A Comparative Analysis of Forest Recovery

After Uncharacteristic Fire in Ponderosa Pine Forest

USDA Forest Service, Kaibab National Forest[1]

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Introduction

A number of questions about management after stand-replacing fires have been raised in peer-reviewed literature, opinion papers and in discussion over specific projects. Many, but not all of these questions, center on the effects of salvage logging related to soil health and long-term forest recovery. Blanket policy recommendations for broad areas, such as "federal lands in the West" have been made, taking examples from one ecosystem and applying them to others that are subject to very different ecological factors. (2)

For example, it is reasonable to assume "that most native species are adapted to natural patterns and processes of disturbance and recovery in the landscape." It does not necessarily follow that, "[human] intervention on the post-fire landscape may substantially or completely delay recovery, remove the elements of recovery, or accentuate the damage [with impacts that] include soil compaction and erosion, loss of habitat for cavity nesting species, loss of structurally and functionally important large woody debris." (2) Most of these recommendations are developed from research or observations in the Pacific Northwest.

Critiques of these sorts of recommendations include that they:

- are overly broad. (5) For Southwestern ponderosa pine forests in particular, "[the historic forest] prior to fire suppression has been extensively reconstructed using historical records, dendrochronology, stand reconstruction and relict stands (e.g., Swetnam and Baisan 1996, Fulé et al. 1997, Mast et al. 1999, Covington 2003). For at least 300 to 500 years prior to the late 19th century, a regime of high-frequency low-intensity fires prevailed (with return intervals of ~ 2 to 20 years), while low-frequency, high-intensity crown fires were very rare or nonexistent (Swetnam and Baisan 1996)." (12)
- by their very nature are not and can not be site-specific as required by NEPA in project planning: (5) Once again, study of Southwestern ponderosa pine forest recovery after uncharacteristic (stand-replacing) fire shows "[two] main trajectories of recovery …: 1) establishment of unnaturally dense ponderosa pine stands vulnerable to further crown fire, and 2) establishment of non-forested, grass or shrub communities." (12)
- do not recognize the adaptive nature of post-fire forest management policy and practice. Some of the broad characterizations of adverse effects claimed are often and increasingly mitigated to a great degree in practice, and may even be positive as a result of management action. (5, 10)

So, how have ponderosa pine areas fared on the Kaibab National Forest that experienced uncharacteristic fire? Has soil productivity been impaired by subsequent management? Are salvage activities resulting in areas without desired amounts of snags or large woody debris?

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Are areas with salvage and/or planting recovering more slowly than inactively managed burned areas?

Fundamentally, the first concern of the Forest is to maintain soil productivity, or retain as much productivity as possible beyond damage done by the fires themselves. Subsequently, the concerns are about the Forest (and the affected areas) progressing toward desired conditions (an uneven-aged, relatively open forest dominated by older and larger ponderosa pine) laid out in the Forest Plan and other law, regulation and policy. These concerns are addressed initially with burned-area emergency response (BAER) activities that may include grass seeding or other erosion control measures.

If salvage or reforestation activities are undertaken later, best management practices and mitigation measures are applied to minimize long-term adverse effects on productivity, diversity and to accelerate development of desired conditions. These practices change over time as knowledge increases or desired conditions change. For example, until the early 1990s, the goal for pine plantations was to establish at least 500 seedlings per acre. This goal has changed as desired conditions in the Plan have changed. About 130 seedlings per acre are all that is required to meet initial desired conditions; substantially higher numbers can leave the regenerated area prone to crown fires and otherwise unnecessary noncommercial thinning expenses.

This paper documents recent field observations of four ponderosa pine forest areas on or near the Kaibab National Forest that experienced stand-replacing fire sometime in the last four decades of the twentieth century. It evaluates the success of these areas in maintaining soil productivity and progress toward attainment of long-term desired conditions.

Three areas were at least partially salvage logged and planted. Reforestation and growth rates of pine trees (both natural and artificial), understory response, presence of coarse woody debris, and an evaluation of the time to recovery of desired forest structure are discussed.

