**Implementation: Rio de las Trampas Watershed Restoration Phase I: State Trust Lands**

**Executive Summary:** The Forest Guild, the New Mexico State Land Office (SLO), and a diverse array of collaborators will restore forests and watersheds through treatments across 350-450 acres in the Rio de las Trampas (Rio Trampas) watershed in north-central New Mexico in 2014-2017 through the Cooperative Forest Restoration Program (CFRP). Restoration activities will occur in piñon-juniper shrubland, woodland, and ponderosa pine cover types. The project will generate an estimated 300-350 cords of fuelwood and latillas, support ten restoration practitioner jobs, employ 15 local youth, and engage five local communities in Fire Adapted Community outreach. Since 2011, the Forest Guild has led a collaboration between Picuris Pueblo, the Bureau of Land Management Taos Field Office (TFO), the Camino Real Ranger District (CRD) of the Carson National Forest, the SLO, the Bureau of Indian Affairs Northern Pueblos Agency, Ecotone Consulting, the Arid Lands Institute (ALI), New Mexico State Forestry Division (NMSF) and the communities of the Rio Trampas watershed. Forest restoration planning for compliance with the National Environmental Policy Act and the National Historic Preservation Act is in progress on lands managed by the Picuris Pueblo, TFO, and CRD jurisdictions. The SLO has succeeded in expediting the planning effort, enabling this initial implementation to occur ahead of the ongoing planning efforts in other jurisdictions. Complementary watershed restoration planning and implementation is underway with Ecotone, ALI, as well as with NMSF on private forestland.

**Statement of Need:** Fire modeling and collaborative prioritization from the 2011 Rio Trampas Planning CFRP project indicate that conditions in the selected treatment areas on state trust lands threaten community safety and are in need of fire risk reduction treatments. The 2011 collaborative prioritization effort indicated that the public's highest landscape priority is water quality and quantity, and the second-highest landscape priority is wildfire risk. The Forest Guild developed a watershed prioritization model to identify proposed treatment areas. This geographic information system (GIS) model captured input from agency partners and wildfire and natural resource professionals, as well as parameters including community protection buffers (from mapping and Community Wildfire Protection Plans), FlamMap outputs using 90 percentile weather inputs, and post-fire erosion risk potential. The prioritized areas were then ground-truthed and adjusted as needed. The ground-truthing largely confirmed model results; the selected areas were in an ecologically poor condition due to historic fire suppression, unmanaged grazing, and general resource overuse. The selected areas for the current effort range from piñon-juniper shrubland to ponderosa pine forest. The conditions of piñon-juniper shrubland at lower elevations are contributing to poor watershed conditions, degraded hydrology, and poor water quality. Piñon-juniper woodlands at the mid and upper elevations are likewise in poor health. The ponderosa pine forest is uncharacteristically dense because of the exclusion of natural fire and is being encroached upon by piñon and juniper trees. All three cover types are susceptible to climate change impacts, drought, insects, pathogens, and high-intensity crown fire. The natural resource needs of this watershed are reinforced by the findings of the 2010 NM Statewide Natural Resources Assessment (EMMNRD Forestry Division 2010), which identified extensive areas for forest restoration at the watershed scale. Furthermore, the proposed treatments are designated by the Taos County and Penasco Community Wildfire Protection Plans as within the wildland-urban interface risk zone. The need for action is significant

**Project History:** The Rio Trampas watershed spans 72,000 acres in southern Taos County and in southeastern Rio Arriba County. The main communities are Ojo Sarco, Trampas, Chamisal, Picuris, and Dixon. The watershed begins in the Pecos Wilderness on Trampas Peak and drains northwest to the Rio Grande. Forest Guild has been working in this watershed for the past 30 years. Prior to 2005, the Forest Guild worked to encourage, train, educate, and develop small-scale forestry crews that supported communities. Alumni from those crews have risen to careers in the Bureau of Indian Affairs or become wildland and structural fire professionals. In 1997 and 2003 respectively, the Guild wrote the Truchas Land Grant Resource Management Plan and the Truchas Land Grant Fire Plan. More recently, in 2006, the Forest Guild facilitated the group process through which over 60 resource professionals and community groups identified landscape restoration priorities across 300,000 of the 3.4 million-acre analysis area as part of the North-Central New Mexico Landscape Assessment. Following those landscape restoration priorities, the Forest Guild was awarded a 2007 CFRP grant, the *Santa Cruz and Embudo Creek Watershed Multi-jurisdictional Restoration and Protection Project* (Santa Cruz/Embudo CFRP, #16-07).[1]

