Restoration Objectives for the 4 Major Forest Ecosystems in New Mexico
(from Short Guide for Developing CFRP Restoration Prescriptions by Melissa Savage, et al , New Mexico Forest Restoration Series Working Paper1, January 2008**)**

Ponderosa Pine Forest

Ponderosa pine forests in the Southwest have become too dense with small trees over the last century because of overgrazing by livestock, suppression of cool surface fires, and logging of the largest trees. Meadows that in the past were scattered throughout the forest have become filled with young trees that have moved in from the forest edge. The forest floor is now covered with
a layer of dead pine needles instead of grasses and other plants. Dead standing trees, especially large ones, are not as numerous as they once were.

Some recommendations for developing an ecological prescription for ponderosa pine forests are
as follows:

• *Remove small trees and keep the larger trees.* The New Mexico Restoration Principles recommend that forest restoration objectives favor the presence of both abundant large diameter trees and an appropriate distribution of age classes on the landscape, with a wide
distribution of older trees. It is generally advisable to maintain ponderosa trees larger than 16 inches DBH (diameter at breast height) and other trees with old-growth morphology (such as yellow-barked ponderosa pine or any species with large dropping limbs, twisted trunks, or flattened tops), regardless of size.1

• *Incorporate prescribed fire into the prescription.* Cool surface fires were part of the history
of almost all ponderosa pine forests in the region. Without these fires a thinned forest will soon revert to a dense, crown-fire-prone stand, perhaps in less than ten years. In the best case, lightning will start natural cool fires often enough to keep fuel load down. These natural ignitions will benefit the forest if they are carefully managed. Otherwise, land managers will need to burn the forest periodically with a prescribed fire.

• *Develop density and basal area targets that reflect local site history.* For example, adult tree density from 40 to 100 trees per acre is probably appropriate on most ponderosa pine sites in the Southwest. You can typically vary density across a project site, with lower density on ridges or near roads, and higher density in areas of wildlife concern, such as goshawk nesting habitat.

• *Create clumps of trees—perhaps 6 to 12 mature trees together—throughout the site to benefit wildlife.* Tree crowns should touch or nearly touch within clumps, but be isolated from tree crowns outside the clump. Aim for two to three or more clumps per acre. Tree clumps are at less risk of crown fire if surrounded by areas of lower tree density.

• *Foster the growth of an understory.* For the most part, the understory will recover on its own, when there is more sunlight and water available after thinning. Leaving some of the branches from thinning treatments strewn on the ground will help understory plants reestablish.

Spreading slash on the ground before a prescribed burn rather than piling and burning may also help. Intense heat from burning piled slash can kill seeds in the soil beneath slash

piles. Consider collecting seed from adjacent forest for use on the restored project.
• *Avoid reseeding.* Even native seed mixes are usually contaminated by weedy species. Most sites have enough native plants to naturally reseed the site.
• *Reduce surface fuels.* The majority of fuels in most ponderosa pine stands are small, living
trees. Thinning treatments will produce large amounts of dangerous fuels from these trees, which must be removed from the site to prevent a hot fire. Cut wood may be

1The New Mexico Restoration Principles: http://www.fs.fed.us/r3/spf/nm-restor-principles-122006.pdf
removed for wood products, firewood, or composting materials. Every last bit of slash need not be removed; leaving some slash is valuable for protecting soils, fostering understory,
and providing wildlife habitat. But enough must be removed to allow a cool fire that does not rise to the canopy. Removing slash greater than four inches in diameter also reduces the likelihood of attracting bark beetles to the stand.
• *Rake away needles from base of large old trees.* Pulling thick pine needle mats and branches three feet away from the base of large tree trunks can protect trees from firecaused
mortality. In general, you probably need to do this only before the first fire.
• *When possible, close small unused dirt roads that are eroding.* Many of these roads will erode into gullies without an understory cover. Eroding roads may need rehabilitation, such as trenches to guide storm water off the road, or branches strewn on the surface to assist revegetation.
• *Preserve large snags for wildlife use.* Lightning, insect mortality, and prescribed burns will create new snags in the future.
• *Incorporate cutting treatments that consider the needs of wildlife.* Include some areas of higher tree density for habitat and travel corridors, and protect tree and shrub clumps. Where appropriate, consult guidelines that protect habitat for Northern goshawks.
For more information on ponderosa pine forest restoration go to:
• http://www.eri.nau.edu/joomla/content/category/5/32/134/

