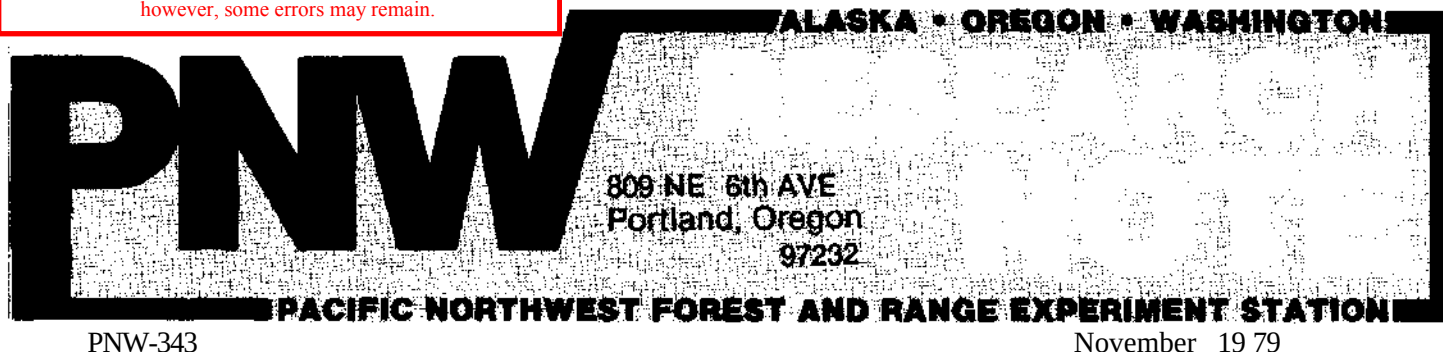




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GRASS SEEDING AND SOIL EROSION IN A STEEP, LOGGED AREA IN NORTHEASTERN OREGON

by

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Abstract

This case study tested the common belief that grass seeding is needed to prevent erosion after areas are clearcut in the Blue Mountains. Changes in the soil surface height at about 500 points each in a seedbed and an unseeded area were measured on four dates covering a 20-month period. Average vertical displacement was not consistently related to seeding nor to degree of disturbance. Variability of vertical displacement within areas treated alike was almost as great as variability between treatments.

Size-graded fluorescent material (Willemite) was placed on 10 sites to characterize downslope soil movement. The maximum movement (240 centimeters) occurred on a severely disturbed area.

KEYWORDS: Seeding (erosion control), herbaceous plants, erosion control, erosion -)vegetation, Oregon (Blue Mountains).

INTRODUCTION

The High Ridge evaluation area was described in detail by Fowler et al. (1979). The objective of the High Ridge study is to evaluate the effects of timber harvest on the ecosystem, including the effects on various attributes of the soil and water resource.

In one of the preharvest conferences on the cutting prescriptions, it became apparent that a conflict would arise between operational and research objectives if the standard practice of seeding grass on all cutting units was allowed. Studies of successional trends of understory vegetation and comparisons of animal activity before and after harvest required that a substantial portion of the area be left unseeded. A compromise—essentially half of the disturbed area would be left unseeded—was agreeable especially when it was proposed that this would allow an additional test of the efficiency of seeding on local erosion.

We agreed to examine soil movement by two methods that have been used elsewhere (Leonard and Whitney 1977, Fowler and Berndt 1969). The objectives of this note are to report the results of our erosion measurements and to compare the development of vegetation in seeded and unseeded areas.

THE STUDY AREA

The study area is located in the Blue Mountains of northeastern Oregon on the Pendleton District of the Umatilla National Forest. It is about 22 km northwest of Elgin and 8 km southwest of the Spout Springs Recreation Area. Soil displacement was intensively measured within a 3.64-ha clearcut (fig. 1) which has a northeastern aspect and a 30-percent average slope. Average elevation is about 1 500 m.

Precipitation at High Ridge averaged 142 cm between 1967 and 1976. On the average, 87 percent of the annual precipitation fell between October 1 and May 31 and 13 percent in the summer months (July through September). Intense thunderstorms, which cause the most severe erosion problems are possible during the summer months. Although intense thunderstorm paths may be up to 60 km wide (Morris 1934), amount of precipitation normally declines rapidly with distance from thunderstorm cell centers. Records indicate that at least one storm in 10 years will deliver 2 cm of rainfall per hour and one storm in 100 years will deliver 2.5 cm of rainfall per hour (Pacific Northwest River Basins Commission 1969).