The Santa Cruz/Embudo implementation grant supported the successful restoration of forest structure on 504 acres in preparation for prescribed fire in high-priority stands across BLM, Forest Service, and Truchas Land Grant jurisdictions. In a complementary effort in partnership with Earthworks Institute, we prioritized the treatment sites for erosion risk and soil degradation in restoration thinning areas. With limited funding, we implemented watershed restoration techniques to mitigate runoff from roads, assist with understory recovery on bare ground, ameliorate existing and potential headcuts, protect existing desired vegetation from burn piles, and repair an incised and degraded arroyo. This work serves as a model for successfully pairing forest and watershed restoration projects under similar ecological conditions. In addition, funded by the State of New Mexico, Earthworks Institute launched a watershed restoration pilot project in the Lower Embudo Valley and is planning to expand watershed research and restoration work in the watershed.

The Santa Cruz/Embudo CFRP was also highly successful in restoration workforce development and young adult education. The crew is now an established forest restoration business, Caro's General Works that operates on private, state, and federal lands.

Within and adjacent to the Rio Trampas watershed, in 2003 and 2007, Picuris Pueblo received CFRP grants to thin overgrown forests and develop innovative wood utilization such as natural charcoal and naturally treated poles, as well as to increase the extent and diversity of forest fungi. In 2010, Chimayo Conservation Corps (CCC) received a CFRP grant on BLM, San Ildefonso Pueblo, and CRD lands to restore forest structure in ponderosa pine, piñon-juniper, and riparian forests.

The Forest Guild and our collaborators actively leverage resources to maintain current forest restoration work in the watershed. The Forest Guild has brought two Forest Health Initiative projects, managed by State Forestry, to the Truchas Land Grant since 2007 and one to the Prajna Mountain Refuge in 2012. The CCC used more than five forest restoration or fuels reduction

[1] The Forest Guild received CFRP funding in 2003 (#26-02), 2005 (#01-05), 2009 (03-09), and 2012 (28-12) unrelated to this project.

grants since 2007, and EarthWorks Institute (now Ecotone Consulting and the Arid Lands Institute) have leveraged three watershed restoration grants in the Rio Trampas Watershed. The collaborators had hoped to increase this leveraging of restoration opportunities, but the lack of implementation-ready forest and watershed projects jeopardized these efforts. To address this, Forest Guild led a collaborative planning proposal (CFRP 10-11) that was funded by the CFRP in 2011. This project funded cultural resource clearance and environmental assessment across 10,000 acres across Picuris Pueblo, the Taos Field Office of the Bureau of Land Management, the Camino Real Ranger District of the Carson National Forest, and the SLO. Planning efforts continue across Tribal and federal jurisdictions; however, planning was fortunately expedited and completed by the SLO in accordance with its protocol (see appendix F for the decision document, the SHPO concurrence and biological report are available upon request). At public meetings for CFRP 10-11, residents of the watershed expressed passionate interest to move into treatments quickly. This proposal is a response to this local concern. Partners convened in December 2013 to develop this proposal.

**Project Partners:** Forest Guild has reached out to and successfully engaged several entities to accomplish the proposed actions. The lead land management agency is the New Mexico State Land Office with support from neighboring land managers: Picuris Pueblo, the TFO, the CRD, the Bureau of Indian Affairs Northern Pueblos Agency, Ecotone Consulting, the ALI, and the NMSF. Copies of letters of support, commitment, and endorsement from collaborating partners are provided in the Appendix. There are seven areas in which collaborators have participated or will participate from inception to completion: proposal development (PD); environmental and cultural clearance (C); prioritization (P) of the watershed; education and outreach (EO) to students and community; monitoring (M) of the project and; and in-kind non-federal match ($).

