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Western Juniper Harvest Systems Comparisons Project

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Technical Reports
Harvesting Western Juniper - A Case Study
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Pre- and Post Harvest Soil Investigations
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Project Administration
Klamath County Economic Development Association

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Special Note from the Author: This western juniper project, like most previous ones, established a number of "firsts":

- First Summary of Potentially Utilizable Western Juniper Volume and Acreage Inventory Data - Published and unpublished data about potentially utilizable juniper volume and acre estimates from Oregon, California, and Idaho were summarized in one table.
- First Pre- and Post-Harvest Soil Investigations - Bulk density was evaluated before and after commercial harvest operations in western juniper woodlands.
- First Systematic Collection and Analysis of Conventional Harvest System Data - Baseline data were gathered about average production of a conventional harvest system in western juniper.
- First Evaluation of Post-Harvest Slash Dispersal - The effectiveness of a grapple- equipped skidder was evaluated in terms of its ability to redistribute juniper slash from a central landing where juniper was mechanically delimbed.
- First Written Evaluation of Use of Pull-Through Delimbers in Juniper Harvest - Two shovel pull-through delimbers and a skidder pull-through delimber were used in a western juniper woodland harvest operation, and data recorded for baseline time/economics calculations.
- First Juniper Harvest Systems Production and Costs Comparison Table - Based on the information gathered for this project, a table was prepared showing cost and production estimates for various combinations of conventional harvest system operational phases in western juniper woodlands. Also included are cost and production estimates for mechanical delimbers and a forwarder.

Based on results from this project, recommended followup includes:

Forwarder Trials in Juniper Harvest - Data and observations need to be collected and analyzed about the use of a forwarder in conjunction with a commercial juniper harvest operation. A forwarder was the only option examined which had immediate potential to reduce harvest costs, at least on paper. Unfortunately, due to insufficient volume and lack of access to a forwarder at the time of the field trials, one was not able to be tested.

Working Prototypes of Juniper-Specific Harvest Equipment - Funding needs to be obtained to develop at least two working prototypes of harvest equipment specific to juniper. It is envisioned that this equipment would delimb and fall juniper at the stump. The results will be similar to "cut-to- length" systems now in use, but equipment design will be much different and costs much lower. Equipment such as this has the potential to reduce harvest costs and improve slash distribution, a critical element in restoration of rangeland habitat. It could also be used in conjunction with a forwarder to access more sites and further reduce costs.

Thank you again for your assistance and support of the Western Juniper Commercialization Project. Please keep in mind that harvest techniques and costs are constantly being worked on, which means the data presented are in a constant state of revision. (See Special Note below)

Special Note: Recent experience with the shovel pull-through delimber indicates that production will significantly increase as the operator became more familiar with the operation. It was estimated initially the increase would be "10-20%", which was used to project the numbers in the Cost and Production Estimates table. The current estimate is that production increased around 40%.).

Sincerely,
LARRY SWAN
U.S. Forest Service
Co-Chair, Western Juniper Commercialization Steering Committee

Western Juniper Harvest Systems Comparisons Project

By Larry Swan, U.S. Forest Service

Technical Reports

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Abstract

Project Need and Purpose

Western juniper (*Juniperus occidentalis*) is the most under-utilized wood fiber resource in Oregon. A number of factors contribute to this situation, but probably the biggest barrier to commercial use is harvest costs: Juniper trees have numerous and large limbs, average volume per acre is much less than current commercial species (such as ponderosa pine or fir), terrain is often rocky, and road systems are primitive. Other major barriers to large-scale use and commercialization include distance from potential markets, lack of industry infrastructure specific to juniper, and market acceptance.

The purpose of this project was to identify and assess harvest systems which already have been tried in western juniper woodlands, what might work which has not been tried, and conduct harvest trials with the best available systems identified. Harvest trial results were evaluated in terms of direct site impacts, production, and production costs. Loggers and landowners with juniper harvest experience were consulted, as well as a harvest systems researcher.

The harvest trials project site was located on property owned by the Lost River Ranch, about six air miles southwest of Bonanza, Oregon. Total project area was about 14.7 acres. Most of the site was considered "above average" for juniper stands with commercial potential: Average height was 33.4 feet, average age at stump height was 89 years, and average diameter at breast height was 12.6 inches. Tree density ranged from 25 to 160 per acre. Average volume per acre ranged from 220 ft^3 to 1,175 ft^3. Tree canopy prior to harvest ranged from less than 10% in the least dense area to over 60% in the densest area. Groundcover consisted for the most part of a thick carpet of cheat grass (*Bromus tectorum*). A shrub layer was virtually absent and there was very little juniper in the seedling/sapling size class.

Western Juniper Harvest Systems

At least seven individuals with commercial western juniper harvest experience, as well as a harvest systems researcher, were interviewed to determine what has been tried, what worked, what did not work, and what has not been tried that might work. Based on their input, ten different options involving all phases of a juniper harvest operation were considered for field trials. The two options which appeared most promising for reducing harvest costs were pull-through delimbers and forwarders. A forwarder could not be tested due to insufficient volume and equipment availability.

Harvest Trials Methodology

Baseline data were not available about average cycle times and production for the operational phases involved with juniper harvest. This prevented comparisons between potential harvest system options and made it imperative to obtain baseline data using the most common western juniper harvest system - chainsaws and a grapple-equipped rubber-tired skidder. Harvest operation phases studied included limbing prior to falling (a

technique used in juniper to reduce cost and risk to fallers), falling with chainsaws, delimbing with chainsaws, mechanical delimbing, and skidding. Three different pull-through delimbers were examined in the mechanical delimbing phase.

Two variables were used to evaluate direct site impacts of the harvest systems investigated: 1) Soil bulk density changes; and 2) Ability to distribute slash (limbs and other logging debris) evenly about the site. A third variable, success of grass seeding, could not be evaluated due to project and report timelines. A total of nine exclosures were erected after harvest to provide control plots for monitoring site response.

Harvest Trials Results

There was no significant production difference between a harvest system which used chainsaws to delimb juniper and a system which used a pull-through delimber. Both averaged about 1.7 tons of juniper per hour, at an estimated cost of $27-$29 per green ton. Production results were considered on the "low end" by both the logging systems researcher (MacNeel 1996) and the logging contractor (W. McGee personal communication). The logging contractor reports that a production increase of 10-20% can be expected as a shovel operator becomes more familiar with the pull-through delimber. (Special Note: The logging contractor recently revised this estimate to around 40%, based on additional production experience with the delimber.)

Performance of the three pull-through delimbers used in these trials differed substantially. The skidder pull-through delimber was least effective with juniper. Limb size and length hindered proper loading and actuation of a set of hydraulic knives. There were various reasons why one shovel pull-through delimber performed better with juniper than the other. These included: Larger, heavier, and taller platform; longer knives; and self-centering head. All three pull-through delimbers appeared suitable and capable of delimbing trees with smaller limb diameters and lengths.