Methods

Areas were observed during field visits in 2008 by an interdisciplinary team that included a silviculturist, fuels specialist, and others.

Four wildland fires that have occurred on or near the Kaibab NF were chosen because, across their range, they:

1) represent uncharacteristic fire effects in the ponderosa pine potential natural vegetation type at mid- and lower elevations;
2) cover basaltic and limestone soils;
3) include areas across a range of several recent decades, allowing a comparison of recovery over time;
4) include salvaged and unsalvaged areas;
5) include planted and unplanted areas.

The four areas discussed are presented in Table 1.

Evaluations

All four areas appear to be quite consistent with the recent research findings for Southwestern ponderosa pine about fire frequency and tree density changes since fire exclusion began in the late 1800s. (12)

One of the areas (Hockderffer) had significant areas of grassland present in its natural condition. Others probably had from 5% to 20% of their historic structure as grassland inclusions. With fire excluded, the grasslands filled in with trees as the forest also became much denser with young trees. These changes created a relatively continuous, dense, laddered forest condition, that lead to uncharacteristic (mixed severity and stand-replacing) fires.

Comparisons of tree density, growth vigor, and other ecosystem characteristics are made between the current conditions and desired conditions from the forest plan. Areas were identified as: 1) salvaged and artificially planted (*salvaged/planted*); 2) unsalvaged and unplanted (*unsalvaged/unplanted*); 3) unburned and planted (*unburned/planted*); or 4) *comparable* areas (adjacent to and outside the fire perimeter that were unaffected by the fire.) It is assumed that the burned areas would resemble nearby unburned areas today if the wildland fire had not occurred.

Some specific indicators of forest recovery are considered here to evaluate forest recovery and progress toward desired conditions. Desired conditions are derived from the Forest Plan and presented in Table 2.

Quantitative measurements have not been made at this point; site-specific observations by professionals, with photo documentation are presented. With these burned and salvaged areas, the evaluation observed the:

- presence and type (planted or natural) of pine tree regeneration
- comparative growth rates of trees in salvaged and nearby areas
- progress toward redevelopment of un-even aged stands dominated by large old trees
- standing snag density
- amount of down coarse woody debris present or readily available from current, on-site sources
- vegetative variety and density for other plants, since these are obvious indicators of soil health
- the redevelopment of elements that could eventually meet target-threshold conditions if the stand were in pine-oak restricted forest.

Photographs were taken for later reference and used in this report.

Table 3 presents the results of site visit observations and a check of records for these areas.

Table 1. Stand-replacing Fires, Soils and Post-fire Management Evaluated.								
Fire Name	**Fire Date**	**Total Area**	**Total PP Area**	**Pine Forest with Stand-replacing Fire**				
				Area	**Soil**	**Salvaged**	**Planted**	**Reforested**
Summit	1966	445	436	255	Basaltic TEU 537, 525	Yes	Yes - 1973	Yes. ~90% with planted pine & resprouted oak only.
Willis	1987	2078	1371	900	Limestone TEU 293, 294, 298	Most	Most	Yes. ~99+% with planted only.
Bridger	1996	53,373	~8050 – 12,800	~2770	Limestone TEU 297, 672	Most	Most	Yes. ~95% planted. Pine-PJ transition/stringer area evaluated.
Hockderffer	1996		~16,055		Cinders/ash (Coc 560)	No	No	No. Heavy elk presence. Includes substantial natural grasslands.

