Three Studies on Ponderosa Pine Management on the Warm Springs Indian Reservation: Stocking Control in Uneven-aged Stands, Forest Products from Fire-damage Trees, and Fuels Reduction[1]

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Abstract

Over 60,000 acres of ponderosa pine (*Pinus ponderosa* P. and C. Lawson) forest on the Warm Springs Indian Reservation (WSIR) in Oregon are managed using an uneven-age system. Three on-going studies on WSIR address current issues in the management of pine forests: determining levels of growing stock for uneven-age management, fire effects on wood suitability for engineered wood products, and mechanical forest fuel reduction alternatives. To evaluate various levels of growing stock, WSIR installed twelve 1.01-hectare plots in four areas of the ponderosa pine forest to test three basal area density levels: 8.0 m^2ha^{-1} (35 ft^2ac^{-1}), 11.0 m^2ha^{-1} (48 ft^2ac^{-1}) and 14.0 m^2ha^{-1} (61 ft^2ac^{-1}). All plots were measured four times over a fifteen-year period. Preliminary results show the variation in periodic basal area growth. Future treatments are planned for 2005 to impose new density levels for the next 20 years. A study of fire effects on wood quality was initiated to compare the strength of recently burned small-diameter ponderosa pine to the strength of unburned, green, small-diameter ponderosa pine. Small logs were shipped to Mississippi State University to test their performance as engineered wood products. A mechanical forest fuel reduction study was designed to compare the effectiveness of two methods for reducing understory conifers, shrubs, and downed fuel. Soil disturbance (both visual classification and soil compaction), machine productivity, system cost, and their ability to treat certain various fuel types will be compared in an 32 ha. (80 ac.) ponderosa pine unit.

Introduction

The Warm Springs Indian Reservation (WSIR) in Oregon has over 100,000 ha (250,000 ac) of commercial forest with approximately 24,000 ha (60,000 ac) of ponderosa pine (*Pinus ponderosa* P. and C. Lawson) type. These forests are managed to provide sustainable yield and associated income, as well as wildlife and cultural amenities, to the Confederated Tribes of Warm Springs. Timber harvesting and fire suppression have changed the structure of these ponderosa pine forests from stands dominated by large, old ponderosa pine (at least 200 years old) to stands dominated by a mixture of scattered old trees and dense groups of young trees (Weaver 1959). This new forest structure presents several new challenges: (1) choice of level of growing stock and stand structure for uneven-age management; (2) utilization of small-diameter ponderosa pine trees; and (3) development of economically efficient

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methods to reduce the potential of stand-replacement catastrophic fire in ponderosa pine forests.

To begin to address these challenges the following three studies were initiated on the WSIR in the ponderosa pine forests: determining levels of growing stock for uneven-age management, fire effects on wood suitability for engineered wood products from small-diameter trees, and mechanical forest reduction alternatives. In this paper a brief overview of each study is presented.

Determining Levels of Growing Stock for Uneven-age Management

Early selection harvests in the ponderosa pine forest occurred in the 1950s and 1960s (Logan 1981). These harvests selectively removed the oldest, large-diameter ponderosa pine of low vigor based on the Keen tree classification (Keen 1943). These selection harvests evolved into treating all diameter classes as prescribed in the Forest Management Implementation Plan 2002 – 2011 (Arena 2003) to meet the target levels of growing stock. These areas are in the ponderosa pine management group, which includes four plant associations (Marsh and others 1987).

In 1964 Earle Wilcox with the Bureau of Indian Affairs (BIA) stressed the need to determine levels of growing stock for the fully regulated forest under future intensive management of ponderosa pine (Wilcox 1964). His focus was on enhancing growth of young ponderosa pine and improving growth predictions for the allowable cut. The focus changed in 1982 from growth rates to optimum levels of growing stock for younger ponderosa pine. Wilcox met with forest managers of large reservations in the Northwest to determine interest in installing permanent stocking study plots (Sassaman 1982). The data from these plots were intended to help managers advise the tribes about alternatives for managing their ponderosa pine forests.