A total of 398 trees were removed, which represented roughly two-thirds of the total standing before harvest (average 82 trees/acre pre-harvest and 27 trees/acre post-harvest). There was very little difference in bulk densities before and after harvest operations, even though post-harvest sampling was biased towards high impact areas, such as landings and skid trails. Surface organic matter actually increased due to needle cast from whole tree skidding and redistribution of mechanically-delimbed slash from a central landing. Slash was better distributed in the area that was delimbed with chainsaws (average cover 65%) than those areas where trees were whole-tree skidded to a central landing, mechanically-delimbed, and slash redistributed back out into the unit (average cover less than 15%).

Implications

Inventory - Research conducted for this project highlighted the sparse and often times incompatible nature of western juniper inventory data. It will be difficult to convince companies to invest significant amounts of capital without better inventory data. Key questions are: 1) How much is there?; 2) What is the quality?; 3) Where is it located?; and 4) How accessible is it (considering physical, geographic, legal, and social factors)?

Existing Juniper Harvest Systems - Western juniper harvest is expensive (averaging $25-$30 per green ton). No one piece of equipment was identified which will solve all or most of the cost and production issues in western juniper. It appears that incremental production increases and cost reductions may be possible through use of different arrangements of conventional systems, but significant increases in production will require more capital investment. For example, the only significant decrease in harvest costs was projected with use of a forwarder. Actual field trials were not conducted with one due to the volume and acreage required. It is estimated a harvest operation using a forwarder would require at least 1,500-2,000 acres per year of medium- to high-density juniper woodlands (50-150 trees per acre, averaging 12-14 inches diameter at breast height).

Slash Dispersal - The ability to evenly disperse juniper slash is critical to meet the goal of improving rangeland habitat through commercial harvest. This is difficult to effectively and economically accomplish using a harvest system which relies on a rubber-tired skidder and grapple. Several methods were tried to improve slash dispersion, none of which worked well. Options to improve slash dispersal were discussed with various government personnel and private industry. Analysis suggests that more limbs can be left on-site without major modification of systems already in use, or a significant negative impact on costs and production.

Mechanical Harvest Impacts on Juniper Woodlands Soils - Some concern has been expressed about the impacts of mechanical harvest on soil types found in western juniper woodlands. Based on the results of this project, minimal impacts are expected on dry clay loam and clay soils. These soil conditions are encountered most frequently in the late summer and early fall, when soil moisture is historically at a minimum.

Harvest Equipment Specifically Designed for Juniper - Several loggers with extensive commercial juniper harvest experience believe what is needed is a piece of harvest equipment which will delimb juniper "on the stump" and cut it. The advantages of such a system are that labor costs will be reduced, personal safety improved, and slash dispersal improved. Costs would be comparable to a shovel/pull-through delimber combination ($75-$80,000). There is no way yet to estimate production because there is no equipment like this on the market.

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Project Purpose

The purpose of this project was to identify and assess harvest systems which have already been tried in western juniper (*Juniperus occidentalis*) woodlands, what might work which has not been tried, and conduct harvest trials with the best available systems identified. Harvest trial results were evaluated in terms of direct site impacts, production, and production costs. Loggers and landowners with juniper harvest experience were consulted, as well as a harvest systems researcher.

Project Background

Western juniper is the most under-utilized wood fiber resource in Oregon. A number of factors contribute to this situation, but probably the biggest barrier to commercial use is harvest costs: Juniper trees have numerous and large limbs, average volume per acre is much less than current commercial species (such as ponderosa pine or fir), terrain is often rocky, and road systems are primitive. Other major barriers to large-scale use and commercialization include distance from potential markets, lack of industry infrastructure specific to juniper, and market acceptance.

This project was formulated and designed by members of the Western Juniper Commercialization Steering Committee, a loosely-organized cooperative venture of the U.S. Forest Service, Wood Products Competitiveness Corporation, Inc. (WPCC), and Oregon State University Extension. Steering Committee membership is composed of wood products industry representatives (small, medium, and large companies), government agencies, private landowners, and non-profit economic development and environmental organizations.

Environmental and Social Setting

There are approximately 3.8 million acres of western juniper woodlands (defined as having at least 10% juniper canopy cover) within the species' primary range of eastern Oregon, northeastern California, and southwestern Idaho. About 58% of this acreage is on public lands managed by the Bureau of Land Management, U.S. Forest Service, State, Indian tribes, and other Federal agencies, and about 42% is privately owned. There are literally millions of acres more of scattered juniper and areas in which young juniper are just now becoming apparent on standard resolution aerial photography.

Western juniper is the least-utilized wood fiber resource in this region. Total woodland volume is estimated to be at least 691 million cubic feet, of which about 39% is on private lands and 61% is on public lands. Volume data do not include western juniper within commercial forest lands or other forested lands. Table 1 (*Western Juniper Acreage and Volume*) summarizes for the first time unpublished and published western juniper inventory data collected by the U.S. Forest Service Pacific Northwest Range and Experiment Station, Portland (Oregon and California) and Intermountain Research Station, Ogden, Utah (Bolsinger 1989; Chojnacky 1991; Gedney personal communication; Woudenberg personal communication).

The area dominated by Western juniper represents a three- to ten-fold increase since the late 1800s. Reasons for this expansion are complex, but generally involve absence of fire, domestic livestock grazing, and short term changes in climatic patterns. Richard Miller, Oregon State University, states that western juniper stands appear denser today than at any time during the past 5,000 years (personal communication). Expansion appears to have slowed in California and much of Oregon, but field investigations indicate a continuation of the trend in some areas (Eddleman personal communication).

The expansion and increasing density of western juniper woodlands greatly concern private landowners, government land managers, and scientists. Many juniper-dominated sites show clear evidence of watershed degradation, loss of site productivity, decrease in forage production, loss of wildlife habitat, and over-all reduction in biodiversity (Eddleman 1995; Bedell et al. 1993).

Numerous private landowners undertake juniper clearing operations every year in eastern Oregon and northeastern California. In total, clearing operations probably average about 10,000 acres per year or less, which can be extrapolated to an estimated 2.2 million cubic feet of juniper fiber[(1)] (Okholm personal communication; Gedney in Haugen 1993). Eddleman offers an estimate of around 40,000 acres of western juniper woodlands treated over the last 10 years (Eddleman et al. 1995 in Miller et al. 1995:9). Due to lack of demand and markets, as well as economics, the juniper removed is often piled and burnt, or simply left to decompose after being knocked-down or cut. Government agencies are currently less active in clearing juniper than private landowners, due to concerns about legal challenges and lack of funding for such projects.

Clearing operations are expected to continue despite a decrease in government subsidies. According to Tom Birch, a Forest Service scientist who summarized data from a national study of forested land owners and their harvest plans, there are probably at least 3,000 ranchers in Oregon and California who plan to thin their juniper woodlands within the next 10 years, at a minimum cost of more than 13 million dollars (personal communication about unpublished research data).[(2)]

As one rancher puts it: "I feel like I'm buying my land a second time due to costs of beating back the juniper." (Otley personal communication).

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Sauerwein, William J. 1982. Western juniper site index curves. *Technical Notes:* Woodland No. 14. USDA Soil Conservation Service, West Technical Service Center. Portland, Oregon.

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Ward, Barney 1994. Personal communication. California Department of Forestry and Fire Protection. Alturas, CA.

