Conifer

Study Findings

- Some treatment impacts visible, but no measure significantly different at 10-year mark

Recommendations

- Provide disturbance (re-entry, fire) or project maintenance within 10 years

Ponderosa Pine

Study Findings

- Treatment impacts beginning right after treatment, variable duration

Recommendations

- Provide disturbance within 10 years
- Manage fuel after treatment

Piñon-Juniper

Study Findings

- Treatment impacts visible but not always immediately, appear to have longest duration of these four forest types

Recommendations

- Investigate success of natural restocking in these systems

What IS Working

Lest this report be perceived as negative, we want to be clear that CFRP has many accomplishments in areas beyond the scope of NMFWRI's research, including jobs created and an improved spirit of cooperation between partners.

In ecological terms, the data show CFRP is "getting it right" with the following metrics:

Dry Mixed-Conifer

Several metrics showed an initial trend toward restoration immediately post-treatment: lower trees per acre, taller average tree heights, increased quadratic mean diameter and so forth. The treatment was effective, it just did not last to the 10-year mark.

Post-treatment monitoring, 2018

Ponderosa Pine

Trees per acre and basal area per acre were lower after treatment even at 10 years.

Piñon-Juniper

At 10 years post-treatment, piñon-juniper projects had lower trees per acre, snags per acre, basal area and canopy cover than they had pre-treatment. Treatment impacts seems to have the longest duration in this forest type.

Program-Wide Conclusions: Is CFRP Meeting its Goals?

Program Goals

1. **Wildfire threat reduction**
2. **Ecosystem restoration, including non-native species reduction**
3. **Reestablishment of historic fires regimes**
4. **Reforestation**
5. **Preservation of old and large trees**
6. Small diameter tree utilization
7. Creation of forest-related local employment
8. Stakeholder diversity

Based on the CFRP's stated goals (reprinted at left from page 2 with ecological goals in bold text), our data shows program-wide success has been mixed.

Wet mixed-conifer projects generally do not show significant changes post-treatment. Dry mixed-conifer projects show clear impacts of treatment, but these are not significant by the 10 year re-measurement. Ponderosa pine projects have some longer-lasting impacts, while all piñon-juniper metrics that showed a significant difference immediately post-treatment still showed a significant difference at the 10 year re-measurement.

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Program-Wide Conclusions: Is CFRP Meeting its Goals? (continued from page 10)

Program-wide success was mixed for the indicators of the wildfire threat reduction, ecosystem restoration, and preservation of old/large trees objectives. The wildfire threat reduction goal seems to have been somewhat successful in dry mixed-conifer and piñon-juniper forest types. While the dry mixed-conifer responses were no longer significantly different from pre-treatment conditions at the 10 year re-measurement, the piñon-juniper metrics were. Little change was observed in the wet mixed-conifer forest type, and ponderosa pine had mixed results, including a trend toward lower tree heights and higher large fuel loads immediately post-treatment.

The ecosystem restoration goal, based on measured responses in snags, sick trees, canopy cover, basal area and tree size, saw some success in dry mixed-conifer, piñon-juniper, and ponderosa pine forest types.

The success of the goal of preserving of old/large trees was also mixed, with either increases or no change in average tree size (QMD) across forest types, and a decrease in post-treatment tree height in ponderosa pine.

The reforestation goal, assessed with the changes in live trees per acre and seedlings/sapling over time, did not see program-wide success. This may be because treatments did not create sufficient sunlight through the canopy to support regeneration. In addition, successful tree regeneration requires a combination of factors: good seed years, rainfall, and scarification among others. Only one CFRP project monitored by NMFWRI was noted as having excellent regeneration; this was so unusual in relation to the other projects that had to be removed from analysis as an outlier. Low regeneration rates are concerning as climate change impacts on forests are expected to worsen in the coming years.

Natural ponderosa pine regeneration near Las Dispensas, 2017

Implementation Recommendations

Based on the aggregate data, there is evidence that effects of restoration treatment on lower-elevation forests (such as piñon-juniper) last longer than in higher-elevation forests like wet mixed-conifer. Other influences are no doubt present; for instance, field crew notes document greater anthropogenic influence in lower-elevation forests. Activities like firewood gathering appear to be helping to remove excess material from these systems.