| COLLABORATOR | Proposal Development | Clearances | Treatments | Education and Outreach | Monitoring | Non-federal match[2] |
|---|---|---|---|---|---|---|
| New Mexico State Land Office | √ | √ | √ | √ | √ | √ |
| Picuris Pueblo | √ | √ | √ | √ | √ | |
| Taos Field Office of the BLM | √ | √ | √ | √ | √ | |
| Camino Real Ranger District | √ | √ | √ | √ | √ | |
| Carson National Forest | √ | √ | | √ | | |
| Northern Pueblos Agency | √ | √ | √ | √ | √ | |
| Ecotone Consulting | √ | | √ | √ | √ | √ |
| Arid Lands Institute | √ | | √ | √ | | |
| Cimarron District of NM State Forestry | √ | | √ | √ | | |
| Acequia Abajo in El Valle, William deBuys | √ | | √ | √ | | √ |
| Caro's General Works | √ | | √ | | √ | √ |
| Penasco High School | √ | | | √ | √ | √ |
| Taos County - Envirothon | √ | | | √ | √ | √ |

[2] To prevent over-matching, only a portion of the total committed match is reflected in the budget.

| | | | | | | |
|---|---|---|---|---|---|---|
| Taos County WUI Specialist | √ | | √ | √ | | √ |
| Acequia del Ojo Sarco | √ | | | √ | | |
| Lessee, WildEarth Guardians | √ | √ | √ | | | |
| Lessee, Charlie Gasca | √ | | √ | | | |
| Watershed Dynamics | √ | | √ | | | |
| Carson Forest Watch | √ | | | √ | | |

**Primary Contact:** Eytan Krasilovsky, Forest Guild Southwest Region Director, eytan@forestguild.org, 505-983-8992 xt 16, 2019 Galisteo St. Suite N-7, Santa Fe, NM 87505

**Objectives**

*Forest Restoration*: Broad consensus among managers and scientists deplores the widespread undesirable conditions in piñon-juniper (Romme et al. 2009) and ponderosa pine (Allen et al. 2002) ecosystems largely due to human land use practices over the past 120 years. The primary culprits have been the negative effects of excessive grazing, logging, and fire suppression (Cooper 1960, Covington and Moore 1994, Lynch et al. 2000). Recent landscape assessments such as the New Mexico Statewide Natural Resource Assessment & Strategy and Response Plans (EMNRD Forestry Division 2010) and the North-Central New Mexico Landscape Assessment (ForestERA Team 2007) have identified vast areas of the Rio Trampas in need of active management to accomplish forest and watershed restoration.

The local watershed-specific prioritization conducted for the CFRP-funded 2011 planning effort combined local knowledge with GIS mapping to identify high-priority areas for restoration. The proposed treatment areas reflect this effort.

Forest restoration implementation strategies to achieve objectives for the watershed are:

1. Removal of excess vegetation structural stage[3] (VSS) classes of piñon pine, one-seed juniper, Rocky Mountain juniper, ponderosa pine, white fir, and Douglas fir through mechanical treatment. This removal will focus on VSS classes 1, 2, and 3 with a goal of moving ponderosa pine dominant stands towards a VSS distribution identified in the USDA Region 3 *Implementing Northern Goshawk Habitat Management in Southwestern Forests: A Template for Restoring Fire-Adapted Ecosystems* (Youtz et al. 2007). Mechanical treatment entails tools such as chainsaws, masticators or blades, skidding, and mechanized harvesting and forwarding operations, etc.
2. Retention of larger VSS classes 5 and 6, in piñon-juniper, piñon-juniper ecotone, and ponderosa pine stands.
3. Retention of large-diameter piñon pine and juniper species.
4. Removal of encroaching conifers from identified meadow openings and grasslands.
5. Limited group selection removals of conifers and aspen trees in ponderosa pine and mixed conifer stands to achieve density or VSS class distribution targets, and improve forest health through removal of stress, damage, and mortality agents such as dwarf mistletoe and spruce budworm.
6. Jackpot, or pile burning of slash in select piñon-juniper and ponderosa pine areas. Through a bid process, the project will hire a burn boss, use the burn plan developed by the SLO, and

[3] Based on the predominant diameter distribution of trees in a stand, group, or clump. VSS classes 1, 2, 3, 4, 5, and 6 are grasses, seedling-sapling, young, middle aged, mature, and old forest, respectively.

hire the engines needed to have on site for the estimated three burn days. The burn boss will coordinate with adjacent resources and ensure National Wildfire Coordinating Group standards are met. Any opportunities to train local wildland firefighters will be pursued with assistance from the Taos County wildfire specialist. The acres of piles burned will contribute to the overall treatment footprint range of 350-450 acres.

