Piñon-Juniper Restoration Protocols

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Forward

Rather than an Introduction, I am leading off with a Forward, a more personal set of observations. These observations are associated with three statements: Our information is incomplete. We can not remain paralyzed by our ignorance. And, what do you want?

I will start with the last statement, the question. The approach that I took in compiling these protocols is based on my years consulting, both with individual landowners in the US and with limited–resource communities in developing countries. The main question for these folks is "What do you want?" What do you want the landscape to look like in X years? Because trade-offs are always present – an off-the-grid house on private land in the middle of an otherwise wild area may be desired, but wildlife habitat will be changed as a result – you need to decide for yourself what you want. As a responsible land manager, you try to think of everything, weigh your options, and move forward. Good land management can give positive results for several things at once, but we may not be "restoring" historic reference conditions in the process.

We are going to need to take a similar approach with areas where no clear consensus exists on what constitutes restoration of piñon-juniper (PJ) woodland. We will have to ask "What do we want?", and do treatments that we think will get us there. (Tausch and others (2009) do an excellent job of expanding the one question into multiple questions to be addressed, albeit for Great Basin PJ).

This willingness to proceed provides an opportunity to move forward to a consensus. It also demonstrates how the other two statements – incomplete information and not being paralyzed – are intertwined. If our questions were easy, they already would have been answered. Does restoring what we think was the historic open woodland really bring back the full ecological function of a PJ-dominated landscape? If a treatment does restore function in one of the five PJ types (see below), for instance, a summer-dominated-precipitation site, does the same prescription also restore function on a winter-dominated-precipitation site? And what do we mean by "full ecological function"?

We won't know the answers unless we monitor; even then, because PJ is so elastic, we won't know the answer for all PJ types by looking at a project in just one type. And we won't be even reasonably sure of the answer until we compile the monitoring from a lot of different treatments in a lot of different projects within the same type. So as you implement treatments, pay attention to your results, and share them with your peers. Formal presentations to groups will deliver a message to a lot of people very quickly, but conversations with neighbors over coffee might be less stressful.

A word about the different types: One of the big challenges with PJ is the need to define what is meant by PJ. The first reaction when someone says "PJ" is to think of the PJ where you spend most of your time. The key accompanying this report breaks PJ into five different types, and this

key was developed by a lumper, not a splitter. It can easily be divided further to separate both PJ-savanna and Juniper-savanna, and both sagebrush-PJ and oak-PJ. And to be clear, this document is intended for use in New Mexico, and does not include PJ-dominated plant communities in other areas, such as in Texas or the Great Basin.

Another way of looking at the diversity in PJ is the Plant Association framework. Plant associations are used to determine what species composition and productivity can be maintained on a site. The Forest Service recognizes 32 distinct plant association dominated by piñon or juniper in New Mexico (USFS 1997). Together with explicit considerations of climate and soils, they inform the Terrestrial Ecosystem Survey. The TES is a system to classify ecosystem types and map ecological units at different spatial scales, and with even more detailed separations; indeed, the TES distinguishes approximately 200 different unit sub-classes that have a dominant vegetative class including piñon and juniper. An introduction to TES can be accessed at https://www.fs.fed.us/soils/teui.shtml. Both plant associations and the TES are valuable ecological tools, and in the future, as we learn more about the way PJ reacts to restoration treatments, they may be used to fine-tune restoration prescriptions. They also point to the fact that blanket prescriptions for tree reduction in PJ could reduce the current range of variability present in New Mexico woodlands (Landis and Bailey 2005). For the time being, however, FWRI is recommending different prescriptions for restoring only six different PJ types.

How to Use These Guidelines

These guidelines are built on earlier collaborative work in New Mexico. Specifically, Public Service Company of New Mexico (PNM) assembled a stakeholder group in about 2005 to develop a consensus on NM forest restoration principles. That group agreed on principles for ponderosa pine and mixed conifer, but the principles for PJ never got beyond the draft stage. The draft contained an excellent review of what was known about thinning treatments in PJ. It also identified the five distinct PJ types that are used here, although the key in that draft did not match their five types. The foundation document (the DRAFT Piñon-Juniper Framework – New Mexico Forest Restoration Principles from 2007) and the Key to 5 PJ Types are both available at the FWRI website. (Go to nmfwri.org and search for "juniper".)