In response to this need, the WSIR installed stocking study plots in 1984. Four sites were selected (*fig.1*). Initially, there was some difficulty locating uneven-aged stands with three age classes that were less than 120-years-old, as well as areas with similar site quality that were disease free. Dwarf mistletoe reconnaissance plots found infection from western dwarf mistletoe (*Arceuthobium campylopodum* Engelmann) scattered through the ponderosa pine forest. Three plots were established at each of the four study sites. Each plot was 1.01 ha (2.5 ac) or 100.58 by 100.58 m (330 by 330 ft) with an exterior buffer 20.12 m (66 ft) wide. The plots were divided into 25 square subplots of 20.12 by 20.12 m (66 by 66 ft). Each plot was randomly assigned a different basal area stocking level yielding three basal area stocking levels at each site. The levels of basal area per acre were: 8.0 m^2ha^{-1} (35 ft^2ac^{-1}), 11.0 m^2ha^{-1} (48 ft^2ac^{-1}) and 14.0 m^2ha^{-1} (61 ft^2ac^{-1}). The selection of these levels was based on work from the Flathead Indian Reservation, where a similar study was installed in 1970. Unfortunately, with the exception of the Beachkomb and Upper Tenino plots, initial levels of growing stock did not match the planned levels (*table 1*).

Warm Springs Forest Products Industries harvested the stocking study plots and buffers between the fall of 1984 and the spring of 1985. The logging slash was piled and burned. The initial measurement was completed in the fall of 1985, and subsequent remeasurements were scheduled every 5^{th} year. All trees greater than 1.5 inch in diameter at breast height (dbh) were tagged and numbered. Tree heights, 5-

year dbh growth, age, and growth basal area were recorded for every tree greater than 30 cm (12 in) dbh, every third tree in the 15-25 cm (6-10 in) dbh class, and every fourth tree in the 5-10 cm (2-4 in) dbh class. Growth basal area (GBA) is the basal area at which dominant trees grow 2.5 cm (1 in) in diameter per decade at age 100. (Hall 1987)

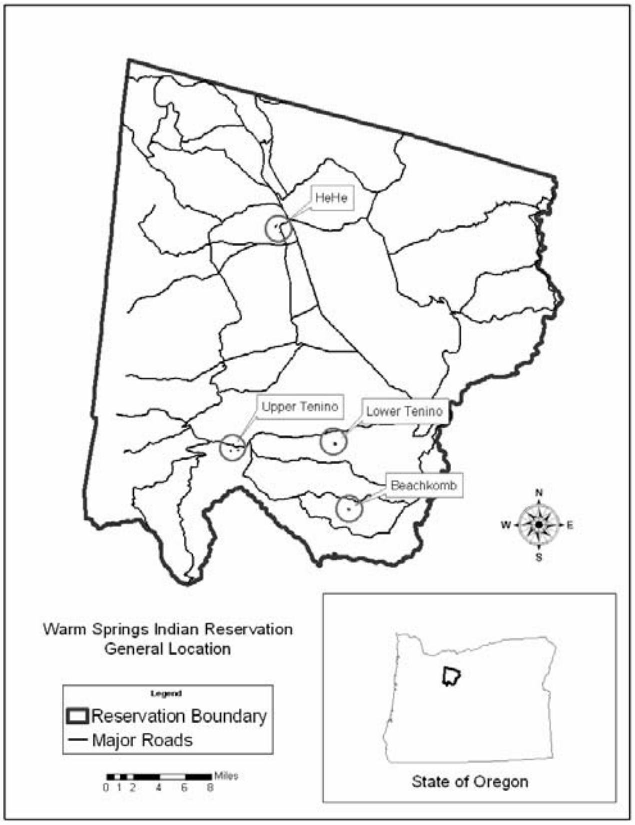

Figure 1— The location of the stocking study plots on the Warm Springs Indian Reservation.

Additional measurement variables that were collected since 1991 included all tree heights, height to lowest live limb, tree problem and severity codes, and crown class as well as a regeneration plot in the center of all sub-plots. In addition, all tagged trees were stem-mapped on each plot. The spatial data were entered into the Warm Springs Geographic Information System database. The University of Idaho remeasured the plots in 1994 as part of a Global Warming Project with WSIR and the Bureau of Indian Affairs Northwest Regional Office. The last remeasurement was done in l999-2000.