Table 2. Forest Plan Desired Conditions Evaluated for Progress Toward Attainment.		
Element	**Desired Condition**	**Note**
1) presence and type (planted or natural) of pine tree regeneration 2) comparative growth rates of trees in salvaged and nearby areas 3) progress toward redevelopment of un-even aged stands dominated by large old trees with open or slightly closed canopy	Initial: ~50 - 130 seedlings/acre Eventual: Large, old-tree dominated groupy, open, uneven-aged sites.	Forest Plan adopts this direction from RM-217 (11). Range needed to eventually develop well-distributed clumps and groups of trees 12" – 30" dbh, across 60 percent of each site with 40 – 50 percent canopy cover in the groups.
standing snag density	2+ trees/acre	Forest Plan adopts this direction from RM-217 (11). Snag density also from other sources.
amount of down coarse woody debris present or readily available	5 – 7 tons/acre	
target-threshold conditions if the stand were in pine-oak or mixed conifer restricted forest	20 trees/acre >= 18" dbh	Pine-oak and mixed conifer elements in target-threshold stands from the MSO Recovery Plan (10% of the pine-oak type on Williams RD; 25% of mixed conifer type on Williams and North Kaibab RDs.)
target-threshold conditions if the stand were in pine-oak restricted forest	20 ft^2/ac of Gambel oak trees	

Table 3. Relative forest productivity and progress toward desired conditions for fire areas.

Fire Name	Pine Regeneration[2]		Pine Growth Rate (height and diameter)		Coarse Woody Debris Present or Available[3]		Understory Variety and Density[4]		Estimated years to 20 tpa >= 18"dbh[5]		Estimated years to 20 ft^2/ac of oak[4]	
	Planted	Natural	Salvaged/ Planted	Unsalva./ Unplant.	Salvaged	Unsalv.	Salvaged	Unsalv.	Salvaged	Unsalv.	Salvaged	Unsalv.
Summit	Well above desired	Well below desired	Comparable to areas not affected by the fire[6]	N/A	Near desired. More available.	Below desired. More available	Oak suckers – poles. Grass/forb similar in *comparable*; higher in *unburned/planted*.		60	60 (planted) 80 - 95+[7] (unplanted)	No area likely to meet threshold Salvaged area developing large oaks	
Willis	Mixed	Far below desired	Comparable to areas not affected by the fire		Near desired. More available.	Above desired. Little more available.	Shrubs common. Grass/forb luxuriant; declining	Shrubs common. Grass/forb luxuriant	75	95+	Oak widespread, but shrubby	
Bridger	Near desired	Far below desired	Comparable to areas not affected by the fire		Near to above desired		Shrubs nearly continuous. Grass/forb luxuriant where shrubs reduced		90	100+	Oak widespread, but shrubby	
Hockder-ffer	N/A	None	N/A		N/A	Well above desired	N/A	Shrubs ??? Grass/forb luxuriant	N/A	100+	N/A	Almost none present

[2] Evaluation relative to the desired conditions in the Forest Plan at the stand level or above - ~130 trees per acre (all sizes).
[3] Evaluation relative to the desired conditions in the Forest Plan of 5-7 tons per acre.
[4] Forest Plan ("Achieve … biotic diversity.") and MSO recovery Plan ("Maintain all species of native trees in the landscape including early seral species.")
[5] Minimum for a "target/threshold" in the MSO Recovery Plan for some pine-oak forest in the Upper Gila recovery Unit. (Note several fires are not in this area.)
[6] The unsalvaged areas are also unburned. One is adjacent to the burn. The other is a plantation within about one mile of the Summit fire.
[7] The "+" denotes this number is a minimum estimate. It makes the unlikely assumption that the area will regenerate at least 20 trees per acre in 5 years.

Summit Fire

Area Description

The 1966 Summit Fire is located on the Williams Ranger District and occurred primarily on two basaltic soils. The stand-replacing portion of the fire occurred primarily on one – a mollic eutroboralf on slopes under 15%. Site index from the terrestrial ecosystem survey is between 70 and 75, with moderate artificial reforestation suitability. There are moderate limits on timber harvest[8] and erosion hazard is slight. The center of the burn area contains a meadow of about 10 acres. This has at least one clump of large Gambel oak that survived the fire.

Because this site is so flat, its very unlikely soil would be displaced from mechanical disturbance after a fire and none was noted from that cause. Trenches approximately 8" deep were created mechanically in 1973 to prepare the site for planting. (8) With close examination, these are still evident today as shallow depressions out of which the planted trees are growing.