Washington, Joseph 1996. Revegetating western juniper-medusa head rangeland. Masters thesis. Oregon State University, Corvallis, OR.

Winnop, Carl 1996. Personal communication. Warner Mountain Resources, Alturas, CA.

Woudenberg, Sharon 1997. Personal communication. U.S. Forest Service, Intermountain Research Station, Ogden, UT.

1. Assuming 10,000 ac./yr. at an average of 225 cu. ft./ac = 2.25 million cubic ft.

2. Key assumption is that ranchers who intend to thin their woodlands over the next 10 years will treat 25% of the average 350 woodland acres/landowner, at a minimum cost of $50 per acre.

3. It is estimated only 10-20% of the total standing trees are what could be considered "saw log" quality. The remainder are too asymmetrical, twisted, or limby to be economically sawn with known and available technology and markets.

4. Time estimate based on at least 8,000 observations during the last 2-3 years (H. McGee personal communication; M. Reynolds personal communication).

5. Special Note: Sauerwein's index is valid only for "well-stocked" stands, which in this case are the medium- and high-density areas (more than 50 trees per acre).

6. Dryland Pasture Blend consisted of Paiute Orchardgrass (29%), Manchar Bromegrass (29%), Oahe Intermediate Wheatgrass (28%), Ladak Alfalfa (10%), with the remaining 4% inert. Seed came from Union Seed Co., Nampa, ID.

Harvesting Western Juniper (*Juniperus occidentalis*)
in Eastern Oregon - A Case Study

J.F. McNeel, University of British Columbia
and
L. Swan, U.S. Forest Service

This paper summarizes the results of a recent study of harvesting operations in a stand of western juniper near Klamath Falls in eastern Oregon (See attached Vicinity Map). Harvesting juniper stands is fairly appealing to many ranchers in eastern Oregon, due to the large areas of range land that have, over time, become dominated by juniper. Juniper stands also reduce the amount of water available to grasses and other forage plants.

Conversion of land invaded by juniper stands is not an easy task. The timber has traditionally been considered a weed species with little or no commercial value as a wood product. When attempting to convert their lands, ranchers are often forced to simply cut down the trees, pile them, and burn the piles. The cost of these operations are prohibitive, ranging from $35 to $75 per acre, and few ranchers are in a position to finance large scale clearing operations to improve their grazing lands.

At present, there are approximately four million acres of western juniper woodlands (where juniper has a 10 percent or greater canopy) in eastern Oregon, northeastern California, and southwestern Idaho. Total volume is estimated to be well over 700 million cubic feet on these lands. About 58 percent of the total acreage Is on public lands and the remainder is privately owned. Over 61 percent of all juniper woodland is located in eastern Oregon.

The area dominated by western juniper represents a three to ten-fold increase since the late nineteenth century. Reasons for this expansion are complex, but generally involve the absence of fire, increases in domestic livestock grazing, and short-term changes in local climatic conditions. The expansion and increasing density of western juniper woodlands is of great concern to private landowners, government land management agencies, and scientists. Many juniper-dominated sites show clear evidence of watershed degradation, loss of site productivity, decreases in forage production, loss of wildlife habitat, and reductions in biodiversity levels.

Western juniper is currently the least utilized wood fiber source in eastern Oregon. Juniper is not considered a viable commercial species by most forest products companies for a number of reasons. Juniper trees have numerous and large limbs, large flared butts, and can contain extensive pockets of butt rot. Other major barriers to more intensive commercial use include the distance to major fiber markets, lack of an industry-specific infrastructure for the commodity, and lack of market acceptance. However, the most significant problems associated with using western juniper as a commercial timber species are those encountered during harvest operations.

Conventional harvesting systems commonly used in Eastern Oregon -- typically consisting of a feller-buncher, skidder, and sometimes a stroke delimber -- are not suitable for handling the butt flare and large, flexible limbs common to western juniper. These properties affect harvesting system productivity in the following manners:

- 1. **Increased time required for manual falling operations** - Fallers are often required to spend considerable amounts of time delimbing the standing tree and clearing limbs from around the bole prior to falling to allow them access to the bole, a practice that requires between two and six minutes depending on the limbiness of the tree. Stem form and limb structure also make the tree butt bounce up after falling, creating a hazard for the faller and adding time to the falling operation.
- 2. **Delays in delimbing** - Considerable time can be lost when manually delimbing the felled tree with chainsaws. Fallers reported average delimbing times that exceed five minutes per tree. This is a significantly longer time than anticipated with other, less branchy species.
- 3. **Reduced skidder loads** - It is difficult, if not impossible, to bunch unlimbed juniper trees prior to skidding, unless the operator is willing to take only one or two stems to the landing per cycle. Aside from

the fact that the trees are manually felled - which limits the potential for bunching an adequate load - the size and quantity of limbs limit the size of the bunches to no more than one or two trees, far less than required for a full load when using a grapple skidder.

Study Objectives

The previously noted problems that can occur when harvesting juniper suggest that there is a limited window of opportunity for this species. A major concern is the actual productivity of a conventional harvesting system and the costs associated with that harvesting operation when working in juniper. Thus, the primary objective of this study is to determine the average productivity by phase for a conventional harvesting system while harvesting juniper. In addition, mechanical delimbing of juniper will be analyzed to determine what changes in productivity might occur through the adoption of this technique into the harvest system.

Methods

The stand harvested during this study was measured and marked prior to harvest. Three stocking densities were noted during the pre-harvest inventory. These included low density stands with between 25 to 50 stems per acre, medium density stands with 50 to 100 stems per acre, and high density stands with 100 to 160 stems per acre. Marking varied depending on initial stocking densities, with 5 to 15 stems removed per acre in the low density stands, 15 to 25 stems removed per acre in the medium density stands, and 50 to 100 stems per acre removed in the high density stands. The average diameter of the harvested stems was 13.6 inches at breast height. The mean weight of the merchantable portion of each harvested stem was 721 pounds or 0.361 tons per stem. The site was relatively flat to rolling terrain with few obstacles present that would affect primary transport operations.

The harvest system used during the study consisted of two to three chainsaw operators, a grapple skidder, a mechanical delimber, and a hydraulic knuckleboom loader (or shovel). The crew had been working for at least five years in harvesting operations, with about six to nine months of experience harvesting juniper stands. The pre-limbing crew (See note below for details on pre-limbing process) had limited experience. The operations involved in the harvest of these stands included the following:

Pre-limbing: Standing trees were manually "pre-limbed" by a chainsaw operator to a height of about six to eight feet. This allowed the faller to later access the base of the tree for the falling phase. This operation is not typically required when harvesting other species, but was necessary in nearly every case during this study. Branches were removed from around the base of the tree by the chainsaw operator to provide an escape route for the faller.

Falling: The falling phase was carried out independent of the pre-limbing operation. Falling was done in a conventional manner using chainsaws. Wedges were used in many cases because of the short (mean height of 30 to 40 feet), limby nature of the tree, which made the severed stems "sit down" on the stump.

Manual Delimbing: Trees were delimbed and topped after falling was completed. All manual delimbing was done "at the stump", where the tree had been felled. Trees were never completely delimbed during the manual operation, because of the problems with accessing the bottom side of the tree. Some work was then required at the landing to finish the delimbing process.