In 1991 each plot was classified by plant association (Marsh and others 1987). Two of the four study sites were located in areas of relatively high site quality; the HeHe site was in the ponderosa pine-Douglas-fir/snowberry plant association, and the Upper Tenino site was in the mixed conifer/snowbrush plant association. In contrast, Lower Tenino and Beachkomb sites were of lower site quality and were in the ponderosa pine/bitterbrush – greenleaf manzanita plant association and ponderosa pine/bitterbrush plant association, respectively.

Growth monitored over 15 years suggests that periodic rates of basal area growth differed among plots (*table 1*). This difference could be seen when comparing plot basal area growth at the Beachkomb and Upper Tenino sites, the sites at which actual basal areas were closest to the planned targets. At the Beachkomb site, basal area periodic annual increments were: 0.243 m^2ha^{-1} (1.06 ft^2ac^{-1}) for plot 1 (residual basal area 7.34 m^2ha^{-1} (32 ft^2ac^{-1})); 0.321 m^2ha^{-1} (1.40 ft^2ac^{-1}) for plot 2 (residual basal area 13.77 m^2ha^{-1} (60 ft^2ac^{-1})); and 0.259 m^2ha^{-1} (1.13 ft^2ac^{-1}) for plot 3 (residual basal area 10.10 m^2ha^{-1} (44 ft^2ac^{-1})). In contrast, at the Upper Tenino site, basal area periodic annual increments were: 0.734 m^2ha^{-1} (3.20 ft^2ac^{-1}) for plot 1 (residual basal area 8.72 m^2ha^{-1} (38 ft^2ac^{-1})); 0.613 m^2ha^{-1} (2.67 ft^2ac^{-1}) for plot 2 (residual basal area 13.08 m^2ha^{-1} (57 ft^2ac^{-1})); and 0.659 m^2ha^{-1} (2.87 ft^2ac^{-1}) for plot 3 (residual basal area 15.14 m^2ha^{-1} (66 ft^2ac^{-1})).

Table 1–*Basal area (ft^2 ac^{-1}) of each plot at each remeasurement. Target basal areas are in the 1982 column.*

	Basal area, m^2ha^{-1} (ft^2ac^{-1})				
Plot	**1982 Target**	**1985 Actual**	**1991 Actual**	**1994 Actual**	**2000 Actual**
HeHe					
1	8.0 (35)	9.9 (43)	12.4 (54)	14.0 (61)	17.7 (77)
2	11.0 (48)	9.9 (43)	12.2 (53)	13.8 (60)	17.2 (75)
3	14.0 (61)	9.4 (41)	11.5 (50)	12.6 (55)	14.9 (65)
Upper Tenino					
1	8.0 (35)	8.7 (38)	12.4 (54)	15.1 (66)	19.7 (86)
2	11.0 (48)	13.1 (57)	16.1 (70)	17.9 (78)	22.3 (97)
3	14.0 (61)	15.1 (66)	18.4 (80)	20.2 (88)	25.0 (109)
Lower Tenino					
1	14.0 (61)	8.3 (36)	10.3 (45)	11.5 (50)	14.2 (62)
2	8.0 (35)	6.9 (30)	8.3 (36)	8.9 (39)	11.0 (48)
3	11.0 (48)	8.3 (36)	10.1 (44)	11.0 (48)	13.3(58)
Beachkomb					
1	8.0 (35)	7.3 (32)	8.7 (38)	9.6 (42)	11.0 (48)
2	14.0 (61)	13.8 (60)	15.8 (69)	16.8 (73)	18.6 (81)
3	11.0 (48)	10.1 (44)	11.9 (52)	12.6 (55)	14.0 (61)

The next phase of this study will be to remeasure the trees, tag and measure the ingrowth, and then harvest the plots and their buffers to the new basal area targets: 8.0 m^2ha^{-1} (35 ft^2ac^{-1}), 11.5 m^2ha^{-1} (50 ft^2ac^{-1}) and 14.9 m^2ha^{-1} (65 ft^2ac^{-1}). These levels are similar to the original targets but will expand the range of densities to test the degree of variation in growth by regeneration and merchantable trees, especially at the higher density. The higher level (14.9 m^2ha^{-1} (65 ft^2ac^{-1})) is just above the prescribed level used in the WSIR Forest Management Implementation Plan 1992 – 2001 (Donaghu 1993).

