NORTHERN ARIZONA UNIVERSITY

Ecological Restoration Institute

ERI Publications ~ Spring 2012

White Paper

Combrink, T., W. Fox, and J. Petersen. 2012. Workforce Needs of the Four Forest Restoration Initiative Project: An Analysis. Ecological Restoration Institute, Northern Arizona University. *ERI–Issues in Forest Restoration*, 19p.

This ERI white paper examines the size, skill sets, and current capacity of the public and private workforce needed to implement the restoration work envisioned for the 750,000-acre Four Forest Restoration Initiative (4FRI) Project. Using information from the U.S. Forest Service and private sector sources, researchers from the Arizona Rural Policy Institute (ARPI) reached a number of conclusions. In terms of the public sector, which will be made up of U.S. Forest Service personnel, there will be a need for roughly 69 individuals who will perform a variety of functions related to treatment preparation and administration. For the most part, the required positions are already in place and the existing personnel are generally adequate to meet the annual needs of the 4FRI. Meanwhile, the private sector workforce will fill the on-site and labor needs of the project – mobilizing, cutting, skidding, delimbing, slashing, loading, and other jobs. These jobs can be filled by numerous local, regional, and, in some cases, out-of-state employers. The results of the ARPI research indicate that 422 full-time equivalent (FTE) employees, of which 300 FTEs will be new FTEs, to meet the annual treatment goals. Follow this link to a complementary ERI fact sheet.

Ecological Research

Abella, S.A., E.C. Engel, J.D. Springer, and W.W. Covington. 2012. Relationships of Exotic Plant Communities with Native Vegetation, Environmental Factors, Disturbance, and Landscape Ecosystems of Pinus Ponderosa Forests, USA. *Forest Ecology and Management* 271:65-74.

The research objectives for this study were to: 1) assess relationships between native and exotic species richness and cover; 2) evaluate relationships of environmental, disturbance, and native vegetation variables with exotic plant community distributions across the landscape; and 3) compare exotic species richness, cover, and composition among landscape ecosystems. To do so, these researchers studied plant communities in ten ecosystem types occurring within ponderosa pine (*Pinus ponderosa*) forests. These types included black and red cinders; clay, mesic, rocky, and xeric basalt; and mesic and xeric limestone as well as aspen (*Populus tremuloides*) and park-like systems across a 271,816-acre forested landscape in northern Arizona. They found that exotic species richness, cover, and community composition were strongly related to the ecosystem classification. They also found that moist ecosystems were more likely to be invaded by exotics than drier, less productive ecosystems. There was a stronger relationship between exotic species and disturbance than with native vegetation and environmental factors.

Bickford, I.N, P.Z. Fulé, and T.E. Kolb. 2011. Growth Sensitivity to Drought of Co-occurring Pinus spp. along an Elevation Gradient in Northern Mexico. *Western North American Naturalist*, 71(3):338-348.

Working in the mountains of Chihuahua, Mexico, these researchers conducted comparisons of Apache pine (*Pinus engelmannii*) and Lumholtz pine (*P. lumholtzii*) to understand whether their growth is sensitive to drought and temperature variation, and how sensitivity differs between these tree species and elevations. Their results suggest that the increasing frequency and severity of drought predicted for this region in the coming decades will reduce the growth of both species, with greater impacts on low-elevation populations and on Apache pine.

Fulé, P.Z., J.E. Crouse, J.P. Roccaforte, and E.L. Kalies. 2012. Do Thinning and/or Burning Treatments in Western USA Ponderosa or Jeffrey Pine-Dominated Forests Help Restore Natural Fire Behavior? *Forest Ecology and Management* 269:68-81.

These researchers carried out a systematic review and meta-analysis of the effects of forest thinning and burning treatments on restoring fire behavior attributes in frequent-fire pine forests dominated by either ponderosa pine (*Pinus ponderosa*) or Jeffrey pine (*P. jeffreyi*), and co-occurring species. They found 54 studies with quantitative data suitable for meta-analysis. After reviewing the findings of these studies, the researchers found that combined treatments (thinning + burning) tended to have the greatest effect on reducing surface fuels and stand density, and raising modeled crowning and torching indices, as compared to burning or thinning alone. While there are a number of qualifications to the findings, overall, the meta-analysis of the literature reviewed strongly indicates that thinning and/or burning treatments do have effects consistent with the restoration of low-severity fire behavior. Follow this link to a complementary ERI fact sheet.