7. Caro's General Works will treat 263 acres, while the remaining 113 acres of forest thinning treatments will go out to bid using a stewardship-based bid process that will distribute acres among up to three contractors. The per-acre costs of these awards will determine the final thinning acres treated, but are expected to be between $450 and $500 per acre.
8. The stewardship block model pioneered by the CRD will be replicated across 20 acres. This will train local stewardship-minded residents in restoration treatment practices and provide them with access to fuelwood. A minimum of $15/cord fee will be assessed by the SLO for the estimated 40 cords generated by this part of the treatment. The entirety of these funds will be used by the SLO to benefit New Mexican public schools. The SLO will issue permits to the successful applicants, and the Forest Guild will manage field operations to ensure they comply with prescribed restoration treatment practices and regulations.
9. The Forest Guild will negotiate fuelwood removal, giving collaborators and partners first preference, and will manage removal to ensure that only fuel wood is removed and woody material that is part of a watershed or soil conservation practice is not removed. Ideally, most of the wood removed will occur during the thinning operations to discourage illegal collection. Based elements of the Ecotone training from project year 1, the Forest Guild will also develop a brochure and signage for project partners and community members to illustrate which slash elements need to remain on-site.

In piñon-juniper stands, treatments will focus on restoring the grassland and shrub vegetation community to reduce potential fire hazards. The treatment will leave approximately 20 to 40 larger trees per acre, and the residual stand will reflect the species and age class mix currently on site (Albert et al. 2004). Patches of trees (clumps) on north- and east-facing slopes will be set aside as thermal and protective cover for large mammals.

In the piñon-juniper and ponderosa pine ecotone, thinnings and prescribed fire treatments will leave stands less susceptible to stand-replacing wildfire events. These treatments will also help protect ecologically significant, old, or large trees from survival stress and wildfire-related mortality during periods of extended drought under a climate change scenario.

In the ponderosa pine restoration areas, treatments are designed to restore conditions to those within the historic range of variability and to create stands that allow fire to return to its natural role. Thinning will also increase biodiversity by encouraging brush and grass growth; protect old and large trees; increase ecosystem resilience by incorporating a natural, frequent fire return interval; and improve hydrologic function by reducing the basal area to historic conditions. The silvicultural prescription will reduce basal area to an average of 30 to 70 square feet per acre across the majority of the treatment stands. This reduction is in line with the best available science on ponderosa pine restoration (Fiedler and Keegan 2003, Moore et al. 2004, Hunter et al. 2007). The treatment prescription calls for the protection of old and large-diameter ponderosa pine trees because they are ecologically significant due to their genetic diversity (Kolanoski 2002); are often resilient in the face of fire (Agee 1998) and drought; provide important habitat

for wildlife (Bull and Hohman 1994, Humes et al. 1999, and Dodd et al. 2003); and serve as long-term carbon stores (Harmon et al. 1990). Old and large trees are also significant because they become persistent snags and downed logs that are important for cavity nesting birds and mammals (Chambers and Mast 2005).

*Watershed Restoration*: Degraded watershed function has been identified as a priority concern in this watershed by the 2007 Upper Rio Grande La Jicarita through Embudo Valley Watershed Management Plan (Environmental Health Consultants), land managers in the Rio Trampas watershed, and in the preliminary findings of the Ecotone Consulting and ALI watershed assessment. Impaired watershed functions are common in areas with elevated levels of erosion and sedimentation, high road densities in forests, and impaired and degraded water quality and degraded stream morphology.