Besides the new density levels, the silvicultural prescription for each plot will project a flatter reverse J-shape curve, shifting basal area from the lower 10-cm (4-in) dbh classes (sub-merchantable classes) to the small sawlog classes. Using tree data formatted for the Forest Vegetation Simulator (FVS) (Wykoff et al. 1982) and the spatial information from the stem-mapped plots, several marking scenarios can be assessed with respect to how well they meet the planned initial stocking levels, as well as establish an expected yield after 20 years. After treatment, the plots will be remeasured every 5 years and harvested every 20 years.

Unfortunately, the HeHe plot #3 burned in a wildfire in 1999 and only four trees remain in the plot. This plot will be remeasured every 5 years to assess post-fire recovery. The number and intensity of recent fires are a major concern on the WSIR in the ponderosa pine forest and, specifically, the stocking study plots.

The maintenance and remeasurement of these plots are long-term investments by the tribes. As the responses to different stocking levels are analyzed and compared, the desired stocking levels and stand structure can be prescribed to ultimately meet the tribal goals and objectives in these ponderosa pine forests. The process of remeasurement, harvest and analysis will continue since more questions will inevitably arise, as they did in 1964 during Earle Wilcox's silvicultural assessments. These plot data when entered into FVS can also be used to calibrate growth projections to the Warm Springs Indian Reservation.

Fire Effects on Wood Suitability for Engineered Wood Products from Small-diameter Trees

Overstocked stands of small-diameter conifer trees in areas that historically carried frequent fires have created problems for landowners in central Oregon and on the WSIR. The cost of thinning and slash treatment necessary to release and protect these stands is very high. If left untreated, these stands may contribute to and be consumed by catastrophic wildfires, resulting in subsequent loss of any wood value, as well as possible site degradation. The solution to this problem might be to develop new products or add value to products manufactured from small-diameter trees. At present, there are limited markets for either burned or green small-diameter trees. This study will test samples of recently burned and green small-diameter ponderosa pine and lodgepole pine for their utility in manufacturing engineered wood products at Mississippi State University (MSU). Eini Lowell and Susan Stevens Hummel from the USDA Forest Service Pacific Northwest Research Station are the principal investigators of this study[3]. Both burned and green ponderosa pine samples came from the southern portion of the WSIR where the B & B Fire burned in 2003. The lodgepole pine samples came from the Deschutes National Forest, Oregon.

In the fall of 2004, trees were selected, cut, and bucked into 2.4-m (8-ft) lengths by two Warm Springs engine crews. Each butt log was tagged, measured, loaded onto a trailer and shipped to MSU. The size of the trees ranged from 7.6 to 20.3 cm (3 to 8 in) dbh. The green trees were selected from a stand near the B & B Fire.

If engineering wood products from presently submerchantable ponderosa pine and lodgepole pine removed in thin-slash-burn treatments meet performance standards, forest managers will have new utilization and silvicultural opportunities. Depending on the cost of extraction and available manufacturing facilities, land managers could produce revenue or at least partly offset the cost of treatment, enabling them to increase the total area that can be treated. Utilization of this wood

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also creates an opportunity to develop scale-appropriate technology for employment through value-added wood products for the WSIR.

Mechanical Forest Fuel Reduction Alternatives for Forest Managers: Non-commercial Component

The ponderosa pine forests of the Warm Springs Indian Reservation are overstocked with young trees. The understory is mostly trees of non-commercial size. This condition predisposes forests to stand-replacement catastrophic wildfire. An Oregon State University, College of Forestry, research study is assessing mechanical options for fuels reduction through mulching and masticating small, severely suppressed, understory trees and surface fuel. The principal investigators are Chad Bolding and Loren Kellogg from the Department of Forest Engineering[4]. Two types of equipment are being studied: (1) a flexible tracked skidding machine with a masticating head and, (2) an excavator based swing-boom machine equipped with a rotary disk mulching head.

The objectives of this study were to assess: (1) effects of treatments on the soil, (2) cost and production rates of the equipment, and (3) apparent efficacy of treatment in altering future fire behavior. Visual soil disturbance classification, and soil strength (compaction) will be compared before and after treatment. The level of productivity per scheduled machine hour will be evaluated through both shift-level and detailed time studies. Productivity observations will determine operating costs per unit volume and area for each machine. The study will also attempt to determine the type or category of forest fuel that each machine can effectively treat (range of dbh classes, dead and down material, shrub component, etc.). The effectiveness of the machines for implementing the silvicultural prescription will be compared by simulation evaluating pre- and post-treatment data with the fire and fuels extension (FFE) to the forest vegetation simulator (FVS) (Reinhardt and Crookston 2003).