Huffman, D.W., J.E. Crouse, W.W. Chancellor, and P.Z. Fulé. 2012. Influence of Time Since Fire on Pinyon-Juniper Woodland Structure. *Forest Ecology and Management*

274:29-37.

In this study, ERI and NAU researchers used a chronosequence of fire sites to examine the development and long-term changes in tree density, seedlings, snags, logs, and shrubs after stand-replacing wildfire in pinyon-juniper woodlands. Although these individual features showed different long-term patterns, the researchers found that woodlands tended to increase in overall structural complexity with time. Using information from this study, managers can evaluate current characteristics of woodland sites and predict possible future trends in development. In addition, management treatments can be formulated to accomplish various goals (e.g., reducing hazardous fuel loads, enhancing wildlife habitat, or restoring degraded woodland sites) while better emulating the effects of natural disturbance in terms of important structural qualities.

Hurteau, M.D., M.T. Stoddard, and P.Z. Fulé. 2011. The Carbon Costs of Mitigating High-severity Wildfire in Southwestern Ponderosa Pine. *Global Change Biology* 17:1516-1521.

The goals of this study were to 1) determine if current aboveground forest carbon stocks in fire-excluded southwestern ponderosa pine forest are higher than pre-fire exclusion carbon stocks reconstructed from 1876, 2) quantify the carbon costs of thinning treatments to reduce high-severity wildfire risk, and 3) compare post-treatment (thinning and burning) carbon stocks with reconstructed 1876 carbon stocks. These researchers found that the current fire-excluded forest structure contained, on average, 2.3 times as much live tree carbon as pre-fire exclusion forests. However, they also note that that fire-excluded forests are increasingly prone to carbon losses due to wildfire and that managers will have to have to consider the trade-offs between carbon stock size and carbon stock stability when they review their forest management plans. Follow this link to a complementary ERI fact sheet.

Kalies, E.L., B.G. Dickson, C.L. Chambers, and W.W. Covington. 2012. Community Occupancy Responses of Small Mammals to Restoration Treatments in Ponderosa Pine Forests, Northern Arizona, USA. *Ecological Applications* 22(1):204–217.

From 2006 through 2009, these researchers trapped eight small mammal species at 294 sites in northern Arizona and used occupancy modeling to determine their responses to thinning and habitat features. The researchers found that understory vegetation cover, large snags, and treatment were the most important variables for predicting small mammal occupancy. They identified two generalist species at relatively high occupancy rates across all sites, four open-forest species that responded positively to treatment, and two dense-forest species that responded negatively to treatment unless specific habitat features (e.g., snags, large trees) were retained. Their results indicate that all eight small mammal species can benefit from restoration treatments, particularly if aspects of their evolutionary environment (e.g., large trees, snags, woody debris) are restored. Finally, they recommend using the occupancy model approach when assessing the impacts of treatments or habitat alteration on wildlife species. Follow this link to a complementary ERI working paper.

Korb, J.E., P.Z. Fulé, and M.L. Stoddard. 2012. Forest Restoration in a Surface Fire-Dependent Ecosystem: An Example from a Mixed Conifer Forest, Southwestern Colorado, USA. *Forest Ecology and Management* 269:10-18.

These researchers conducted a replicated plot experiment to test the effects of restoration treatments (thin/burn, burn only, control) on forest structure in the warm/dry mixed conifer forests of southwestern Colorado. They found no significant changes in the control and burn only treatments for tree density, basal area, canopy cover, and tree regeneration. Meanwhile, the thin/burn treatment produced significant changes in terms of decreased tree density, principally white fir (*Abies concolor*) and Douglas-fir (*Psuedotsuga menziesii*); lower tree canopy cover; diminished basal area, primarily from white fir; increased aspen (*Populus tremuloides*) tree regeneration; and decreased white fir regeneration. Overstory trees that died tended to be younger, shorter, and/or smaller in diameter. Thin/burn treatments moved warm/dry mixed conifer forests rapidly along the trajectory toward historical reference conditions by altering forest composition and structure. Burn only treatments were less effective, but also less costly.

Laughlin, D.C., J.P. Roccaforte and P.Z. Fulé. 2011. Effects of a Second-entry Prescribed Fire in a Mixed Conifer Forest. *Western North American Naturalist* 71(4):557-562.