Mechanical Delimbing: Mechanical delimbing with a low cost pedestal mount delimber was studied as an option to manual delimbing to determine if this approach would improve system productivity and lower costs. Two mechanical delimbers were evaluated during the study, a Dansco and a CTR. Both operated on the principle of drawing the stem through a set of hydraulically actuated knives with a knuckleboom loader. A number of factors were critical to the success of this operation:

1. Operator experience - The operator had little or no experience with this phase prior to the study. As the study progressed, delimbing cycle times improved dramatically.

2. Loader performance - If the loader had been a bit more powerful, delimbing would have been somewhat faster, although no major problems were encountered relative to the loader.

3. Knife angle and length - Some problems were encountered due to the placement angle of the delimbing knives, where the knife blade would "dig in" to the bole while delimbing. Also, the knife blades on one delimber were not large enough to completely shear off some larger limbs. The typical limb diameter at the bole averaged between three and six inches, with some limbs ranging to nine inches in diameter at the bole.

4. Presence of a self-centering head - The operator indicated that the presence of a self-centering head greatly improved delimbing times.

5. Size and weight of the delimber - The taller, heavier delimber observed in this study did not tip over, and provided a better pull through motion for the loader.

6. Pre-limbing height - Pre-limbing heights of at least eight feet were required to adequately handle the stem during mechanized delimbing.

7. Presence of slash - It was critical that slash be removed from the front of the delimber after only one or two cycles. If this was not done, positioning of the stem in the delimber was more difficult and resulted in longer delimbing cycle times.

Skidding: The system uses a grapple skidder, which may be the only option available for skidding juniper. Skid cycles were timed for both limbed and unlimbed stems. In addition, the number of stems skidded per cycle was obtained to estimate differences in load for these two options.

The skidder's return cycle was used to distribute slash throughout the harvest unit to improve groundcover growth and survival. The site was seeded with forage grasses prior to harvest and the slash added organic material to the marginal soils, decreased soil temperature, and improved soil water retention. The slash was also considered a deterrent to grazing of the newly established grasses by domestic and wild animals.

Loading: Loading was not timed during this study, as most of the material was decked. However, loading cycles can probably be estimated from other studies where loading cycles were observed since there is little difference in loading times by species for specific log sizes.

All trees were manually pre-limbed and felled. Some were then manually delimbed prior to skidding to provide comparative data. The remaining trees were skidded without being delimbed (whole-tree skidding), mechanically delimbed at a central landing, and then decked or stored for later delivery to a local mill. Slash was then re-distributed throughout the harvest unit using the grapple skidder.

After the data for each cycle was collected, the information was entered into a spreadsheet for analysis. The objective of the analysis was to determine the average time required to complete each phase of the processing operation.

Data was collected using conventional time and motion study techniques. Cycles were defined for each phase of the harvest operation and then timed using a stop watch. Recorded times were then entered into a spreadsheet for basic statistical analysis. After the average time to complete each phase was estimated from the data, a complete cycle time estimate was developed. Cycle times were then paired with production estimates obtained from mill records to obtain an estimate of the average production per cycle in tons per productive minute.

All phases of this system typically handled only one stem per cycle. Only during the skidding phase was more than one stem handled during a single cycle. To estimate the cycle time per stem, the following equation was used to modify the average cycle time for skidding:

SpS = S/N (eq. 1)

Where:
SpS = Mean Skid time per stem
S = Mean Skid time (observed)
N = Mean number of stems per cycle (observed)

A total cycle for the harvesting operation could include either manual or mechanical delimbing, but not both phases. So, the total cycle time estimate for the operation consisted of:

TC (min) = PL + F + SpS + MD (eq. 2)

or:

TC (min) = PL + F + S + DM (eq. 3)

Where:
TC = Total Cycle Time
PL = Pre-Limb Time
F = Fell Time
MD = Mechanical Delimb Time
DM = Manual Delimb Time

Total scheduled hour production was estimated using the relationship illustrated in equation 4. By determining the total number of cycles per scheduled hour and combining that value with the estimated average weight per stem, an estimate of the average hourly production can be obtained.

Prod = (60 min per SchedHr/TC) * Wt (eq. 4)

Where:
Prod = Production per Scheduled Hour (tons/hr)
Wt = Mechantable weight per stem (tons)
TC = Total system cycle time per stem (scheduled minutes)

As no estimates of the overall utilization of the system were made, an assumption was made regarding utilization. The system was assumed to work approximately 75 percent of the total scheduled time during the day. In addition, the system was assumed to be harvesting trees with an average yield equal to that estimated in the study. Predictions outside the range observed in the study were avoided. However, it should be pointed out that these estimates of production will typically hold for only small changes in stem size, so that any significant change in stem size would make production estimates difficult using the data provided through this study.

Results

Descriptive statistics are provided in Table 1 for all of the harvesting phases observed during the study. Using equations (2) and (3), two different estimates of the total harvest cycle time per tree can be obtained, depending on whether manual or mechanical delimbing was included:

For mechanical delimbing:

TC = PL + F + S + MD

and;

TC = 2.53 + 2.02 + 2.27 + 2.91
TC = 9.73 productive minutes per cycle

For manual delimbing:

TC = PL + F + S + DM

and;

TC = 2.53 + 2.02 + 2.27 + 3.13
TC = 9.95 productive minutes per cycle

Assuming an average 75 percent utilization rate for the system, the total cycle tome for the system using a mechanical delimbing phase can be estimated as:

TC (sched) = (9.73)/0.75
TC (sched) = 12.97 scheduled minutes

and

Prod = 60 min/12.97
Prod = 4.64 cycles per scheduled hr

Where:
Prod = Total number of cycles per scheduled hour

Table 1: Descriptive statistics for harvest phases during harvest operations in a partial harvest of western juniper.

Harvest Phase	Mean Cycle Time	Std. Deviation	N
Pre-Limbing	2.53	1.90	64
Manual Felling	2.02	1.14	21
Manual Delimbing[1]	3.03	2.02	9
Skidding[2]	5.20	2.37	14
per stem...	2.27		
Mechanical Delimbing[1]	2.91	1.77	59

[1] Manual delimbing occurred prior to skidding and precluded any need for mechanical delimbing operations. Mechanical delimbing occurred at the landing after skidding operations and no manual delimbing was required when this operation was included in the system.

[2] Skidding cycles averaged 2.3 stems per cycle. Average cycle time was adjusted to provide the average cycle time per stem, as indicated above.

For manual delimbing, the same approach is used, and the total cycle is estimated as:

TC = (9.95)/0.75
TC = 13.27 scheduled minutes

and

Prod = 60 min/13.27
Prod = 4.52 cycles per scheduled hr

Where:
Prod = Total number of cycles per scheduled hour

The production rate for this system defines the volume or weight of wood harvested per scheduled hour of production. Using the mean weight per harvested stem of 0.361 tons and equation 4, the production rate for a system using mechanical delimbing is estimated to be:

Prod = (4.64*0.361)
Prod = 1.67 tons per scheduled hour

Thus, the estimated production for this system using mechanical delimbing on an hourly basis is 1.67 tons per hour. If the value of a green ton (freshly harvested) of juniper is estimated to equal $40 per ton, the gross return from this system is estimated to be:

Gross = 1.67 tons * $40 per ton
Gross = $67 per hour of production

For the manual delimbing option, the production rate is very similar, estimated at 1.63 tons per scheduled hour. Combined with the estimated harvested stem weight for the stand, the gross revenue that could be expected for juniper bringing $40 per ton would be $65 per scheduled hour.