Forest and watershed restoration actions are interconnected. Restoring forest structure will also improve hydrologic function through reduced sublimation of snowfall (Essery et al. 2003; Woods et al. 2006) and the establishment of vegetation conditions that may increase water availability (Baker 1986; Kaye et al. 1999; and Ffolliott and Thorund 1977).

The watershed restoration component of the project will include a site assessment to identify erosion features, erosion rates, erosion hazards, drainage patterns, and needs to change drainage and erosion conditions. Based on the site assessment, the project team and the thinning contractors will plan erosion control and drainage management measures through sensible thinning practices and additional soil conservation techniques. The project team will also work with the watershed contractor selected through the bid process to plan implementation details to achieve the desired project objectives in a cost-effective manner, optimize watershed protection and restoration benefits, and establish the foundation of baseline data for future monitoring.

Watershed restoration activities include:

1. The project team and thinning contractor will develop a thinning prescription that meets watershed protection and restoration goals in tandem with forest health improvement goals.
2. Watershed-wise thinning practices will be assessed across the 350-400 acres on the two SLO parcels targeted by the project.
3. On a 50-acre area on the parcel east of Dixon, soil and water conservation techniques will be applied in addition to the thinning prescription to enhance the ecological health of the drainages, alluvial bottomlands, and drier uplands. In this area, the proposed treatments will complement arroyo stabilization work and lop-and-scatter woodland thinning already accomplished in a previous project in 2013.
4. Thinning treatments may include clumping, leaving buffers, directional felling, and slash spreading (lop-and-scatter) in selected areas.
5. The site assessment may identify the need for additional soil and water conservation techniques such as swale and berm treatments, arroyo and slope treatments, juniper picket palisades, logs, one-rock dams, and contour rock lines, as well as drainage treatments to roads and skid trails such as rolling dips, in-sloping or out-sloping, and drainage swales with log or rock dissipaters. These tasks will be awarded to a successful bidder.

The proposed project in this area will serve to implement watershed planning recommendations that are being developed in an ongoing initiative to update the Watershed-Based Plan of the Lower Embudo Valley[4] by ALI and Ecotone, both of whom are working in concert with the New Mexico Environment's Surface Water Quality Bureau. As a result, the project sites will serve as demonstration areas for a continuing watershed restoration initiative and will encourage additional watershed investments to continue implementing the State's Watershed-Based Plan alongside the forest restoration plan in the Trampas watershed.

The focus watershed also faces increasing pressure from the changing climate. The climate in the region is likely to be warmer and drier overall by the end of the 21st century than it was during the 20th century with warmer spring and summer temperatures; reduced snowpack and earlier snowmelts; and longer, drier summer fire seasons (Westerling et al. 2006, IPCC 2007, and Dominguez et al. 2010). Three lines of evidence suggest that warming and drying conditions are likely to cause increased fire activity (Westerling et al. 2006, Westerling and Bryant 2008). Other effects of a warmer, drier climate in the Southwest include reduced vegetation growth and increased mortality (Williams et al. 2010). A warming climate and altered precipitation regimes will cause other ecosystem changes such as increased success for bark beetles (Bentz et al. 2010). Although uncertainty surrounds how the warming climate will manifest itself across the watershed, it is certain that forest restoration is a crucial means of fostering resistance and resilience to the impacts of climate change (Millar et al. 2007). In fact, forest restoration may be the best strategy to respond to climate change (Fulé 2008).

*Sustainability*

The project will build upon past successes in collaborative forest management across agencies, communities, and private businesses. The project will engage partners in forest and watershed restoration across multiple jurisdictions. A goal for this watershed as identified by CFRP #10-11 is to realize thousands of acres of forest restoration treatments by 2020 across federal, tribal, state, and private lands. The CRD is planning on treating a large portion of its acres in the watershed through a variety of mechanisms. The planned treatments will enhance the sustainability of the restoration jobs supported by this implementation effort. Engaging local youth in natural resource education will empower future generations with knowledge needed to support and practice natural resource stewardship.

*Education and Outreach*

The Forest Guild and the collaborators will conduct education and outreach efforts through a variety of pathways:

1. Convene multiparty team meetings in Penasco and Dixon that encourage public attendance.
2. Engage with Penasco High School and Taos County Envirothon students in field and classroom education.
3. In concert with Taos County, the project will promote Fire Adapted Communities (www.fireadaptednewmexico.org) best practices to 5 local communities at risk to wildfire to empower those communities to take steps toward reducing their risk.

