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

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

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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

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Personal Communications

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