The 32-ha (80-ac) study area is divided into 16 2-ha (5-ac) subunits in the southeast portion of the ponderosa pine forest on the WSIR. Each piece of equipment will treat approximately 16 ha (40 ac), comprising eight randomly selected subunits. The specific silvicultural prescription outlines the density level by diameter class for the residual stand, as established in the Warm Springs Forest Management Implementation Plan 2002-2011 (Arena 2003). Tree groups are scattered throughout the study area, ranging from patches of old-growth ponderosa pine with an understory of bitterbrush (*Purshia tridentata* (Pursh) DC.) and greenleaf manzanita (*Arctostaphylos patula* Greene) to patches of young ponderosa pine within a narrow range of diameters. The diameter class of each group will determine the tree spacing guideline, but all trees greater than 28 cm (11 in) dbh are designated as leave trees. The shrub layer of bitterbrush and greenleaf manzanita will also be treated. Operators are not permitted to use any other equipment besides the two being compared to complete their specified subunits.

[4] Chad Bolding, PhD Graduate Student, and Dr. Loren Kellogg, Oregon State University, College of Forestry, Department of Forest Engineering, Corvallis, OR

Summary

These three studies address the need for more information concerning management in the ponderosa pine forest. As mentioned earlier, the long-term investment in the stocking study plots should yield significant returns in the form of better stocking guidelines that the WSIR can apply in managing their ponderosa pine forest. These plots will help the Confederated Tribes identify options that best meet the diverse needs of their members. Any innovative value-added wood products may offer potential for both new manufacturing jobs and cost-effective ways to reduce overstocking of small-diameter conifer trees. The mechanical fuel reduction study examines treatment options and associated soil impacts, productivity, and costs in different fuel types, and should thereby help forest managers select the best treatment option for various stand and fuel conditions in these ponderosa pine stands.

References

Arena, J.V., technical coordinator. 2003. **Forest Management Implementation Plan 2002 – 2011**. Branch of Forestry, Warm Springs Indian Reservation, Warm Springs, OR: 68-82

Donaghu, W.B., technical coordinator. 1993. **Forest Management Implementation Plan 1992 – 2001**. Branch of Forestry, Warm Springs Indian Reservation, Warm Springs, OR: 33-43

Hall, F.C. 1987. **Growth basal area handbook**. R6 – ECOL – 181b – 1984. Portland, OR; U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 86 p.

Keen, F.P. 1943. **Ponderosa pine tree classes redefined**. Journal of Forestry. 41(4): 249-253.

Logan, R. 1981. **Historical Perspectives: The Warm Springs Forest through 1980**. 37 p.

Marsh, F.; Helliwell, R.; Rodgers, J. 1987. **Plant Associations Guide of the Commercial Forest of the Warm Springs Indian Reservation.** Bureau of Indian Affairs, Branch of Forestry, Warm Springs Indian Reservation, Warm Springs, OR. 142 p.

Reinhardt, E.; Crookston, N.L. (tech eds). 2003. **The fire and fuels extension to the forest vegetation simulator.** Gen. Tech. Report RMRS-GTR-116. Ogden, UT: Rocky Mountain Research Station, Forest Service, U.S. Department of Agriculture, 220 p.

Sassaman, R.W. 1982 August 19. Letter on file at Branch of Forestry, Warm Springs Indian Reservation, Warm Springs, OR.

Weaver, H. 1959. **Ecological changes in the ponderosa pine forest of the Warm Springs Reservation in Oregon**. Journal of Forestry: 57(1) 15 – 20.

Wilcox, E.R. 1964. **Growing stock objectives for management of ponderosa pine**. Unpublished paper, on file, Branch of Forestry, Warm Springs Indian Reservation, Warm Springs, OR.

Wykoff, W.R.; N.L. Crookston; Stage, A.R.. 1982. **User's guide to the Stand Prognosis Model**. Gen. Tech. Report INT-133. Ogden, UT: Intermountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 112 p.