[4] Information about this can be accessed by ALI online at: http://aridlands.org/project/updated-watershed-based-plan-lower-embudo-watershed-new-mexico.

4. The Taos County Wildland Fire Coordinator will notify local fire departments and community members in advance of any burning and incorporate lessons learned from CFRP #28-12.

| Who will benefit? | How will they benefit? |
|---|---|
| Rio Trampas Watershed | ✓ Degraded forested watersheds will receive strategically located and collaboratively developed forest and watershed restoration treatments. Such watersheds that are highly departed from their desired future condition are at risk from crown fire events and resulting erosion that would create a further departure from their desired future condition.<br>✓ Piñon-juniper woodlands and juniper shrublands that are degraded and exhibit high rates of erosion will receive restoration treatments. |
| Local Youth | ✓ Local youth through the Taos County Envirothon and Penasco High School will gain natural resource and forestry skills through hands-on training in forest ecology and measurement. Based on past experience, several of these youth are likely to evolve this valuable experience into careers in natural resource stewardship to benefit their home communities. |
| Wood harvesters and utilizers | ✓ Wood harvesters and users in the area will be able to keep crews working and have access to wood for utilization through the bid process. |
| Acequia groups and communities | ✓ Implementation of a 20-acre trial stewardship block program will increase community access to fuelwood while directly engaging the interested public in forest and watershed restoration.<br>✓ In the long-term, these groups will benefit from improved water quality (reduced sediment), reduced fire risk, and responsibly harvested wood products. |

**Work Plan:**

| What will be done? | Who will lead it? | When will it be done? |
|---|---|---|
| Convene partners to develop proposal | Forest Guild | December 2013 |
| Ensure NEPA compliance is complete | State Land Office and Forest Guild | January 2014 |
| Convene partners to review proposal, solicit feedback on implementation plan, and confirm details and roles of monitoring efforts | Forest Guild | September 2014, 2015, and 2016 |
| Collect ecological data | Forest Guild and Envirothon students | Fall 2014, summer 2015, 2016, and 2017 |
| Convene restoration practitioners for all-day training on watershed conservation techniques | Ecotone | Fall 2014 |
| Initiate forest restoration treatments | Caro's General Works and Forest Guild | Fall 2014 and 2015 |
| Complete a bid process in compliance | Forest Guild and | Fall 2015 |

| | | |
|---|---|---|
| with Forest Guild procurement protocol for watershed restoration, forest restoration, burn boss, and support engines. | State Land Office | |
| Initiate watershed restoration treatments | Forest Guild and Ecotone | 2015-2016 |
| Initiate final forest treatments and implement stewardship block pilot program. | Forest Guild | 2016-2017 |
| Implement pile burning | Forest Guild, State Land Office, and awarded burn boss | 2017 |
| Comply with financial and programmatic reporting requirements | Forest Guild | Throughout |
| Attend annual CFRP workshop | Forest Guild | Annually |
| Convene final group meeting to review project for input into the final multiparty assessment | Forest Guild | September 2017 |

**Monitoring Plan:** The Forest Guild and the multiparty team will convene project meetings to review progress and ecological and socioeconomic data. At these meetings, the collaborators will have opportunities to provide input into the project and recommend changes to better achieve grant goals. The primary monitoring of the project will be at the implementation level, i.e. confirming how and how well grant goals were met. The project will also use the five core CFRP ecological indicators to establish permanent plots. Generally, the project will use indicators and methods from the *Short Guide for Grant Recipients*. Post-pile burning, the multiparty team will conduct a review of documented activities to identify potential areas of improvement. The multiparty team will select watershed restoration metrics to assess the implementation of the watershed treatments.

The indicators listed may be increased through the multiparty process at the onset of the grant, but at a minimum will include the core indicators set for the ecological monitoring requirements for CFRP: (a) canopy cover (percent); (b) understory cover (percent ground and/or shrub); (c) crown base height (ft); (d) stand structure, including tree species, size (DBH), and density (stems/acre live and dead, basal area); as well as socioeconomic indicators including (a) number, types, and duration of jobs; (b) trainings and education provided; (c) and equipment utilization.