The published research on PJ is extensive. A bibliography of the literature reviewed for these protocols is available on the same FWRI website specified above. One caution on diving into the literature is to pay attention to the area and the PJ type where the research was conducted. The work on PJ in the Great Basin (Monson and Stevens 1999, Miller et al 2014) is excellent, but should be applied to New Mexico woodlands with caution. With that in mind, Forest Service research often publishes proceedings of PJ conferences; these collections of presentations (Aldon and Shaw 1993, Shaw et al 1995, Gottfried et al 2008, Board et al 2018) provide good snapshots of a broad range of results and opinions, often with NM-specific examples.

The first step for a NM land manager interested in restoring PJ is to review the 2007 Draft, to become familiar with how elastic PJ can be. That review, along with the key, will lead to the identification of the PJ type occupying the area under consideration. Finally, selection of the appropriate restoration options for a project can be made from the sections below.

The underlying driver of the key and of the following restoration recommendations is soil depth, the related soil fertility, and how they relate to fire. When soils are deep, grass cover should be sufficient to carry a fire that kills most woody regeneration. On rocky soils, grass is not sufficient to carry fire, and PJ can survive and thrive.

From the PJ Restoration Guidelines 2007

Develop site-specific knowledge
- Develop a comprehensive understanding of historical and current conditions.

Look for evidence that restoration is necessary
- Areas can seldom be readily identified.

Don't do restoration just because you need to do something
- Use resources on areas that are truly degraded and in need.

If you can't clearly identify a restoration need, but you want to reverse ongoing degradation, use best management practices.
- All restoration is good, but not all good practices are restoration.

Don't be too quick to burn the project area
- You may need to scatter-and-leave a substantial portion of the woody biomass to help site recovery, especially if it can't be rested from grazing.

Summary of Logical Possibilities

For the time being, skip Persistent Woodland.

Treat Shrubland and Open Woodland with caution, with the understanding that we don't know a lot about it.
- After treating, monitor the project area
- Re-introduce fire, or rather, manage so that fire can be re-introduced
  o And continue to monitor

Go ahead and restore Grassland or Savanna.

Only by getting a lot of data points are we going to be sure about our treatments.

Treatment Protocols by PJ Type

Table numbers in this section correspond to tables in the Draft PJ Restoration Guidelines 2007, available at https://nmfwri.org/restoration-information/plant-guides/pinon-juniper-framework-new-mexico-forest-restoration-principles/view.

Table 2a. PJ Persistent Woodland

Example: Mesa Verde National Park

Generally, the recommendation is that this type be left alone, not touched. It is a low priority for treatment, and money is better spent elsewhere.

What do you want?

If fire is a worry, in this order:
- Cut some openings in it, locating the openings on deeper soils within the stand. Gottfried (2008) suggests openings of about 2 acres, distributed across the landscape, break up a large homogeneous landscape, providing food and adjacent thermal cover.
- Thin from below in the rest of the stand.

Beyond and possibly including these two steps, any work would be considered something other than restoration.

FWRI takes the position that the best possible land management is restoration, but we recognize that good land management does not necessarily include restoration.

Table 2B. PJ Open Woodland

Example: Along 1-25 east of Glorieta Pass

The restoration here is not back to grassland, but reducing density back to what might have been historically present.

What do you want?

To restore open woodland:
Assume deeper soil grew better grass and thus carried fire, so those areas would have been relatively free of woody plants.
- Thus, cut the trees on areas with deeper soils. This implies a need for a minimal soil-survey pre-treatment.
- If an herbaceous layer is absent, leave activity fuel.

On the remainder of the stand: in areas with rocky and/or coarse silts that didn't support continuous grass that could carry fire, thin from below, leaving more trees in rockier soil. A single-tree selection is considered the best method to fit most natural PJ stand conditions (Ellenwood 1995.) Page (2008) thoroughly explains a technical approach to thinning PJ, and presents spacing guidelines for the residual stand. In any case, attempt to keep the same species mix, in the same proportions, on the site.

Monitor, especially post-treatment
- Does grass come back? How quickly?
- Do trees come back into the open areas?
- How does fire behave? Is enough grass present for fire to carry?
- Share your monitoring results.

If the area is grazed, the animals are going to work against maintaining the openings, by reducing grass – fine fuel – levels.