The area was planted about seven years after the fire and six years after salvage. The entire area evaluated within the fire perimeter was salvage logged. Few, if any snags were left standing, as was the practice at the time this fire was salvage logged.

An unevaluated area to the east that burned left most forest structure intact and do not appear to have been either salvage logged or planted. A subsequent silivicultural treatment in this portion occurred as part of a timber sale in the 1990s.

Comparisons are made between the *salvaged/planted* area (Fig A.), the adjacent area outside the fire perimeter (*adjacent*) and an unburned area about a mile away that was planted a year after the fire was planted (*unburned/planted*) (Fig. C).

Current Conditions

Salvaged/planted areas have more than 130 trees per acre over 25' - 35' tall everywhere it was salvage logged (Fig. A.) Tree growth appears to be quite similar to the *unburned/planted* area in terms of heights, diameters, and canopy fullness (Fig. C.) Natural conifer regeneration in the *salvaged/planted* area occurs within 100' of seed sources outside this portion of the fire, with virtually none within it. Naturally regenerated trees are significantly smaller than the planted trees, probably because they got a later start and are competing with the larger, planted trees. Naturally regenerated trees provide a second age class for this narrow band of the fire perimeter.

The plantation is in need of a thinning to reduce increasing risk of another crown fire, to begin development of a clumpy/groupy pattern, to make space for understory plants and to begin development of a second age class of trees. Planted trees are beginning to produce cones.

Understory vegetation density in the *salvaged/planted* area is similar to the adjacent *comparable* area. It seems lower than the *unburned/planted* area a mile away; however, this site is in a swale while the other two sites are on a ridge. Density in the *salvaged/planted* area appears to be declining as tree dominance increases. Invasive plants were not noted in any of the three areas described here. Oaks have responded in the *salvaged/planted* area with more rapid suckering and diameter development (Fig. B) than the *comparable* area. The rapid growth of the oak in the

[8] Timber harvest limitations are limits to be considered when evaluating the impact of timber harvest with regard to maintenance of soil productivity. Limits relate to year round or seasonal use of equipment, as the result of climate, soil characteristics and landform.

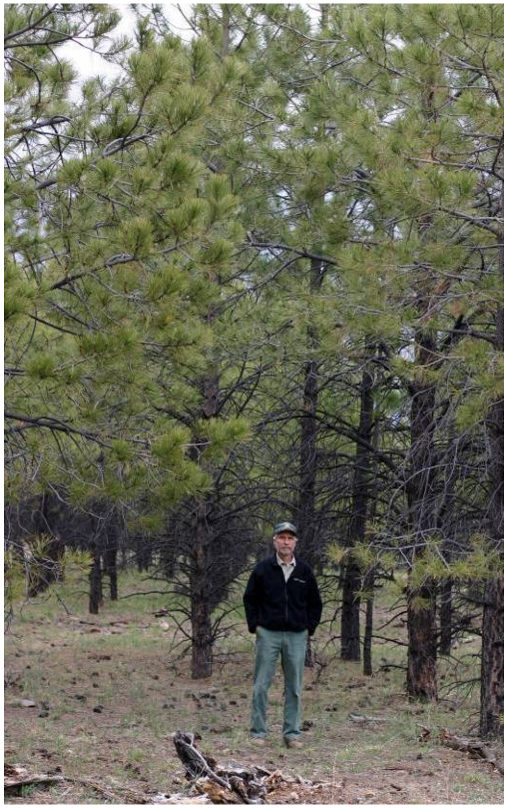

Fig A. Summit Fire *Salvaged/Planted*. Planted in 1973. Note course woody debris on left and in background.

Fig B. Summit Fire *Salvaged/Planted*. Gambel oak group resprouted since the fire salvage over 5” drc.