While socioeconomic conditions vary, forest-based businesses generally suffer from intermittent activity due to the seasonality of forest work and lack of consistent wood supply. Socioeconomic monitoring will record changes in indicators through a supplementary narrative that the quantitative measures may not fully explain.

| **Implementation Monitoring** | **Desired Outcome** | **Sample Measurements** |
|---|---|---|
| Was the project collaborative? | Collaboration is maintained and strengthened over time. | Number of meetings, attendance, meeting notes, and partnership |

| | | |
|---|---|---|
| | | outcomes. |
| Were youth and young adults exposed to forest restoration, management, and monitoring? | Youth and young adults gain an understanding of forest restoration processes and monitoring. | Number of youth and young adults engaged, in what capacity, and description of effort and learning. |
| How many jobs were created or sustained? | Significant job investment is quantified. | Jobs and FTE. |
| What were the impacts of the suite of treatments? | The thinning, watershed, and burning treatments move site conditions towards restoration objectives (stated above). | Photographs, impressions of the multiparty team, findings from core indicators, and long-term monitoring results. |
| **Existing Socioeconomic Condition** | **Desired Future Condition** | **Sample Measurements** |
| Training opportunities in prescribed fire and watershed protection are limited in the area. | Private contractors (forest restoration practitioners) increase their training, understanding of, and ability to implement burning and watershed restoration techniques. | Number and type of trainings and skills gained, skills applied on jobs subsequent to trainings. |

**Appendices:**

A. Maps
B. Personnel qualifications
C. Letters of Commitment
D. Letters of Support
E. Letters to Tribes
F. NEPA decision documentation
G. References
H. Communication log
I. Pre-proposal meeting notes and sign-in sheet
J. Forest Guild liability insurance coverage.

**Appendix G**
References:

Agee, J. K. 1998. Fire and pine ecosystems. In: D. M. Richardson, editor. Ecology and biogeography of *Pinus*. Cambridge University Press, Cambridge.

Albert, S., N. Luna, R. Jensen, and L. Livingston. 2004. Restoring Biodiversity to Piñon-Juniper Woodlands. *Ecological Restoration* 22(1):18-23.

Baker, M. B., Jr. 1986. Effects of Ponderosa Pine Treatments on Water Yield in Arizona. Water Resour. Res. 22(1):67-73.

Bentz, B. J., J. Régnière, C. J. Fettig, E. M. Hansen, J. L. Hayes, J. A. Hicke, R. G. Kelsey, J. F. Negrón, and S. J. Seybold. 2010. Climate Change and Bark Beetles of the Western United States and Canada: Direct and Indirect Effects. Bioscience 60(8):602-613.

Bull, E. L., and J. E. Hohmann. 1994. Breeding biology of northern goshawks in northeastern Oregon. The Northern Goshawk: Ecology and Management, Studies in Avian Biology(16):103-105.

Chambers, C. L., and J. N. Mast. 2005. Ponderosa pine snag dynamics and cavity excavation following wildfire in northern Arizona. Forest Ecology and Management 216(1–3):227-240.

Cooper, C. F. 1960. Changes in Vegetation, Structure, and Growth of Southwestern Pine Forests since White Settlement. *Ecology* 42:493-499.

Covington, W. W., and M. M. Moore. 1994. Southwestern Ponderosa Forest Structure: Changes since Euro-American Settlement. *Journal of Forestry* 92(1):39-47.

Dominguez, F., J. Cañon, and J. Valdes. 2010. IPCC-AR4 climate simulations for the Southwestern US: the importance of future ENSO projections. Climatic Change 99(3):499-514.

ENMRD Forestry Division. 2010. *New Mexico Statewide Natural Resource Assessment & Strategy and Response Plans*. State of New Mexico, Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM.

Essery, R., J. Pomeroy, J. Parviainen, and P. Storck. 2003. Sublimation of Snow from Coniferous Forests in a Climate Model. Journal of Climate 16(11):1855-1864.