Figure 1.—A view of the study-area. The area in the foreground was seeded; the background, unseeded.

Soils in the general area of the study site were probably of the Tolo or Helter Series, which are classified as Typic Vitrandepts or Entic Cryandepts (Geist and Strickler 1978). According to these authors, these soils are characterized by a layer of volcanic ash over an older buried soil. The ash layer is often 50 cm or more thick, with an A1 horizon of up to 15 cm. Texture is classified as silt loam throughout the ash overburden, and it grades into loam and finer textures in the buried soil. These soils contain a high percentage of organic matter relative to other soils in the Blue Mountains. Organic matter averaged 7.89 percent in the 0- to 15-cm layer; 4.70 percent in the 15- to 30-cm layer; 2.34 percent in the 30- to 60-cm layer; and 1.02 percent in the 60- to 90-cm layer. Geist and Strickler (1978) and Hall (1973), who classified the area as belonging to the Abies grandis - Linnaea - forb plant community, concluded that the soils are erodible by wind when exposed and that they have capacities for rapid infiltration.

Before logging, the area was densely stocked with grand fir (Abies grandis (Dougl.) Lindl.), Engelmann spruce (Picea engelmannii (Parry)), subalpine fir (Abies lasiocarpa (Hook.) Nutt.), western larch (Larix occidentalis Nutt.), and Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco).

METHODS

Logging

Trees were felled, bucked into log lengths, then skidded to landings where they were loaded on trucks. Skidding with tractors left trenches up to 50 cm deep in several places (fig. 2). After the merchantable material was removed, the large residue was piled by tractors and a fireline was constructed around the clearcut; the residue was later burned. Residue too small for piling was broadcast burned. After the burning, tractors were again used to scatter unburned fuels and to construct water bars in the skid trails and firelines.



Figure 2.--A skid trail running up and down the slope. Note the severe soil disturbance.

Seeding

The clearcut was divided in half at right angles to the slope contour. The northwestern half was seeded in October 1976 with 1.14 kg/ha hard fescue (*Festuca ovina duriuscula*), 0.87 kg/ha intermediate wheat grass (*Agropyron intermedium*), 1.34 kg/ha orchard grass (*Dactylis glomerata*), and 0.56 kg/ha white clover (*Trifolium repens*). The other half of the clearcut was not seeded. In April 1977, 370 Engelmann spruce and 475 western larch seedlings per hectare were planted in the entire clearcut.

Soil Surface Changes

Two methods were used to index displacement of soil. The first method, described by Fowler and Berndt (1969), consisted of "salting" 10 plots with size-graded fluorescent material (Willemite). Our intention was to index movement of particles of various sizes, not to test control of erosion by grass seeding. Within each plot, three 25-cm-diameter spots were covered with Willemite: one each with 1-mm particles, 1- to 3-mm particles, and 3- to 25-mm pieces. The plots were chosen to represent the following conditions of surface disturbance caused by logging and residue treatment: (1) none (the forest floor was still intact); (2) slight (the litter layer was burned, but the humus layer was not disturbed); (3) moderate (the humus layer was churned up, but the subsoil was not exposed); and (4) severe (disturbance of subsoil; i.e., a 20-cm-deep trench running upslope caused by log skidding).

Movement of the Willemite from the original location was determined by visiting the sites at night and using a black light to find the current location of the fluorescent material. A meter stick was used to measure maximum displacement of the material, and each site was examined for evidence of animal activity or rills made by running water associated with disturbance of the Willemite.

Variations of our second method for indexing soil displacement have been used for many years by hydrologists and soil conservationists to document changes in stream channel cross sections and land surfaces over time. More recently, Leonard and Whitney (1977) used essentially the same method reported here for documenting changes in forest trails caused by people and animals. Our method was as follows: (1) A numbered nail was driven vertically into each of several stumps along three contours across the study site. About 2 mm of space was left between the underside of the nail head and the top of the stump. Distance between stumps varied from 3 to 24 m. (2) A thin, nylon string was stretched tightly between two stumps and tied to the nails. (3) The distance from the nylon string to the soil (or residue) surface was measured at 30-cm intervals (fig. 3) and recorded to the nearest millimeter. (4) The same procedure was followed for all transects.