If the cost of the equipment, insurance, parts, repairs, fuel, and labor exceed this revenue on an hourly basis, the operation is unprofitable. If these costs are less on an hourly basis, then the system can operate profitably when harvesting

a stand similar to that studied here. The productivity associated with mechanical delimbing did not differ significantly from that for manual delimbing. However, it should be noted that the mechanical process required only the loader operator, who was located in a protected cab during delimbing. In contrast, the manual delimbing process required an individual on the ground to operate the chainsaw. The manual delimbing was also considered a very dangerous and fatiguing operation, particularly given the average limb size and number of limbs that had to be removed. Generally, the contractor greatly preferred the mechanical system, as it seemed more productive, and created a safer work environment for the crew.

This analysis assumed no costs associated with stumpage. While this is uncommon in most harvest operations, the situation with juniper is somewhat different. Many landowners in eastern Oregon and elsewhere want to have their juniper woodlands thinned, and know that they cannot do it themselves. Some are willing to exchange the harvested timber for having the stand thinned to their specifications. In this study, for example, no stumpage fee was charged to the contractor, and the landowner appeared pleased with the initial results.

On the other hand, many landowners will need to be convinced that their particular patch of juniper is virtually worthless. Based on the experience of the few who have commercially harvested juniper, there are only a few situations where stumpage can be paid for western juniper. For example, stumpage ranging to a high of $5 per green ton has been paid to landowners in the following situations:

- 1. Where there is easy access to a local mill willing to take the material.
- 2. Good quality logs in a dense stand (> 100 stems per acre)
- 3. Presence of a strong biomass or "dirty" chip market

Generally, landowners should not expect to receive any stumpage for their juniper stumpage. If the market for this material becomes more viable and mills begin to accept western juniper as a needed raw material, the situation might change.

Conclusions:

This study examined partial harvest operations in a western juniper stand in eastern Oregon. Total cycle time estimates for this operation were developed for both manual and mechanical delimbing operations. While there was little difference in the productive times recorded for these two options, the contractor preferred the mechanical option, both for safety and production reasons.

Generally, production for this system was low, with an observed average productivity of less than two tons per scheduled hour. This low rate of production is countered by the negligible cost associated with the stumpage, suggesting that a conventional harvesting operation could be effective in harvesting juniper from rangeland sites. Obviously, factors such as initial stocking, harvested stem size, log quality, and removal densities will also have a significant effect on the profitability of these operations. Land owners interested in harvesting juniper woodlands need to work closely with local logging contractors and mills to determine whether commercial harvest is an option for thinning their woodlands. In many cases, due to the factors mentioned previously, commercial harvest will not be an option, even if the landowner is willing to give the timber to the contractor.

Pre- and Post-Harvest Soil Investigations
Western Juniper Harvest Systems Comparisons Project

By Eric Nicita and Larry Swan
U.S. Forest Service

December 1, 1996

Abstract

The purpose of this investigation was to evaluate mechanical harvest impacts on soils in a western juniper (*Juniperus occidentalis*) woodland parcel of about 14.7 acres. The project site is located on property owned by the Lost River Ranch, about six air miles southwest of Bonanza, Oregon. This is the first study to examine the effects of mechanical harvest on the soils of a western juniper woodland parcel.

Western juniper entirely dominated the pre-harvest overstory, ranging from 25-35 stems/acre in the lowest density area to 120-160 stems/acre in the highest density area. Shrub cover was sparse and groundcover consisted of a dense carpet of cheat grass (*Bromus tectorum*). Juniper canopy cover was estimated from aerial photographs to be less than 10% in the low density area and greater than 60% in the high density area. Average age of the junipers on site was 80-90 years at stump height. No trees were cored that were older than 90 years. Average diameter at breast height was 12-14 inches and average tree height was 33.4 ft. Juniper reproduction was sparse.

Project site soil developed residually on the south-west side slope of a dissected volcanic plateau of Pliocene and Miocene basalt. Soil age ranges from 6.88 to 3.61 million years ago (Sherrod and Pickthorn, 1992). The *Soil Survey of Klamath County, Oregon* (Soil Conservation Service, 1985) mapped the project area's Family soil as "Lorella very stony loam, 2% to 35% slopes". The Lorella series soil has a loamy surface overlying an illuviated clay loam subsurface.

The harvest site was heavily grazed by sheep prior to conversion to a cattle ranching operation about 40 years ago. The area is not regularly grazed currently except for a few horses during the summer. Landowner objectives were to increase forage for domestic livestock, and maintain forage and cover for deer.

Mechanical harvest impacts were measured in terms of bulk density change after harvest operations. Soil structure and surface organic matter changes were qualitatively examined. Control values for bulk density were obtained by collecting soil samples immediately prior to harvest operations from two randomly placed and directed ten-point transects. Soils in the high density stand area were not sampled due to the inability of the core sampler to penetrate the cobbly soil. Little impact was expected by harvest operations due to the lithic nature of the soil. Following harvest operations, sampling strategy was biased towards identifying the highest possible impact.

About 40% of the standing junipers within the project area (about 400 trees) were removed during harvest operations. There was very little difference in bulk density before and after harvest operations, even though post-harvest sampling was biased towards high-impact areas. Surface organic material actually increased due to redistribution of slash around the site.

The lack of soil bulk density change is best explained by the fact that harvest operations were conducted and monitored in early fall, when soil moisture is historically at a minimum. It is expected that similar operations will detrimentally affect similar soils if conducted when there are saturated conditions.

A puzzling result of the investigation was that although one would expect juniper productivity to be greatest in the deepest loamy soil, the converse was true. Juniper stand density was highest in the shallowest soil with the most clay. One explanation proposed is that loamy-textured soil has greater macropore space and consequently

decreased potential for long-term water storage in arid lands (Hopkins personal communication).

Project Purpose and Background

The purpose of this project was to evaluate mechanical harvest impacts on soils in a western juniper (*Juniperus occidentalis*) woodland parcel of about 14.7 acres. Project funding was provided through a grant from the Oregon Regional Strategies Program, which uses lottery dollars to support economic development projects.

There are three- to ten-times more area dominated by western juniper than in the late 1800s. Reasons for this expansion are complex, but generally involve absence of fire, domestic livestock grazing, and short-term changes in climatic patterns. The expansion and increasing density of western juniper woodlands greatly concern private landowners, government land managers, and scientists. Many juniper-dominated sites show clear evidence of watershed degradation, loss of site productivity, decrease in forage production, loss of wildlife habitat, and over-all reduction in biodiversity (Beddell et al. 1993).

A public/private partnership has been actively trying to commercialize western juniper for the last four years (Western Juniper Commercialization Steering Committee). A major challenge is how to economically thin western juniper woodlands in an environmentally-sensitive manner. This is the first investigation to examine the effects of mechanical harvest on the soils of a western juniper woodland parcel.