Fig C. *Unburned/Planted* near Summit Burn. Planted in 1974. No coarse woody debris is present. Until recently, “corn row” planting has been the usual practice.
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burn area is because it was free to grow for a number of years after the fire. In the *comparable* area, the ponderosa pine overstory competition has kept recent oak sprouts small. There are no oak in the *unburned/planted* area, although they are nearby.

Snags from the fire appear to be absent across the burn and none were left in the *salvaged/planted* area. It appears they were also felled elsewhere in the fire - as was a common practice at the time.

Coarse woody debris amounts are close to the desired amounts in the Forest Plan of 5-7 tons per acre. Many planted trees are now about 8” dbh and could immediately supply any needed course woody debris, if it were desired.

Willis Fire

Area Description

The 1987 Willis Fire occurred on the North Kaibab Ranger District (Fig. D.) It is located mostly on three limestone soils, primarily distinguished by slope and a slightly lower elevation for one. They are all mollic eutroboralfs. Slope breaks between soils are at 15%. The elevation break between soils is about 2200 meters (7200’). Site index from the terrestrial ecosystem survey is 75 for the higher elevation sites and 60 for the lower. Ratings of artificial reforestation suitability are moderate for the upper two and low for the lower elevation unit. Timber harvest limitations are moderate for all three. Erosion hazard is slight or moderate.

There appears to be very little soil displacement because of post-fire logging activities. One small area on a slope over 30% was noted, where cross-slope skidding displaced soil three to five feet downhill across less than 0.1 acre (Fig. G.)

Comparisons are made between the *salvaged/planted* area, and *unsalvaged/unplanted* areas in the burn. One of the unsalvaged areas is a shallow sinkhole (in Fig. E). These were routinely removed from timber harvest for safety concerns for equipment operators.

Current Conditions

The Willis Burn has a patchy distribution of planted trees 6’ to 12’ tall in the *salvaged/planted* portion (Fig. D, E & F.) Natural tree regeneration in the areas visited is virtually absent. Only two naturally regenerated trees were noted. Both were within about 150’ of seed sources and were both younger and smaller than nearby planted trees. Planted trees are growing at a moderate to rapid pace and have healthy, dark green foliage. Parts of the plantation are in need of a thinning to reduce increasing risk of another crown fire. There are some patches in the salvaged portion fire that were likely planted but support little regeneration. A check of an aerial photo, dated 5-16-1963 (ELE-6-166) shows this portion of the Willis Fire to have at least five patches of two to four acres with less than 20% historic tree cover. Warm, dry conditions and competition from grasses on this rather low-elevation site seem to be the most likely causes for the persistence of these open areas, despite planting efforts.

The two *unsalvaged/unplanted* areas observed had no regeneration evident.

Shrubs, particularly oak, are receiving heavy ungulate browsing. Some differences in understory composition, probably due to aspect exist in steeper areas. One grass species in the *salvaged/planted* area – orchard grass - is non-native and was probably seeded after logging. No other invasive plants were noted.

Figure D. Willis Burn Panorama. Virtually all regeneration is planted and growing rapidly. Understory luxuriant. Oak is shrubby and heavily browsed. Most retained snags have fallen down. Coarse woody debris near desired amount.

Figure E. Willis Burn. The no salvage/no plant area, delineated with an orange line, has no natural regeneration evident. The patch in the middle ground with less regeneration than stump evidence is about 3 acres – the largest such case noted in the salvaged area. See text.

Understory vegetation is luxuriant in both areas. Oak and other shrubs are present in similar microsite locations in both areas. No shrub species in a *comparable* area adjacent to the fire were noted that were not also in the fire. No attempt was made to identify and grass or forb differences.

A number of snags were left in the *salvaged/planted* areas and all were left in the *unsalvaged/unplanted* portion. Well over 95% have fallen down. At this point (21 years after the fire) the treatment areas are essentially equal with regard to standing snags – almost none left.

Coarse woody debris amounts are close to desired levels in the Forest plan in the *salvaged/planted* area and well above it in *unsalvaged/unplanted* areas.

Fig. F. Willis Fire planted trees.