Ffolliott, P. F., and D. B. Thorud. 1977. Water resources and multiple-use forestry in the Southwest. Journal of Forestry 75(8):469-472.

Fiedler, C. E., and C. E. Keegan. 2003. Reducing crown fire hazard in fire-adapted forests of New Mexico. Pages 39-48 in P. N. Omi and L. A. Joyce, editors. Fire, Fuel Treatments, and Ecological Restoration. USDA Forest Service, Fort Collins, CO.

Forest Ecosystem Restoration Analysis (ForestERA) Team. 2007. Multi-Jurisdictional Application of ForestERA Landscape Decision Support Tools in North-Central New Mexico: Final Report to the Joint Fire Science Program, Project ID: 04-2-1-27. Northern Arizona University, Flagstaff, AZ.

Fulé, P. Z. 2008. Does It Make Sense to Restore Wildland Fire in Changing Climate? Restoration Ecology 16(4):526-531.

Harmon, M. E., W. K. Ferrell, and J. F. Franklin. 1990. Effects on carbon storage of conversion of old-growth forests to young forests. Science 247:699-702.

Humes, M. L., J. P. Hayes, and M. W. Collopy. 1999. Bat Activity in Thinned, Unthinned, and Old-Growth Forests in Western Oregon. The Journal of Wildlife Management 63(2):553-561.

Hunter, M. E., W. D. Shepperd, J. E. Lentile, J. E. Lundquist, M. G. Andreu, J. L. Butler, and F. W. Smith. 2007. A comprehensive guide to fuels treatment practices for ponderosa pine in the Black Hills, Colorado Front Range, and Southwest. RMRS-GTR-198, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Eds. R.K. Pachauri and A. Reisinger., Geneva, Switzerland.

Kaye, J. P., S. C. Hart, R. C. Cobb, and J. E. Stone. 1999. Water and Nutrient Outflow Following the Ecological Restoration of a Ponderosa Pine-Bunchgrass Ecosystem. Restoration Ecology 7(3):252-261.

Kolanoski, K.M. 2002. Genetic variation of ponderosa pine in northern Arizona: Implications for restoration. MSc thesis, Northern Arizona Univ., Flagstaff, AZ. 148 p.

Lynch, D. L., W. H. Romme, and M. E. Floyd. 2000. Forest Restoration in Southwestern Ponderosa Pine. *Journal of Forestry* 98(8):17-24.

Millar, C., N. Stephenson, and S. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. Ecological Applications 17(8):2145–2151.

Moore, M. M., D. W. Huffman, P. Z. Fulé, W. W. Covington, and J. E. Crouse. 2004. Comparison of Historical and Contemporary Forest Structure and Composition on Permanent Plots in Southwestern Ponderosa Pine Forests. Forest Science 50(2):162-176.

Romme, W. H., M. L. Floyd, and D. Hanna. 2009. *Historical Range of Variability and Current Landscape Condition Analysis: South Central Highlands Section, Southwestern Colorado & Northwestern New Mexico*. Colorado Forest Restoration Institute at Colorado State University and USDA Forest Service, Fort Collins, CO.

Westerling, A., and B. Bryant. 2008. Climate change and wildfire in California. Climatic Change 87(0):231-249.

Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam. 2006. Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity. Science 313(5789):940-943.

Williams, A. P., C. D. Allen, C. I. Millar, T. W. Swetnam, J. Michaelsen, C. J. Still, and S. W. Leavitt. 2010. Forest responses to increasing aridity and warmth in the southwestern United States. Proceedings of the National Academy of Sciences 107(50):21289-21294.

Woods, S. W., R. Ahl, J. Sappington, and W. McCaughey. 2006. Snow accumulation in thinned lodgepole pine stands, Montana, USA. Forest Ecology and Management 235(1-3):202-211.

Youtz, J. A., R. T. Graham, R. T. Reynolds, and J. Simon. 2008. Implementing northern goshawk habitat management in southwestern forests: A template for restoring fire-adapted forest ecosystems. Pages 173-191 *in* Integrated restoration of forested ecosystems to achieve multiresource benefits. PNW-GTR-733. USDA Forest Service, Pacific Northwest Research Station, Portland, OR