The Willemite plots were established and the first survey made on October 8, 1976, after all activity with machinery was finished. During the first survey, each sample point was rated according to disturbance by the categories Klock (1975) used. Areas where litter and topsoil were still in place were rated as having little or no disturbance, areas where the topsoil was well mixed were rated as moderately disturbed, and areas where the subsoil was exposed were rated as severely disturbed.

Vertical soil displacement was determined at about 500 points each in the seeded and unseeded portions of the clearcuts. To test the precision of the measurement method, we measured 24 points on one transect twice on 1 day. The average difference in the two sets of data was only 0.8 mm.



Figure 3.--Measuring vertical displacement of soil.

Vegetation Sampling

At the end of the 1978 growing season, 14 randomly located plots, each with an area of 0.4 m^2 , were established in each half of the clearcut. Species of plants growing on each plot were recorded, and the vertical projection of foliar material onto the ground surface was measured for all plants present by Tiedemann and Klock's (1973) methods. An ocular estimate was made of the percent of ground covered by litter and logging debris in each plot.

Data Analysis

Because this is a case study without replication, a rigorous statistical analysis of variance is not possible. We chose to present average values, express data variability for vertical displacement, and draw conclusions from these values.

¹/vegetation sampling was by Dr. A. R. Tiedemann, formerly Range Scientist at the Forest Hydrology Laboratory, Wenatchee, Washington, now project leader at the Shrub Sciences Laboratory, Provo, Utah. His contribution to this study is gratefully acknowledged.

RESULTS AND DISCUSSION

Soil Displacement on the Willemite Plots

The maximum soil movement, as indicated by the largest size of Willemite, was 240 cm downslope in a severely disturbed skid trail. The smallest size material was rapidly (within the first sample period) dispersed and included within the mineral soil and was not detected. Frost heaving, raindrop impact, and settling appeared to be partially responsible. The material was scattered across the slope by deer or elk when they occasionally stepped on a plot.

Vertical Changes in the Soil Surface

The results of the measurements (table 1) represent average differences (declined soil surface) between the initial measurement on October 8, 1976, and the later measurements. Average surface decline was slightly greater in the seeded area than in the unseeded. Variation around the mean values, as defined by end points of the 95-percent confidence interval^{2/} in table 1, indicates that values for seeded and unseeded areas usually overlap for a given measurement date. One exception was on July 12, 1978: The surface reduction of seeded area was 2.84 cm, with a range of 2.43 to 3.26 cm; the average for the unseeded area was 1.63 cm, with a range of 1.29 to 1.97 cm.

We classed 55 percent of the point samples as having little or no disturbance; 45 percent, moderate to severe disturbance. There was no consistent difference in displacement between the two disturbance classes.

The trend toward decreased soil surface location between October 8, 1976, just after the logging and residue treatments were completed, and July 12, 1978, is real. This effect could be the result of several processes. When our first measurements were made (October 8, 1976), the soil surface in many parts of the area was fluffed up, much like a plowed field. The combined impact of raindrops and pressure exerted by the snowpack tended to compact the surface soils during the 21 months (two winters) between the first and last measurements. Decomposition of the litter layer would also make the surface recede relative to the benchmarks.

Vegetation Development

Results of the vegetation survey are presented in table 2. Average plant cover was 56 percent on the seeded area, 20 percent on the unseeded. Native species included Ross sedge (Carex rossii), Ribes species (Ribes spp.), and elderberry (Sambucus glauca Nutt.). The most frequently encountered seeded species were orchard grass and hard fescue.

^{2/}95-percent confidence interval = $\bar{x} \pm t_{0.05} S_{\bar{x}}$. This interval includes 95 percent of the measurement values.

Table 1—The average cumulative difference (decrease) in the elevation of the soil surface (x) between October 8, 1978, and the survey dates^{1/}

Survey date	Little or no disturbance		Moderate to severe disturbance	
	Seeded	Unseeded	Seeded	Unseeded
	<u>Centimeters</u>			
6/8/77	0.51 (0.25-0.77)	0.42 (0.22-0.62)	1.00 (0.72-1.28)	0.60 (0.32-1.64)
10/12/77	1.29 (.92-1.65)	1.15 (.89-1.42)	.92 (.54-1.30)	1.06 (.48-1.64)
7/12/78	2.84 (2.43-3.26)	1.63 (1.29-1.97)	2.31 (1.87-2.75)	1.72 (1.28-2.16)
^{1/} The 95-percent confidence interval (in parentheses) = $\bar{x} \pm t_{0.05} s_x$.				