Project Location

The project site is located on property owned by the Lost River Ranch, about six air miles southwest of Bonanza, Oregon. The northern boundary of the project site borders North Poe Valley Rd., approximately four miles east of the intersection of State Highway 140 East and North Poe Valley Rd. (T. 39 S., R. 11 1/2 E., SE 1/4 of SW 1/4 of Section 22, Northern Geodetic Vertical Datum of 1929). See Project Vicinity and Project Location Maps.

Environmental Setting

The project site is located on a portion of the west-facing slope of a low-lying peninsula of western juniper woodlands. The peninsula is surrounded on three-sides by irrigated pasture and crop lands. Three small ephemeral drainages are present in the northwest portion of the project site.

Western juniper entirely dominates the overstory, ranging from 25-35 stems/acre in the lowest density area to 120-160 stems/acre in the highest density area. Shrub cover is sparse, consisting of a few big sage brush (*Artemesia tridentata*) and current (*Ribes* sp.). A dense carpet of cheat grass (*Bromus tectorum*) dominates the groundcover. Medusahead (*Taeniatherum captu-medusa*), a noxious weed, was observed in patches adjacent to the project site and was sparsely present in a small area of scabrock in the northwest corner of the project site. No harvest activities occurred in areas with medusahead.

Juniper canopy cover was estimated from aerial photographs to be less than 10% in the low density area and greater than 60% in the high density area. Average age of the junipers on site was 80-90 years at stump height (age at breast height averaged 70-80 years). No trees were cored that were older than 90 years. Average diameter at breast height was 12-14 inches, with a range from less than two inches (seedlings/saplings) to 25 inches. Average height was 33.4 ft., with a range from seedlings to 48 ft. Juniper reproduction is sparse. Older junipers are present just east of the project site in an area of scab rock, however ages were not determined. Based on previous experience, they appeared to be at least 200 years old.

The wooded peninsula on which the project area is located is currently used by Lost River Ranch for winter feeding of cattle. Most of the feeding occurs east of the project site, on top of the peninsula. According to Bill Kennedy (ranch owner), cattle are normally moved into the area in November and moved off in March. A small herd of horses (five) grazes the larger peninsula area during the summer. There was little evidence of domestic livestock grazing observed at the time harvest operations were conducted (few cow trails and very little manure).

A resident herd of deer probably utilizes the project site more than domestic livestock, as well as deer which migrate through in the fall and spring. Over 12 were consistently in the area, and up to 30 were seen after the first cold snap and right after mechanical harvest operations were completed in the middle of October.

According to Mr. Kennedy, prior to conversion to a cattle operation about 40 years ago, the area was intensively grazed by sheep. It is surmised that previous vegetation was characterized by a few old growth juniper in the scabrock along the spine of the peninsula, and a bitterbrush/big sagebrush/bunchgrass plant association.

Landowner objectives were to increase forage for domestic livestock, and maintain forage and cover for deer.

General Description of Soil and Geology

Project site soil developed residually on the south-west side slope of a dissected volcanic plateau of Pliocene and Miocene basalt. Soil age ranges from 6.88 to 3.61 million years ago (Sherrod and Pickthorn, 1992). The *Soil Survey of Klamath County, Oregon* (Soil Conservation Service, 1985) mapped the project areas's Family soil as "Lorella very stony loam, 2% to 35% slopes". The Lorella series soil has a loamy surface overlying an illuviated clay loam subsurface. A complete soil description is attached (see Attachment A).

Methodology

Mechanical harvest impacts were measured in terms of bulk density change after harvest operations. Soil structure and surface organic matter changes were qualitatively examined. The project area was divided into three areas, corresponding to obvious differences in juniper density on an aerial photo: 1) Low Stand Density (approximately 25-49 trees/acre); 2) Medium Stand Density (approximately 50-99 trees/acre); and High Stand Density (approximately 100-160+ trees/acre). Soil sampling was stratified based on the three stand densities identified.

Control values for bulk density were obtained by collecting soil samples immediately prior to harvest operations from two randomly placed and directed ten-point transects, in the low- and medium-stand density areas. Three transects in each portion of the harvest area would have been desirable, however harvest operations had already commenced. Soils in the high-density stand area were not sampled due to the inability of the core sampler to penetrate the cobbly soil. Little impact was expected by harvest operations due to the lithic nature of the soil.

Following harvest operations, sampling strategy was biased towards identifying the highest possible impact. Samples were taken from: 1) High traffic skidder and delimbing trails on the central landing; 2) Skid trails in the low- and medium-stand density areas; and 3) Between skid trails in the medium-stand density area. Only skid trails were sampled after harvest in the low-stand density area due to lack of harvest traffic.

Results

Pre-Harvest Sampling

Based on samples collected and analyzed, only one-third of the project site roughly fits the Lorella series soil mapped for this area in the *Soil Survey of Klamath County, Oregon* (1985); the other two- thirds of the project site are soils related to, but with distinct differences from, the Lorella soils. In general, project site soils have a coarse fragment content ranging from 0% to 75%+ (on the eastern edge of the unit, in the high stand density area). Rock fragments are highly weathered and typically cobble size in high- and low-density stand soils.

The soil supporting the medium-density stand area is closest to the Lorella series, however the surface texture is a clay or clay loam rather than the loam listed in the soil series description. The soil profile does not exceed 15 inches, which is within the range of the published series description. It is possible the loam surface from upslope soils eroded and deposited slightly down-slope on the soil supporting the area categorized as low-stand density.

The soil supporting the low-density stand is located north of the medium-density stand. It appears to be the Lorella series with an alluvial (from sheet erosion) or aeolian (wind) deposited loamy overburden of 20 inches. It has less than five percent gravel content in the top 20 inches of soil.

The high-stand density area lies for the most part upslope and east of the moderate-stand density area. The soil is lithic with a clayey surface soil texture (typical scabland).

Post-Harvest Sampling

The average bulk density of the soil before and after harvest are summarized in **Table 1** (*Average Bulk Densities and Soil Moisture Changes - Pre-Harvest (Control) and Post-Harvest*). Also included in **Table 1** are the moisture and gravel content of the soil. The cobble portion of the rock fragment is not included.

TABLE 1
Average Bulk Density and Soil Moisture Changes
Pre-Harvest (Control) and Post-Harvest

Harvest Unit Area	*Bulk Density (g/m^3)*	*Moisture (%)*	*Bulk Density Change*
Control			
Low-Density Stand	1.31 (SD=0.05)	7.49 (SD=1.24)	----
Medium-Density Stand	1.19 (SD=0.09)	11.16 (SD=2.42)	----
Skid Trails			
Low-Density Stand	1.28 (SD=0.07)	7.39 (SD=0.94)	- 0.03
Medium-Density Stand	1.17 (SD=0.06)	9.44 (SD=2.11)	- 0.02
Landing			
Medium-Density Stand	1.19 (SD=0.11)	9.87 (SD=1.34)	0
Between Skids			
Medium-Density Stand	1.16 (SD=0.10)	9.80 (SD=2.21)	-0.03

Average bulk density before harvest in the medium-stand density area was 1.19 g/cm^3 and 1.31 g/cm^3 in the low-stand density area. There were very little or no observable changes in bulk density after harvest. On the landing, where the biggest difference was expected, bulk density remained at 1.19 g/cm^3. Between skid trails (intra-skids), bulk density decreased 0.03 g/cm^3 to 1.16 g/cm^3. On the skid trails, bulk density decreased 0.02 g/cm^3 to 1.17 g/cm^3 in the medium-stand density area, and 0.03 g/cm^3 to 1.28 g/cm^3 in the low-stand density area.