Bridger Fire

Area Description

The portion of the 1996 Bridger Fire area (North Kaibab RD) evaluated is at the lowest elevation of the ponderosa pine type, in a shrubby ecotone transition with piñon-juniper. It is located primarily on one limestone-derived mollic eutroboralf with sustained slopes under 15%. The elevation is below 2200 meters (7200'). Site index from the terrestrial ecosystem survey is 65. Ratings for artificial reforestation suitability and timber harvest limitations are moderate. Erosion hazard is slight.

Comparisons are made between the *salvaged/planted* areas (Fig. I), and *unsalvaged/unplanted* areas (Fig. H) in the northwestern-most pine areas of the burn. Unsalvaged areas are on generally steeper slopes or are on gentler slopes above steep areas.

Salvage activities were limited to slopes less than 30%. No soil displacement from post-fire logging activities was noted.

Current Conditions

The Bridger Burn has a patchy/scattered distribution of planted trees 1' to 3' tall in *salvaged/planted* areas (Fig. J.) Planted seedling density is less than 130 per acre but present in numbers equal to or exceeding the number of salvaged trees. Planted trees are growing at a moderate pace and have healthy, dark green foliage. Natural tree regeneration in the areas visited is virtually absent; two naturally regenerated trees noted were within about 150' of seed sources. Natural regeneration essentially has not occurred despite the fact that the seed trees have had at least two and probably three good cone years since the fire.

Common mullein was the only invasive plant noted in this portion of the fire. Cheatgrass is common in piñon-juniper/grassland areas to the west (at lower elevations.) Grasses, forbs and shrubs are comparable in abundance between the two areas.

Gambel oak, New Mexico locust and other shrubs are quite dense across both areas. There are interspaces between dense shrub areas where understory vegetation is luxuriant.

Fig G. Willis Burn. Steepest *salvaged/planted* and *unsalvaged/unplanted* areas. East-facing foreground is *salvaged/planted*. West-facing back slope is *unsalvaged/unplanted*, except near the top. Most fire-created snags have fallen down.

Fig H. Bridger Fire. Foreground unsalvaged.

Fig. I. Bridger Fire. Salvaged area.

A number of snags were left in the salvaged areas and all were left in the unsalvaged portion. Well over 90% have blown down or - near open roads - were poached.

Coarse woody debris amounts are well above the desired amounts in the Forest plan in the *salvaged/planted* and *unsalvaged/unplanted* areas. However, when averaged over a few acres, it is near desired amounts due to the naturally patchy arrangement of trees in this area.

Fig. J. Bridger Fire. A typical planted seedling.

Hockderffer Fire

Area Description

The 1996 Hockderffer Fire is located on the Coconino NF about five miles east of the Williams Ranger District of the Kaibab NF. The soils in the area evaluated derive from cinders and ash. Site index from the terrestrial ecosystem survey is in the range of 50. Artificial reforestation suitability is moderate and timber harvest limitations are low. Erosion hazard is slight. Grassland inclusions make up a significant percentage of this map unit.

None of the area evaluated was either salvaged or planted. It is used here as an *unsalvaged/unplanted* area comparison for *salvaged/planted* areas of other fires.

This area evaluated is a PP-bunchgrass/grassland site, with aspen clones sprinkled through near some cinder cones. A 300-meter transect - from the edge of the burn into the burn 100 m, turning and paralleling the road for 100 m, then returning 100 m to the road – was run. Some of the area sampled is directly under a few surviving cone-bearing trees, some is 100+' from the nearest survivor.

Current Conditions

There were no tree seedlings noted at any point along the transect. It is not apparent when this site will begin to recover either forest or savanna structure in the burn area.

Some cheatgrass and toadflax are present most places along the transect. A few shrubs are also present. However the large majority of plant cover is a dense mat of native grasses and sedges. Fuel loadings are above desired conditions in areas that may have historically supported ponderosa pine forest (Figure K) but lighter in areas that may have been historic grassland or savanna inclusions (Figure L.)