Table 2—Vegetation and litter cover on sample plots located in a clearcut in the Blue Mountains of Oregon^{1/}

Plot No.	Seeded area			Unseeded area		
	Native plants	Seeded plants	Litter cover	Native plants	Seeded plants	Litter cover
	<u>Percent</u>					
1	10	20	70	10	0	35
2	40	10	80	5	0	25
3	0	40	40	30	0	55
4	2	35	50	5	0	65
5	5	80	25	20	0	42
6	5	80	10	25	0	45
7	7	25	30	45	0	35
8	5	75	25	10	0	80
9	50	20	50	45	0	70
10	10	25	5	10	0	30
11	2	70	20	25	0	10
12	5	30	10	35	0	20
13	5	85	10	10	0	20
14	0	50	25	10	0	55
Mean	10.4	46.1	32.1	20.4	0	41.9

^{1/}Size of sample plots was 0.4 square meter.

Average ground cover by native species on the unseeded plots was double that on the seeded plots. This may indicate that seeded species initially tend to crowd the native plants out.

CONCLUSIONS

Since this study was not replicated, observations apply only to the conditions of soil, topography, and climate in the study area. With these limitations in mind, the following conclusions can be stated. First, grass seeding had little or no effect on soil surface changes in this clear-cut. This conclusion is based on our measurements, as well as our observations of places where overland flow occurred. We observed evidence of overland flow only in the deep skid trails; and even there, soil movement was limited to a few meters. The greatest daily rainfall measured during the study was 3.2 cm. A difference in erosion between the seeded and unseeded areas might have occurred if an intense rainstorm had hit the area during the 1st year after seeding.

Grass seeding appeared to have a negative effect on the rate that native plants developed on the cutover land. We did not attempt to evaluate the effect of grass seeding on survival or growth rate of planted seedlings. Because the effects of seeding in other combinations of soil type, slope steepness, and precipitation regime are not known, a replicated study is needed to evaluate the effects of seeding on soil erosion for the common soil types and topography of the Blue Mountains.

LITERATURE CITED

- Fowler, W. B., and H. W. Berndt.
1969. Fluorescent materials index soil movements. USDA For. Serv. Res. Note PNW-107, 7 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
- Fowler, W. B., J. D. Helvey, and C. Johnson.
1979. Baseline climatic and hydrologic relationships for the High Ridge evaluation area. USDA For. Serv. Gen. Tech. Rep. PNW-91, Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
- Geist, J. Michael, and Gerald S. Strickler.
1978. Physical and chemical properties of some Blue Mountain soils in northeast Oregon. USDA For. Serv. Res. Pap. PNW-236, 19 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
- Hall, Frederick C.
1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA For. Serv., R6 Area Guide 3-1, 62 p. Reg. 6 Off., Portland, Oreg.
- Klock, Glen O.
1975. Impact of five postfire salvage logging systems on soil and vegetation. J. Soil and Water Conserv. 30(2):78-81.
- Leonard, R. E., and A. M. Whitney.
1977. Trail transect: A method for documenting trail changes. USDA For. Serv. Res. Pap. NE-389, 8 p. Northeast. For. Exp. Stn., Upper Darby, Pa.
- Morris, William G.
1934. Lightning storms and fires of the National Forests of Oregon and Washington. 27 p. Pac. Northwest For. Exp. Stn., Portland, Oreg.
- Pacific Northwest River Basins Commission.
1969. Climatological handbook, Columbia Basin States Precipitation. Vol. 2. 351 p. Vancouver, Wash.

Tiedemann, Arthur R., and Glen O. Klock.

1973. First-year vegetation after fire, reseeding, and fertilization on the Entiat Experimental Forest. USDA For. Serv. Res. Note PNW-195, 23 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

English Equivalents

1 centimeter = 0.394 inch
1 meter = 1.094 yards
1 hectare = 2.471 acres
1 kilogram/hectare = 0.892 pound/acre
1 kilometer = 0.62 mile
1 millimeter = 0.04 inch
1 square meter = 10.76 square feet

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