Soil structure was slightly platy prior to the harvest operation and did not appear to change following harvest.

Changes in surface organic material were qualitatively examined. The small amount and type of surface organic material that existed prior to harvest was not observable post-harvest on the landing and skids where traffic was concentrated due to the crushing action of skidder tires. On the other hand, surface organic material actually increased as a result of harvest activities in the intra-skid area where traffic was diffuse. The increase resulted from slash material being removed from the landing where the juniper was delimbed and scattered throughout the site during skidding operations.

Discussion

It is clear harvest operations had minimal impact on project site soil. Differences in bulk density can be attributed to statistical variations in testing and localized soil differences. The platy soil structure observed may have been due to past heavy grazing on the site.

The increase in surface organic matter is not surprising. Slash was purposefully left where it fell during manual pre-falling and delimbing operations, or was distributed back onto the site after juniper was mechanically delimbed at the landing. Whole-tree skidding also decreased soil impacts and increased organic matter.

Harvest operations were conducted and monitored in early fall when soil moisture is historically at a minimum. Similar operations probably will detrimentally affect project site soils if conducted when soils are saturated. Although the amount of compaction cannot be estimated without seasonally specific monitoring, a soil is most prone to plastic deformation when saturated. This enables water to run off the site and concentrate in skids and roads, thus decreasing the amount of water infiltrated into the soil and increasing soil erosion.

Although there was no significant effect on the soils from this harvest, it may be a site specific phenomena. Sites where the soil has a siltier texture, more moisture, or less historical grazing should be monitored closely for compaction and organic horizon disruptions. Conversely, little effect on dry clay loam and clay soils with a past history of heavy grazing practices is expected with similar harvest methods.

A puzzling aspect of the site should be mentioned. One would expect juniper productivity to be greatest in the deepest soil with the loamy structure, and decrease with decreasing soil depth and increasing clay. However, the converse was true in this case: Juniper stand density was highest in the shallowest soil with the most clay. A literature search was not performed, however one possible explanation is that the loamy-textured soil has greater macropore space and consequently decreased potential for long-term water storage in arid lands (Hopkins personal communication).

References

Bedell, T.E., L.E. Eddleman, T.Deboodt, and C.Jacks 1993. Western Juniper - Its Impact and Management in Oregon Rangelands. Oregon State University Extension Service. EC 1417.

Sherrod, D.R., and Pickthorn, B.G. 1992. Geological Map of the West Half of the Klamath Falls 1 by 2 Quandrangle, South-Central Oregon. U.S. Geological Survey Miscellaneous Geological Investigations Map I-2182, scale 1:250,000.

Soil Conservation Service, U.S. Department of Agriculture. 1985. Soil Survey of Klamath County, Oregon - Southern Part.

Personal Communications

Hopkins, William. Area Ecologist for the U.S. Forest Service. December, 1996.

Western Juniper Woodlands Reconnaissance Form
Lost River Ranch, Bonanza, OR.

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1. File Data

Project: Western Juniper Harvest Systems Comparisons Proj., Lost River Ranch, Bonanza, OR.

Date: September & October, 1996

By Whom: Larry Swan, U.S. Forest Service (with assistance from Bill Hopkins, U.S. Forest Service, Zone Ecologist)

2. Location Information

Legal: T39S, R11 1/2 E, SE 1/4 of SW 1/4 of Section 22, Northern Geodetic Vertical Datum of 1929

Access: Unit located on private land adjacent to North Poe Valley Rd. Dirt road bisects unit.

Map Ref.: USDI, Geological Survey, Diary Quad, OR. (1985). Scale = 7.5'

Aerial Photos: 7-6-93, BLM, 12 , 6-93-BLCI, 2-16A-6, 7
1990, NRCS, P35, Tract 852

3. General Description

Acres:
Scabrock = 0.8 ac
Low Density Juniper (0-49 trees/ac) = 4.5 ac
Medium Density Juniper (50-99 trees/ac) = 3.8 ac
High Density Juniper (100-150+ trees/ac) = 5.6 ac
Total = 14.7 ac (per NRCS aerial photo)

Elevation: 4,140 ft.

Aspect: Southwest

Slope: 0-5%

Soil Type/ Depth: See soils report (Nicita 1996)
Low Density Stand = Loamy overburden (20 in. deep)
Medium Density Stand = Clay to clay loam
High Density Stand = Lithic, clayey

Rock:
Visible Scabrock = 0.8 ac in NW corner of unit
High Density Stand, Very lithic = 5.6 ac.

Timber:
See acres summary above. Even-aged western juniper overstory, ranging from low density to high density.

Brush: <1% (scattered sagebrush and a few scattered *Ribes* sp.)

Other: Project site is located on a portion of the west-facing slope of a low-lying peninsula of western juniper woodlands. The peninsula is surrounded on three-sides by irrigated pasture and crop lands. Three small ephemeral drainages are present in the northwest portion of the project site.

4. Stand Data

Site Index (per Sauerwein 1982): 29-33 (medium high to high for medium and high density stand areas)

Site Index Samples			
Stand Density	*Tallest Tree Per 1/5 Acre Plot*	*Age at DBH*	*Index*
High Density	43	73	33
Medium Density	45 42	73 80	33 29
*Low Density	38 40	75 73	28 29

*Special Note: Site index not considered valid for low density portion of stand. According to Sauerwein (1982), site index curves were calculated for "well-stocked" stands, "mostly in the 65-100 range, while on higher sites, up to 250 trees per acre were counted". Low density stand in this case averaged 35 trees/acre.

Narrative Description of Overstory/Understory:

Western juniper entirely dominates the overstory, ranging from 25-35 stems/acre in the lowest density area to 120-160 stems/acre in the highest density area. Shrub cover is sparse, consisting of a few big sage brush (*Artemesia tridentata*) and current (*Ribes* sp.). A dense carpet of cheat grass (*Bromus tectorum*) dominates the groundcover. Medusahead (*Taeniatherum captu-medusa*), a noxious weed, was observed in patches adjacent to the project site and was sparsely present in a small area of scabrock in the northwest corner of the project site. No harvest activities occurred in areas with medusahead.

Juniper canopy cover was estimated from aerial photographs to be less than 10% in the low density area and greater than 60% in the high density area. Juniper reproduction is sparse. Older junipers are present just east of the project site in an area of scab rock, however ages were not determined. Based on previous experience, they appeared to be at least 200 years old.

Previous Logging: None. Very few stumps evident.

Animal Damage: None observed.

Competing Veg.: See "narrative description" above.