Most snags have fallen in the area evaluated, but a number in excess of the desired minimum remain. Chambers and Mast reported 41% of the snags had fallen seven years after this fire – in 2003. (4)

Fig. K. Hockderffer Fire.

Fig. L. Hockderffer Fire.

Discussion

Unfortunately, we have little science to inform us about the true efficacy of "no salvage/plant" or "salvage/no plant" in this system, but the inferences are easier to make on those than the other two choices – "salvage/plant" and "no salvage/no plant".

If the management activities caused either soil compaction or erosion, they were not serious enough to be apparent in the vegetative response comparisons between salvaged and unsalvaged areas now. For the areas examined, tree regeneration, shrub, and understory species all seem to be much more responsive to slope, aspect and the habitat types they are in than any effect from salvage logging. Invasive plants are not a serious problem for any area examined. On Willis, some non-local grasses are present in the fire and were very likely seeded as an erosion control measure – either as part of the BAER, as part of salvage activities, or both. Seeding of non-native persistent grasses was a common practice up until the early 1990s, but has been discontinued in most cases.

The general lack of a natural reforestation response after uncharacteristic fires in these four areas is consistent with two of the three outcomes documented in Southwestern research by Savage & Mast. (12) Recovery of forest structure is not taking place naturally in most places where stand-replacing fire occurred.

In 2006 the Warm Fire burned through large areas of ponderosa pine and dry mixed conifer on the Kaibab Plateau. The following fall (at an elevation above the fires evaluated here) a mat of ponderosa pine seedlings was noted on the site visited. These came from seeds of the previous year's cone crop. The seedlings sprouted where all or nearly all trees were killed but soils retained some organic material. By the following summer, the seedlings had died. If the weather in the intervening period had been favorable, it is conceivable that many or most of these seedlings would have survived. In that event, then the third outcome noted by Savage and Mast – a "hyper-dense forest" – might have been on its way into development. A forest in this condition is quite prone to another crown fire, killing most or all of the new trees and what is left of the living forest structure from the previous uncharacteristic fire.

If reestablishing forest structure in any defined timeframe after uncharacteristic fire is a goal, planting is usually required. In most cases, the Kaibab National Forest has succeeded in establishing desired numbers of trees with artificial means. In all cases reviewed it has been much more successful than natural processes to date.

Artificial reforestation efforts in the past few years are being increasingly adapted toward reestablishing trees in clumps and groups, rather than the "corn row" patterns evident in the plantations presented here. Where historic tree patterns are detectable, this should help prevent over-planting and speed to recovery of the historic clumpy-groupy nature of the forest.

Table 3 shows predicted times to development of some target-threshold tree structure called for in the MSO Recovery Plan, based upon field observations. Artificial reforestation has greatly accelerated its development in all cases where it has been used. In the Summit Burn, this has accelerated recovery by about 35 years, at a minimum. Since regeneration in all *salvaged/planted* areas is growing at expected rates and in densities at or above historic densities, salvage logging appears to not have adversely affected site productivity or vegetative response in any case for the periods evaluated. Oak tree structure is developing in the *salvaged/planted* area of the Summit fire faster than the associated *comparable* area. If salvage logging has an adverse effect on oak development, it is not detectable in this case.

Fewer than half the snags are standing in either salvaged (Bridger) or unsalvaged (Bridger, Hockderffer) areas 11 years later. On Willis, nearly all the snags have fallen down in both the salvaged and unsalvaged areas. Adapting to results of recent research, the Forest now includes retaining snags in groups in project design, which appears to add some years to their longevity. However, it is noteworthy that this measure seems to make little current difference on Willis (21 years after the fire.) Loosing most or all living forest structure, such as occurs with a stand-replacing fire, also means there will be a period of several decades without any significant snag density in that same area.