• http://www.nmhu.edu/nmfwri/pdf/prescriptions%20combined.pdf

For information on Northern goshawk habitat restoration guidelines go to:
• http://fsweb.r3.fs.fed.us/for/silviculture/goshawk.html

For more information on bark beetles go to:
• http://www/fs/fed/us/r3/resources/health/beetle/index/html

Piñon-Juniper Forests
Piñon-juniper forests in the Southwest are more diverse than ponderosa pine forests in structure
and fire history. In general, there are three broad categories of piñonjuniper ecosystems: savannas, shrublands, and persistent woodlands.

Piñon-juniper or juniper savannas are usually found on low hills or valleys with deep soils, where precipitation comes mostly during summer monsoons. Savannas have low tree densities because of limited water or because cool fires burn through them frequently.
There is some debate on types and frequencies of fire in piñon-juniper savannas.
Piñon-juniper shrublands have higher densities of trees than savannas, although densities vary from scattered trees with a thick understory to dense trees with a sparse understory. Shrubland trees tend to be short with multiple stems. Although there is debate, the current consensus is that shrublands historically experienced moderately frequent, mixed-severity fires which were carried by trees and shrubs. These fires were often patchy, burning some clumps within a stand.
Piñon-juniper persistent woodlands tend to have older and denser trees within them. Fires are less frequent in persistent woodlands, and these woodlands may be relatively stable for 100 to 1000 years. When fires burn through persistent woodlands they tend to be large, severe fires that kill many trees and start the growth of a new stand. Persistent woodlands usually grow on rugged upland sites with rocky soil.
Recommendations for developing an ecological prescription for piñon-juniper ecosystems include:
• *Restoration of piñon-juniper should try to identify the type of ecosystem – savanna or shrubland – and use the ecosystem type to guide the prescription.* You may identify the ecosystem type with assistance from land managers, university staff, or New Mexico State Forestry. Soil erosion and site degradation can justify proactive management in savannas and shrublands – even where it is difficult to show that densities have changed.
• *No restoration treatments should occur in persistent woodlands.* Since persistent piñon
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juniper woodlands likely experience high-intensity fires only infrequently, they probably do not need restoration to a past condition. Fuel reduction treatments may be appropriate in order to protect structures and communities from the occasional hot fires that burn naturally in this type of woodland.
• *In savannas, reintroduce low intensity fires.* If there are large areas of bare soil, you may
need to lop and scatter slash in order for the fire to carry through the stand. In time, understory plants will recover sufficiently to carry cool fires across the surface.
• *In shrublands, thin trees and distribute the slash on the ground to help protect soil and encourage grass and shrub growth.*
• *Plan for follow-up treatments in sites with juniper.* Some juniper species, such as alligator
juniper, resprout from the stump after being cut. You will need to follow initial treatments
with prescribed fire or additional thinnings.
• *Preserve large snags for wildlife.*

For more information on piñon-juniper forests restoration go to:
• http://www.fs.fed.us/rm/sd/pinyonjuniper.pdf

• http://www.forestguild.org/rg_sw_pinon_juniper.html

• http://ag.arizona.edu/OALS/watershed/highlands/pinyonjuniper/pjtreatments.html

• http://www.werc.usgs.gov/fire/lv/pj/lakemead/

For more information on how to determine the type of piñon-juniper forest on a site, go to:
• http://www.cfri.colostate.edu/docs/P-J_disturbance_regimes_short%20synthesis_5-07.pdf

Southwestern Mixed Conifer Forest

In contrast with other forest types, there is less certainty about the structures of mixed conifer forest in the past, making it more difficult to develop prescription targets. Mixed conifer forests contain a variety of tree species generally at elevations between 8,000-10,000 feet. The most common tree species include Douglas-fir, white fir, blue spruce, and aspen. Other tree species include Engelmann spruce, subalpine fir, ponderosa pine, limber pine, Southwestern white pine, and Gambel oak.

Current scientific research suggests that the structure and species in Southwestern mixed conifer forests have changed greatly over the last century. Many mixed conifer stands now appear to be much denser than they were historically. In some cases, fire suppression has led to an unnatural increase in white fir, which is susceptible to fire. In the past, fires in mixed conifer forests occurred less frequently than in ponderosa pine forests, on the order of several decades. Fires in mixed conifer forests varied in severity from low-intensity fires to patchy crown fires in small areas. Drier stands of mixed-conifer – those that are dominated by ponderosa pine and Douglas-fir – are more likely to need restoration than wetter and higher stands – those dominated by spruce and large white fir.