At Grand Canyon National Park, these researchers analyzed the effects of a second-entry prescribed fire in a mixed conifer forest. They found that the surface fire had little effect on large ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Psuedotsuga menziesii*) and white fir (*Abies concolor*) trees, and did not change total tree density or basal area. The fire reduced the overall density of small (< 12") conifer seedlings by 87%, but had a smaller effect on taller seedlings and on sapling density. The fire reduced litter depths by 33%, duff depths by 23%, fine woody debris by 21%, and coarse woody debris by 44%. These effects were generally consistent with the park managers' restoration goals in mixed conifer forests and continue to move this forest toward reference conditions.

Laughlin, D.C., P.Z. Fule, D.W. Huffman, J. Crouse, and E. Laliberte. 2011. Climatic Constraints on Trait-based Forest Assembly. *Journal of Ecology* 99(6):1489-1499.

Predicted changes in climate will likely affect future plant community assemblages. These researchers evaluated the usefulness of the maximum entropy (MaxEnt) model for assessing changes in forest communities occurring along a 53.6 degree F gradient of mean annual temperature. They then used independent cross-validation to evaluate model predictions from sites where trait constraints are predicted from environmental conditions. They found that the model performs moderately well in predicting forest community structure using empirical trait–environment relationships. However, they also noted that it required many traits to achieve good fits, and three orthogonal axes of trait variation performed poorly as predictors of community structure. To be useful predictors, traits must vary strongly among species and community-weighted mean traits must vary predictably along environmental gradients.

Loberger, C.D., T.C. Theimer, S.S. Rosenstock, and C.S. Wightman. 2011. Use of a Restoration-treated Ponderosa Pine Forest by Tassel-eared Squirrels. *Journal of Mammalogy* 92(5)1021-1027.

The tassel-eared squirrel (*Sciurus aberti*) is dependent on ponderosa pine (*Pinus ponderosa*) for food and cover, and is likely affected by management treatments intended to restore currently dense ponderosa pine forests. These wildlife researchers used radiotelemetry to determine how restoration treatments affected habitat use by tassel-eared squirrels. Their results suggest retaining some denser, untreated patches and treated areas with canopy cover of 51–75% because tassel-eared squirrels specifically use such areas as winter habitat.

McGlone, C.M., C.H. Sieg, and T.E. Kolb. 2011. Invasion Resistance and Persistence: Established Plants Win, Even with Disturbance and High Propagule Pressure. *Biological Invasions* 13:291-304.

These researchers conducted a study in a southwestern ponderosa pine (*Pinus ponderosa*)/bunchgrass system to determine the susceptibility of remnant native plant communities to cheatgrass (*Bromus tectorum*) invasion, and the persistence of cheatgrass in invaded areas. Their results suggest that two factors dictated the persistence of the resident communities: 1) the competitiveness of mature, native vegetation, especially bottlebrush squirreltail (*Elymus elymoides*) when it is dominant on a site; and 2) the pre-treatment levels of plant-available nitrogen and phosphorus in the soil because annual species typically require higher levels of plant-available soil nutrients than perennial plants. The study shows that established plants and lower level of soil nutrients can buffer the influences of disturbance and high numbers of cheatgrass seed.

Roccaforte, J.P., P.Z. Fulé, W.W. Chancellor, and D.C. Laughlin. 2012. Woody Debris and Tree Regeneration Dynamics Following Severe Wildfires in Arizona Ponderosa Pine Forests. *Canadian Journal of Forest Research* 42:593-604.

To investigate post-fire woody debris and regeneration dynamics, these researchers studied severe fire areas in Arizona, spanning a timeframe from 1 to 18 years after burning. They found that snag densities varied over time, with predominantly whole snags in recent fires and broken or fallen snags in older fires. Coarse woody debris peaked between 6 and 12 years after fire, and at a value higher than previously reported in post-fire fuel assessments in this region, although after 12 years the amount of debris loadings were within the range of recommended management values. Sprouting deciduous species (e.g., oaks, aspen) experienced high levels of regeneration and commonly dominated the overstory. Ponderosa pine (*Pinus ponderosa*), on the other hand, failed to regenerate on

57% of the sites. This indicates that many post-wildfire sites are likely to change to shrublands or grasslands rather than returning rapidly to pine forest. While these researchers indicate that more time is needed to see whether these patterns will remain stable, they feel that there are substantial obstacles to pine forest recovery including competition from sprouting woody species and (or) grasses, lack of seed sources, and the forecast of warmer, drier climatic conditions for coming decades. Follow this link to a complementary ERI fact sheet.

Stoddard, M.T., C.M. McGlone, P.Z. Fulé, D.C. Laughlin, and M.L. Daniels. 2011. Native Plants Dominate Understory Vegetation Following Ponderosa Pine Forest Restoration Treatments. *Western North American Naturalist* 71(2):206-214.