It is also important to note the inference that large areas of mostly fire-killed ponderosa pine trees are an uncharacteristic state of natural forests in the Southwest, at least, since the fire behavior that could create them has never been documented in historic forest structure. (12) "Loss of habitat for cavity nesting species" is an unfortunate fact following uncharacteristic fire for most of the recovery period regardless of whether salvage occurs. Leaving all snags does not appear to make any difference on the site after ten to twenty years in any case.

Concerns about the "loss of structurally and functionally important large woody debris" are germane in pine forest, but it does not follow that because some large woody debris is good that more is better.

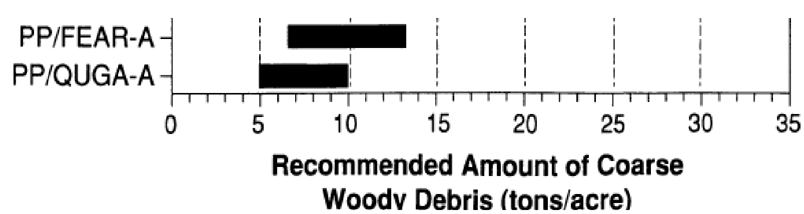

Fig. M. Coarse Woody Debris recommendations for pine forest on the Kaibab, Coconino and Apache-Sitgreaves NFs. (7)

Fig. N. 8.5 t/ac of course woody debris in pine forest. (1)

The Forest Plan desired condition for CWD is generally five to seven tons per acre in ponderosa pine (immediately after treatment.) The Goshawk Scientific Committee in a peer-reviewed, paper for Southwestern forests developed this range. (11) As the authors of another peer-reviewed research paper note, "[t]he management of coarse woody debris is critical for maintaining functioning ecosystems in the Rocky Mountains. These forests have great diversity, with each forest habitat type developing and retaining different amounts of debris." (7) The recommendations developed for Southwestern ponderosa pine forests come from plots on the Kaibab Plateau and near Flagstaff. They recommend between 5 and 13 tons per acre (Fig. M). The authors note these figures "are conservative [erring to the high side] to ensure that enough organic matter is available after timber harvest to maintain long-term forest productivity."

A visual representation of this condition is in Fig. N.

In another study done that included ponderosa pine forests and dry Douglas-fir in Montana and accounted for the presence of CWD over time in severely burned areas, the recommended range is between 5 and 20 tons per acre for these types. (3)

Although all the fire areas evaluated here are in ponderosa pine, it is reasonable to expect similar outcomes for recovery into much of the dry mixed coniferous areas of the Kaibab National Forest. The historic fire frequency and behavior in this type has been studied and found to be quite similar to the pine forest sites nearby. (6) In 1909, a survey of large trees on over 2500 plots was conducted by the Forest Service on the Kaibab Plateau. (9) A recent analysis of this data found that about 40% of the plots met the definition for mixed forest in the MSO Recovery Plan of less than 80% ponderosa pine in the overstory. However, over 40% of these plots had at least a plurality of ponderosa pine in the overstory. Recovery of native species diversity and sustainable processes and structure after an uncharacteristic fire are very likely to also require artificial reforestation efforts.

Conclusions

While concerns and opportunities to learn and improve management are always present with any project proposal, the oft-repeated, off-site, out-of-region, generalized conclusions raised with local salvage sale proposals seem at odds with local Forest experience as documented in the site-specific examinations made here.

It does not appear from the four fire areas evaluated that salvage and/or planting activities have "substantially or completely delay[ed] recovery, remove[d] the elements of recovery, or accentuate[d] the damage" caused by the fire and its immediate effects.

Instead, it appears that:

1. Salvage logging after uncharacteristic fires as practiced in these examples has not had an observable adverse effect upon site productivity ten to forty years later.

2. Salvage logging often reduced the amount of coarse woody debris, but not below desired levels. No treatment often left coarse woody debris levels higher than either desired or necessary.
3. In all cases, forest structure has begun to recover faster with planting of pine trees than without the practice. In fact, there is no defined time for recovery of forest structure by natural means in the unplanted areas evaluated that experienced uncharacteristic fire.

Citations

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