Table 2c. PJ Shrub woodland

Examples: oak – southern slopes of the Gila; sage – south of Tres Piedras

This type is considered to be "restored" when the system is stable, when the fire can burn and the system not be destroyed. In this case, not being destroyed means it will burn in a mosaic, and some areas will be high severity. This implies some areas need to burn at low intensity, and these areas are what we ought to be creating.

What do you want?

First, assume that a land manager wants to maintain all the dominant plants on the site: PJ, oak or sage, plus a diverse herbaceous layer. (Removal of the oak or sage may be desired by the land owner, but that scenario is not a part of these protocols, since FWRI does not consider that to be restoration.) Maintaining the pre-treatment diversity, including all ages, may mean considering a couple of alternatives. It most likely also means a pre-treatment inventory of the project area that looks at soil depths and/or age distribution of the PJ and the oak/sage. The manager may decide to remove PJ from the oak/sage area, from areas with deeper soils, or a combination of both. Fire should be reintroduced as a system component, but we have little feeling for proper fire regime. Finally, either of the alternatives presented here could lead to the oak/sage groups moving throughout the area over time, which is how we think the system functioned historically.

Alternative 1: Restore by removing PJ where it has encroached onto deeper soil. This alternative assumes trees grew in rockier soil historically, and sage or oak in deeper soils.
- Assumes oak or sage present to be able to occupy the created opening.
- This alternative might remove younger PJ:
  o If PJ is encroaching from shallow into deeper soil, those PJ would be younger.
  o With insects or just aging, older trees might completely disappear.
- Means PJ and oak/sage groups might move across the stand, probably not a problem

Alternative 2: Restore by removing PJ, no matter the age, that is growing in areas of more oak/sage. This alternative assumes PJ regeneration is occurring in both PJ- and oak/sage-dominated areas.
- Oak/sage would be released, because only cutting PJ where oak/sage is already present
- Doesn't rely on a soil survey
- This alternative might remove younger PJ:
  o If PJ is encroaching from older PJ into oak/sage areas, those PJ would be younger.
- Means PJ and oak/sage groups might move across the stand, probably not a problem

Monitor: herbaceous growth, woody regeneration, fine fuels and fire behavior, oak/sage response, and share the monitoring results.

Table 2d. PJ savanna or Juniper savanna

Examples: north of the Sandias, top of Rowe Mesa

The difference between this type and Grassland can be subtle, since the main historic difference is a very few trees vs no trees. Thus, it can be very easy to remove all the PJ in a project area and call the result a grassland, when historically the site was a savanna. This mistake can be avoided by leaving the trees on areas of rocky soils, or leaving trees that stand out as being older than the rest of the stand. At the other end of the spectrum, groups of PJ could be left as thermal cover in areas that historically were grassland and devoid of trees.

What do you want?

Assume you want to restore the grass component and leave an area that is mostly open. Any method of tree removal is acceptable, assuming wildlife, soil, surface water, and other factors are considered. These removal methods include fire, bulldozing, chaining, mastication, and herbicides. However, leaving individual trees and small groups would be difficult when implementing some of these methods.

For this type, restoration involves removing trees on large expanses, and an operator can easily get carried away and take the trees that were meant to be left. The residual trees or groups will need to be marked clearly, and probably extravagantly. Residual trees should be based on presence on rocky outcrops and size. If selecting for thermal cover, base the selection on what is most useful for the animals.

Erosion is a potential problem. On sites with heavy pre-treatment PJ cover, the herbaceous layer may be almost non-existent, and removing the PJ will expose large expanses of bare ground. This potential should be evident during pre-treatment surveys, and the decision made then to lop-and-scatter much of the woody debris from the PJ removal. In extreme cases, seeding of a native grass/herb mix may be needed.

Understand that as long as a seed source is in the area, PJ, and especially juniper, will come back. The regeneration will need to be managed.

Understand the snow will melt faster from treated areas, and wind may take snow off of treated areas. The reduced transpiration and sublimation from removing trees may balance the snow loss, at least in the short term, but this appears to have never been measured.

Monitor: erosion, grass regeneration, PJ seedling appearance, encroachment of invasive grasses. We need a good index of minimum grass needed to carry sufficient fire to control PJ regeneration.