Using three stand-scale replicates, these researchers examined understory community composition, species richness, and plant cover responses to four different tree-thinning intensities—1) thinning to 1.5-3 trees per historic evidence per acre, 2) thinning to 2-4 trees per historic evidence per acre, 3) thinning to 3-6 trees per historic evidence per acre, and 4) no thinning . They found that the restoration treatments altered the composition of the understory community regardless of thinning intensity, and, while the results were highly variable among the replicates, they observed strong trends of increasing richness and cover in the treated stands. Initially non-native species cover comprised 6% of the total cover where treatment-induced disturbances were the greatest, but that initial increase did not persist and was 3% six years after treatment.

Wu, T., Y.-S. Kim, and M.D. Hurteau. 2011. Investing in Natural Capital: Using Economic Incentives to Overcome Barriers to Forest Restoration. *Restoration Ecology* 19:441-445.

In an opinion piece, these authors contend that despite an increase in resources and attention, the persistence of economic impediments has forestalled the successful expansion of forest restoration to a landscape level. They make the case that a failure to properly account for the full range of costs and benefits from restoration treatments has contributed to the asymmetry between needed action and actual implementation. They argue that the valuation of non-market ecosystem services, such as carbon sequestration, along with the ability of ecological restoration to act as an agent of economic stimulus, should be incorporated into the policymaking process. Follow this link to a complementary ERI fact sheet.

Fact Sheets

Egan, D. 2011. Fact Sheet: Systematic Reviews and the Quality of Evidence. Ecological Restoration Institute, Northern Arizona University, 4p.

Federal land management policies direct agencies to use “the best available science” to inform agency decisions. However, reactions to the term “best available science” sometimes lead to assertions that the quality of such science is a matter of opinion. How then do managers evaluate and select scientific information that is defensible and supportive of management policies and decisions as well as environmental assessments? This is especially important for restoration and forest management projects at larger spatial scales where field experiments are too costly and/or slow to produce needed results. Recently, conservation science has begun employing a rigorous analytical approach, known as a *systematic review*, for evaluating the existing scientific information and then informing managers about treatment options. This ERI fact sheet examines how systematic reviews work and how the ERI intends to use them.

Greer, W.J. 2012. Fact Sheet: Managing Sources of Conflict in Collaborative Settings. Ecological Restoration Institute, Northern Arizona University, 2 p.

Anyone who has been involved in a collaborative process knows that a conflict within the group typically involves multiple participants, can be complex, and can intensify dramatically, if left unresolved. In this ERI fact sheet, Windy Greer examines issues vital to avoiding and resolving conflicts in a collaborative group. She examines topics such as self-awareness, the importance of self-evaluation, sources of conflict (i.e., competition, domination, miscommunication, misunderstandings, and injury). Windy concludes that knowing how to manage or resolve conflict is a big part of succeeding at collaboration, and maintaining respectful relationships and that managing conflict productively is a skill that requires constant practice. Using some of the basic skills and information discussed in this fact sheet, stakeholders can begin to understand what they can do to turn a seemingly negative situation into a positive one--one that allows the collaborative to move forward toward its common goals.

Stoddard, M.T. 2011. Fact Sheet: Historical Forest Structural Characteristics Review. Ecological Restoration Institute, Northern Arizona University, 7p.

This ERI fact sheet provides pre-EuroAmerican settlement overstory structural reference conditions (i.e., tree density and basal area) for pinyon-juniper, ponderosa pine, ponderosa pine-oak, aspen, and mixed conifer forests across the southern Colorado Plateau. It is intended to help managers visualize and describe what the forest structure looked like before frequent surface fires were disrupted in the areas they now manage. This reference information should also serve as an aid in making informed decisions that are consistent with the evolutionary range of variability associated with individual forest types.

Vosick, D. 2011. Fact Sheet: Lessons from the Wallow Fire. Ecological Restoration Institute, Northern Arizona University, 1 p.

Diane Vosick outlines six lessons learned from the 2011 Wallow Fire, which consumed more than 840 square miles of forested land in eastern Arizona and western New Mexico.

Her main points are: 1) the size of such fires requires immediate action; 2) these fires are destroying critical wildlife habitat, including that of the Mexican spotted owl (*Strix occidentalis lucida*); 3) WUI treatments worked as designed; 4) small restoration treatments can withstand a high-intensity wildfire; 5) mixed conifer forests need our attention; and 6) the real costs of fires, such as the Wallow Fire, are extremely high and detrimental to society and the environment.

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