Some "weak spots" of existing treatments appear to be overall project success in the wet mixed-conifer forest type, project maintenance in the dry mixed-conifer forest type, and sufficient regeneration in ponderosa pine and piñon-juniper.

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Implementation Recommendations (continued from page 11)

There is some evidence that forests are "escaping" back to near-pre-treatment states by 10 years post-treatment. Field crews consistently report that projects do not appear to have been revisited after initial treatment. Prescribed fire in particular is rare, despite being a part of many CFRP project plans. Because of the critical role of fire in many of New Mexico's forests, Dr Kent Reid, director at NMFWRI believes "sites cannot be considered truly 'restored' until they have seen fire, and are able to see it again without fear of a high-severity, catastrophic burn."

Prescribed fire on Luera Mountain, 2017

Remember that natural cycles in ecosystems include periods of disturbance such as windthrow, fire, ice, pest and disease. Restoration work must re-set and continue that cycling to be successful. For this reason, forest restoration cannot be a one-time effort in any given area. We recommend project maintenance, re-entry and monitoring. An examination of grazing practices, actual implementation of prescribed fire, and other anthropogenic influences in project areas could help clarify how treatments could change to better achieve all program objectives.

Program-Wide Recommendations

Several program-wide recommendations were made in previous publications that are supported by the findings of this project, such as monitoring assistance for grantees to standardize protocols and provide improved quality control. Tree condition data (e.g. healthy, unhealthy, mistletoe presence,) is inconsistently collected. It would be valuable to collect slightly more detail than just "live" or "dead" for a tree, and mistletoe identification and severity rating is within the skill set of most community members familiar with their forests.

Gaining access to data remains a major hurdle in conducting program-wide analysis. Ideas for a central data repository have been previously discussed, and should include not only final reports but also photographs, shapefiles, and information on project maintenance or re-entries. There is at present inconsistent enforcement of CFRP reporting and little incentive to follow through with timely analysis and publication of data. If that were to change, this data could be available for use in adaptive management decisions, particularly within the CFRP or CFLRP.

In working on this project, every attempt has been made to collect all available data from CFRP Coordinators on the Gila, Lincoln, Carson, Cibola, and Santa Fe National Forests. On the Gila, the CFRP Coordinator did not respond to requests; on the Lincoln and the Carson, Coordinators acknowledged the request but did not provide data; on the Cibola and Santa Fe, Coordinators provided some information but were not able to provide all of the data requested. A simple and timely reporting system would greatly reduce the stress that Forest CFRP Coordinators may feel when asked for data that has been filed away, unused, for many years, thereby improving communication and responsiveness.

Importance of CFRP Monitoring

The law creating CFRP was idealistic and forward-looking plan for collaboration and restoration of community relationships, local economies and ecosystems. Its purpose is to promote watershed health and reduce fire risk, decrease the number of small diameter trees and encourage their commercial use, to improve communication and collaborative partnerships, and to "develop, demonstrate and evaluate ecologically sound forest restoration techniques." Proposed projects must not only demonstrate their commitment to social and economic goals, but also must "incorporate current scientific forest restoration information." Combined with the unique 15-year monitoring mandate, it is clear that the ecological monitoring information generated as part of this project was never intended to sit in shelved reports somewhere. Instead, monitoring results need to be a key part of an adaptive management framework designed to improve not only the CFRP but Southwest forest management overall.

You taking the time to read this report shows your commitment to this process—thank you!

A View from the Ground

The FWRI crew works on a 10-year re-measure in dry mixed-conifer. The project had been burned the previous October. As they hike through the area, they talk excitedly. The broad ridge-line is a mosaic of burned and unburned areas. Ash and stump holes cover one plot, grass and flowering forbs the next. In some places, logs lie cross-slope to prevent soil erosion. In others, large-diameter Douglas-fir stand tall and proud. It is clear the area has been pile-burned, and in some places the fire was allowed to run up-hill for a couple hundred feet, mimicking a natural wildfire. Patches of young aspen compete for sunlight. They glitter from a distance as the wind moves their leaves. To any eye calibrated for restoration work, it is truly beautiful.

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