Overstory Stand Data: See Table 4: Lost River Ranch Stand Data Summary

Species Comp: Western juniper.
Age: 77 at DBH; 89 at stump height
Ht./DBH Range: Sapling-48 ft.; Sapling-24.7 in.
Distribution: Stand is even age; reprod. is scattered and sparse.
Density: Scabrock = 125/ac (0-9" DBH; 0-25 ft.)
Low Density = 35-49 trees/ac
Medium Density = 50-99 trees/ac
High Density = 100-150+ trees/ac
Growth Vigor: Low Density = 10/20 last 10 years
Med Density = 10/20 last 10 years
High Density = 8-16/20 last 10 years
Pathogens: None observed.
Miscel. Comments:
Stand is even-aged. A few scattered old growth located to east of unit in scabrock. See table labeled "growth samples" for growth history - usually peaks before 50 years and then tapers. A few snags noted in SE corner of unit. No visually obvious reasons for mortality evident.

Understory Stand Data:

Species Comp.: Western juniper.
Age: Unknown
Ht/DBH Range: Seedling/Sprout/Sapling
Distribution: Scattered
Density: Sparse
Growth/Vigor: Growth = Unknown; Vigor = Seemed browsed.
Pathogens: None noted.
Narrative:
Very sparse juniper reproduction, mainly stump sprouts and a few saplings; more reproduction in scabrock in NW portion of unit.

5. Proposed Treatment

Landowner Objectives: Improve forage for cattle and horses, and maintain cover for domestic livestock and wildlife, especially resident deer herd.

Silvicultural Prescription: Seed before harvest operations with dryland pasture mix (lbs/acre?) and thoroughly scarify ground surface after harvest (see attached FAX message from Mike Borman, OSU Range Extension Agent, regarding cheatgrass treatment options).

Remove 60-80% of stand, concentrating on leaving clumps and screening along fence lines. Leave all trees with bird nests or cavities. Concentrate clumps to maximize solar protection and protection from storm track winds from west. Delimb all leave trees to 6 ft. to improve cover access for livestock and deer.

Slash Treatment: Leave scattered clumps and piles for wildlife (2-4/ac) and scatter remainder of slash. Maintain existing heavily-traveled animal trails along fence lines.

Monitoring: Establish series of exclosures with landowner permission, and monitor once per year for seeding success and reestablishment of native species. Establish photo points and record annually in spring. Landowner does not report any immediate plans to graze livestock in area, other than a few horses in the spring and summer. Cattle are fed on peninsula to east during winter months, but do not appear to come into area very often (very few cow plops).

6. Harvest Plan

System: Chainsaw fall; manually delimb on site or skid to central landing and mechanically delimb; remove and scatter slash back onto site.

7. Red Flags

Noxious Weeds: Medusahead observed on peninsula uphill and to east of unit where cattle are fed during winter months; a few sprouts observed in scabrock area in NW corner of unit.

Fence Lines: Protect existing fence lines.

Drainages: Three ephemeral drainages in northern portion of unit - dry during Sept. and Oct.

8. Other Resource Information

Archaeological Sites: None. Only one obsidian flake observed. Small rock wall outside SE corner of unit.

Recreation: None

Wildlife: Resident herd of deer (10-15); large owl (great horned?); lots of small birds and robins feeding on berries; up to 25 deer in area during harvest.

Soils Sensitivity: None expected - lithic and dry.

Boundaries: Well established and marked by fence lines.

9. Unit Layout

Marking: Tried blue paint, but switched to flagging clumps due to difficulty seeing paint under low crowns.

Boundaries: Clearly evident - fence lines to west and north; scabrock to east; road to south.

Sketch Maps: None produced.

Table 4: Lost River Ranch Stand Data Summary - Pre- and Post- Harvest Bonanza, Oregon

Timing & Stand Density	***DBH Range*** *(in)*	***DBH Average (in)***[1]	***Height Range*** *(ft)*	***Height Average*** *(ft)*	***Trees/Acre*** *(Live)*	***Volume/Acre*** *(cu ft)*[2]
Preharvest						
Low Density	5.0-18.5	10.4	11-38	24.7	35	220
Med. Density	9.6-16.7	13.6	23-45	36.4	35	420
	Sap-20.1	13.0	Sap-47	32.3	60	730
High Density	Sap-17.6	14.1	Sap-48	38.0	160	1175
	Sap-24.7	11.7	Sap-47	35.8	120	810
Summary	**Sap-24.7 in**	**Avg 12.6 in**	**Sap-48 ft**	**Avg 33.4 ft**	**Avg. 82**	**Avg 671 cu ft**
Post Harvest						
Low Density	13.1-17.4	15.9	35-44	39.3	20	300

	10.2-18.6	15.5	19-41	33.8	20	275
Med. Density	10.2-15.7	13.2	34-42	40.0	15	173
	5.6-22.9	14.9	20-47	37.7	15	275
High Density	6.4-14.7	9.6	26-48	37.3	15	110
	Seed-12.1	9.2	Seed-40	28.3	45	155
	10.7-24.7	14.8	30-47	36.2	25	380
	4.4-16.9	9.9	28-47	36.6	50	353
	6.7-15.9	10.4	21-50	36.5	40	298
Summary	**Seed-24.7 in**	**Avg 12.6 in**	**Seed-50 ft**	**Avg 36.2 ft**	**Avg 27**	**Avg 258 cu ft**

1. Averages for DBH and height do not include seedling/saplings.

2. Cubic-foot tree volume from 12 in. stump to 4 in. top (Chittester and MacLean 1984).

September 4, 1996

To: Larry Swan
From: Mike Borman
Subj: Juniper treatment options

After visiting with Bill Krueger and Lee Eddleman, we have some options to consider. However, recognize that the risk of failure is quite high (>50%). We haven't been on the ground to evaluate soils, potential other vegetation, longevity of cheatgrass on site, etc. You might consider trying more than one option on different parts of the area you have available.

Option 1: If you can wait until spring to do the juniper treatment, cut and scatter in the spring, then bum it all in the fall to get the nutrient flush. This is not a normal recommendation, however, Lee suspects a nutrient deficiency that burning the juniper would help rectify. Then use a half-width rangeland drill to drill in a desired species as late as possible in the fall.

Option 2: If the cheatgrass still has the majority of its seed intact, burn now, drill a desirable species, then do the juniper treatment.

Option 3: If the cheatgrass has dropped most of its seed, use a propane burner to kill the seed on the ground, drill a desirable species, then do the juniper treatment.

Option 4. Thoroughly scarify the ground (to about 2") to bury much of the cheatgrass seed, then drill a desirable species, then do the juniper treatment. If drilling a desirable species is not an option, then broadcast seed and drag over it to get soil coverage.

Recognize that making these recommendations from a distance is risky. Also recognize that the probability of success for achieving a good forage stand iq low given the current cheatgrass, dominance,

Good Luck.

Mike Borman

Growth Samples in 1/20 of an Inch

Years	Sample No. 1 (High Density Area)	Sample No. 2 (High Density Area)	Sample No. 3 (High Density Area)
0-10	NA	27	26
10-20	13	45	38
20-30	16	53	37
30-40	21	40	31
40-50	21	28	12
50-60	19	20	17
60-70	NA	10	8
70-80	NA	8	8
80-90	NA	7	8