Table 2e. Grasslands

Example: Fort Stanton area

See Savanna discussion.

OTHER TYPES

PJ stringers – along arroyos and other minor drainages. Treat as Open Woodland or possibly Persistent Woodland, since the soils on the edge of the arroyo are mostly eroded, rocky, and thin.

Transition to ponderosa pine – This type was not discussed in the 2007 Draft Guidelines, but it is found throughout NM. With the exception of some riparian areas, this PJ-to-ponderosa pine transition zone is the most dense native plant community. It is dense, like the forests above it, because of fire exclusion. In this zone, the PJ is more susceptible than ponderosa pine to frequent, low-intensity fire, and so would not have been present historically; thus, a restoration to the HRV would remove the PJ in the transition zone. However, given the growing scientific consensus that plant communities will move up the mountain as the climate warms, removing this PJ band today may result in a tree-free zone in 50 years, as the current ponderosas die off. On the other hand, removing the existing ponderosa - assisting migration of the PJ up the mountain – means that we are removing individual pines that are best placed to have the genetics to reproduce in a warmer climate.

So, what do you want? Assuming we want a hillside that has trees on it, apply a modified ponderosa pine restoration prescription. Take 90% of the trees in the transition area. Leave all the ponderosa pine, especially any advanced regeneration. As much as possible, leave the residual stand with groups and openings. Groups can be a mix of species and sizes, but take care to avoid leaving ladder fuels that may cause loss of larger trees. All the juniper can be removed, since they are most susceptible to fire, and most likely to burn intensely under current conditions. Run a prescribed fire through the area as soon as you can.

Monitor: grass cover, woody regeneration, fire effects, and let all of us know how it comes out.

Maintenance

If a seed source is nearby – and in New Mexico, a PJ seed source is always nearby – a treated area will begin to regenerate with PJ (Jaremko-Wright 2014). This inevitability leads some to conclude that areas where PJ woodland is present should be managed as woodland, and current efforts to exclude regeneration is comparable to excluding fire during the last century. However, if your answer to "What do you want?" is "I want more grass in my PJ", then you will need to maintain the herbaceous layer and control PJ encroachment.

In a restoration context, where we are interested in restoring full ecological function, fire is the preferred control method, and regular broadcast burning is the preferred way to apply fire. Fire historically was part of the ecosystem, and reintroducing it may provide benefits beyond woody plant control. For fire to work, grass has to be allowed to grow to the point fire can carry and be hot enough to kill young trees. This may not be possible in areas managed for cattle. In these cases, fire can be applied directly to individual seedlings with a drip torch or fusee. This practice will greatly increase labor cost, and it should be done when moisture content of the grass is high.

Herbicide control is another option. NMSU has done significant work on herbicide control of PJ, including investigating control of larger trees. A useful website on chemical control of woody plants on rangeland is https://aces.nmsu.edu/pubs/_circulars/CR597/welcome.html.

Another option is mechanical control, which means cutting or digging out PJ regeneration. This work will be tedious and carry significant labor costs, but clearing a treated area every five years should be sufficient. A family-owned property outside of Nogal maintained an alligator-juniper savanna in this manner for several decades; the area had several large junipers scattered throughout, with only grass underneath. The property changed hands about 2007, the new owners no longer do the mechanical control, and small junipers are colonizing the area.

The use of intense cattle grazing is not recommended. A few years ago, FWRI was approached to test the idea that by concentrating herds on grassland where PJ seedlings were present, the hoof action would trample and kill the regeneration. In designing the potential study, cattle producers sympathetic to the idea said that control might be possible, but the cost of herding would be prohibitive. The idea was never tested.

Finally, bison promoters say that bison will horn-up seedlings growing in grassland and serve as an effective control on PJ regeneration.

Monitoring

Post-treatment monitoring will be critical for meaningful progress. The PJ plant community is so robust, and so adaptable, that we can't do sufficient research that takes into account every combination of variables. This means every project is an experiment; it also means that monitoring will not be useful unless we share results with one another. At minimum, the following questions need to be answered for each project.

- Does grass come back? How quickly?
- Do trees come back into the open areas?
- Is enough grass present for fire to carry? How does fire behave?
- In PJ shrubland, how does the oak/sage respond?
- Do invasive species establish?
- Who do I need to tell about this? Who would benefit? Where can I talk about it?