Some recommendations for developing an ecological prescription for mixed conifer forests include:

• *Develop a site specific thinning treatment.* Because there are many tree species in mixed conifer forests, there are a wide variety of appropriate thinning treatments. Individual tree, group, or patch thinning systems can encourage regeneration of tree species that are fire tolerant. You may need to create large open areas in order to help shade intolerant species grow into the canopy. For example, Douglas-fir seedlings require full sunlight to flourish.

• *Thin dense trees.* You should thin dense mixed conifer forests to a level safe for cool fires. Current tree densities require thinning in order to allow safe prescribed or managed natural fires.

• *Re-establish low intensity fires.* In many areas, particularly those with high fuel loads, an

early spring prescribed burn, when the site is still wet, is most appropriate. Prescribed fire may also be effective in the fall when coarse woody material is still moist from the rainy season.

• *Reduce unnatural high densities of white fir.* Many mixed conifer stands currently have large numbers of small white fir. In many mixed conifer forests, white fir has established in densities that are historically unnatural. Since white fir can grow to large sizes quickly, it may also be appropriate to remove some larger diameter white fir.

• *Encourage aspen trees where groups exist.* Aspen trees needs light to regenerate, so you should remove most if not all other trees from an aspen patch. Keep cows, deer, and elk away
from regenerating aspen by constructing fences or enclosing an area with tall brush piles.

• *Preserve large snags for wildlife.*

For more information on mixed conifer forest restoration go to:

• http://www.forestguild.org/rg_sw_mixed_conifer.html

• http://www.forestguild.org/rg_sw_aspen.html

• http://www.cfri.colostate.edu/docs/aspen_change.pdf

• http://www.ncrs.fs.fed.us/gla/reports/ecology-mgt-aspen.pdf

• http://www.cpluhna.nau.edu/Biota/mixedconifer.htm

• http://ag.arizona.edu/OALS/watershed/highlands/mixedconifer/mcmanagement.html

For a case study of a mixed conifer case study, visit New Mexico Forest & Watershed Restoration
Institute's website:

• http://www.nmhu.edu/nmfwri/managers.html

Bosque Forest

Southwestern streams and rivers have unique ecosystems along their banks called bosques. In the past, bosques included cottonwood stands, dense young willow and native olive patches, and wetland areas with rushes and cattails. This mosaic of vegetation was home to a diverse group of animals and birds. Most lowland streamside communities are now highly dense stands of invasive trees such as tamarisk, Russian olive and Siberian elm trees. When these non-native trees invade bosques, they reduce diversity, increase fire danger, and use more water than native
vegetation.

Other problems in bosques include lowered water tables and increases in woody fuels on the ground. The dense thickets of invasive plants and woody debris are of special concern because they have increased the risk of crown fire in bosques. These fires burn with high intensity under current conditions, and cause widespread mortality of all trees in the bosque, including large cottonwood trees. Historically, fires were not a natural part of the bosque ecosystem, and prescribed fires are not considered appropriate in this forest type.

Some recommendations for developing an ecological prescription for bosque forests include:

• *Remove invasive species.* Cut and remove invasive non-native species such as tamarisk, Siberian elm, and Russian olive trees. You will need to use follow up treatments with hand-pulling or conservative use of safe herbicides to prevent these invasive trees from reestablishing at the site.

• *Remove large amounts of dead, down wood.* You should eliminate large pieces of wood by removing them from the site, by using a chipper, or by piling and burning. A hydro-ax or Fecon head machinery allows you to chunk trees into varying sizes.

• *Restore natural river flow and flooding.* When restoring natural river flow is not possible, you may provide artificial water flow by diverting irrigation channels.

• *Replant native species if needed, including cottonwood trees, willows, New Mexico olive, and other species.*

For more information on bosque forest restoration go to:

• http://www.forestguild.org/rg_sw_bosque.html

• http://www.nm.nrcs.usda.gov/technical/tech-otes/pmc.html

• http://nmdaweb.nmsu.edu/animal-and-plant-protection/tamarisksaltcedar/NM%20Tamarisk-Watershed%20Plan.html/