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SOIL SURFACE CONDITIONS FOLLOWING BALLOON LOGGING

by

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ABSTRACT

Balloon logging caused substantially less soil disturbance than previous studies had shown for tractor, high-lead, and skyline logging methods. Deeply disturbed and compacted soil areas occupied 4.3 percent of the total area, and 15.8 percent of the area was classed as slightly disturbed.

Keywords: Logging forest cutting systems, soil conservation.

In recent years, added emphasis has been placed on development of improved logging systems which minimize soil disturbance, especially by road construction.[1/] One of the newer systems uses a helium filled balloon. In addition to reduction of road mileage, the main advantage is that the lift provided by the balloon keeps logs clear of the ground the entire yarding distance, thus minimizing soil disturbance. This paper reports the results of some preliminary measurements taken to test this assumption. Similar studies,

[1] Virgil W. Binkley. Economics and design of a radio-controlled skyline yarding system. Portland, Oreg., Pac. Northwest Forest & Range Exp. Stn. USDA Forest Serv. Res. Pap. PNW-25, 30 p., illus., 1965.

using the same measurement techniques, have already been reported for areas logged by the three yarding methods most commonly used in the Pacific Northwest--tractor,[2] high-lead,[2] and skyline.[3] This report provides a good opportunity to compare the effects of balloon logging on surface soil with the effects of three other logging methods.

THE STUDY

This study was conducted at the Deception Creek balloon logging test site in the Lowell Ranger District, Willamette National Forest. This was a cooperative venture to test the feasibility of balloon logging undertaken from 1966 to 1970 by the Pacific Northwest Forest and Range Experiment Station, the Willamette National Forest, and Bohemia Lumber Company. During this time, a total of five clearcuts, ranging from about 44 to 99 acres in size, were logged by balloon. Initially a V-shaped balloon was used, but in 1968 this was replaced by a more stable, natural-shaped balloon (fig. 1).[4] By use of this method, direct lift to the logs is provided by the balloon which is tethered about 500 feet above the butt rigging.

Figure 1.--Balloon logging area at Deception Creek, Lowell District, Willamette National Forest. The sampled clearcut units (units 2 and 5) are to the left of the balloon.

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[2] C. T. Dyrness. Soil surface condition following tractor and high-lead logging in the Oregon Cascades. J. For. 63: 272-275, illus., 1965.

[3] C. T. Dyrness. Soil surface conditions following skyline logging. Portland, Oreg., Pac. Northwest Forest & Range Exp. Stn. USDA Forest Serv. Res. Note PNW-55, 8 p., 1967.

[4] Virgil W. Binkley and Ward W. Carson. An operational test of a natural-shaped logging balloon. Portland, Oreg., Pac. Northwest Forest & Range Exp. Stn. USDA Forest Serv. Res. Note PNW-87, 8 p., illus., 1968.

Soil surface observations were made on two of the five balloon-logged units--units 2 and 5. The units are contiguous, with 45 acres in unit 2 and 38 acres in unit 5. Both units occupy a steep (about 60- to 70-percent) south-facing slope and extend from a ridgetop to just north of Deception Creek (fig. 1). The most common soil in the area is a Regosol derived from breccia parent material. The soil possesses a granular silt loam surface horizon and an average stone volume of approximately 35 percent. Before logging, the area supported a stand of old-growth Douglas-fir mixed with western hemlock and western redcedar. Average tree d.b.h. (diameter at breast height) was about 36 inches.

Trees in unit 2 were felled in 1966, and logs were yarded during 1966 to 1969. Falling was carried out in unit 5 during the summer of 1969, and yarding occurred during the fall of 1969 and spring of 1970. Our observations of surface soil condition were made in late March 1970. In both units, logs were yarded downhill to a landing on the opposite (south) side of Deception Creek. All of unit 5 and most of unit 2 were yarded with the natural-shaped balloon. That small portion of unit 2 yarded with the V-shaped balloon was included in the sample, as no obvious differences could be discerned.

Four soil surface disturbance classes were used to determine the extent of disturbance after logging:

1. Undisturbed--litter still in place and no evidence of compaction.
2. Slightly disturbed--three conditions fit this class:
   a. Litter removed and mineral soil exposed.
   b. Mineral soil and litter intimately mixed, with about 50 percent of each.
   c. Pure mineral soil deposited on top of litter and slash.
3. Deeply disturbed--surface soil removed and the subsoil exposed.
4. Compacted--obvious compaction due to dragging of a log. The soil surface directly under large cull logs was assumed to be in this condition.

The percentage of the total logged area in each of the four disturbance classes was determined from observations made at 10-foot intervals along six randomly located transects. These transects crossed both units 2 and 5 and were run on the contour.

Slash density observations were made within 1 square foot centered at each observation point. The four slash density classes are as follows:

1. Heavy--entire square foot covered with slash at least 1 foot deep.
2. Light--10 percent or more of the square foot covered with slash less than 1 foot deep.

3. Absent--total slash cover is less than 10 percent of the square foot.
4. Cull log--log 12 inches or more in diameter present on the square foot.

RESULTS AND DISCUSSION

Soil surface disturbance and slash density were observed at 1,125 points within the two balloon-logged units. Estimates of proportion of the total area in the disturbance and slash density classes are shown below:

Class	Percent of total clearcut area
Soil surface disturbance:	
Undisturbed	78.1
Slightly disturbed	15.8
Deeply disturbed	2.6
Compacted	1.7
Nonsoil areas[5]	1.8
Total	100.0
Slash density:	
Heavy	20.2
Light	52.6
Absent	21.3
Cull log	5.9
Total	100.0

Results of disturbance estimates for balloon logging are compared graphically in figure 2 with results for three more common logging methods. Although the tractor, high-lead, and skyline logging studies were conducted in the H. J. Andrews Experimental Forest about 30 miles to the northeast, timber, soil, and topographic conditions are sufficiently similar to allow comparison.[6]

The proportion of the area in the deeply disturbed and compacted classes was very low (see tabulation), much lower than with other logging methods (fig. 2), totaling only 4.3 percent of the total clearcut unit. Only 15.8 percent of the area had been slightly disturbed, also considerably lower than for any of the other logging methods (fig. 2).

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[5] Stumps, rock outcrops, and streambeds.

[6] All units supported old-growth Douglas-fir, principal soils were somewhat stony Regosols derived from breccia, and all units (with the exception of the tractor area) had average slopes of 55 to 65 percent.

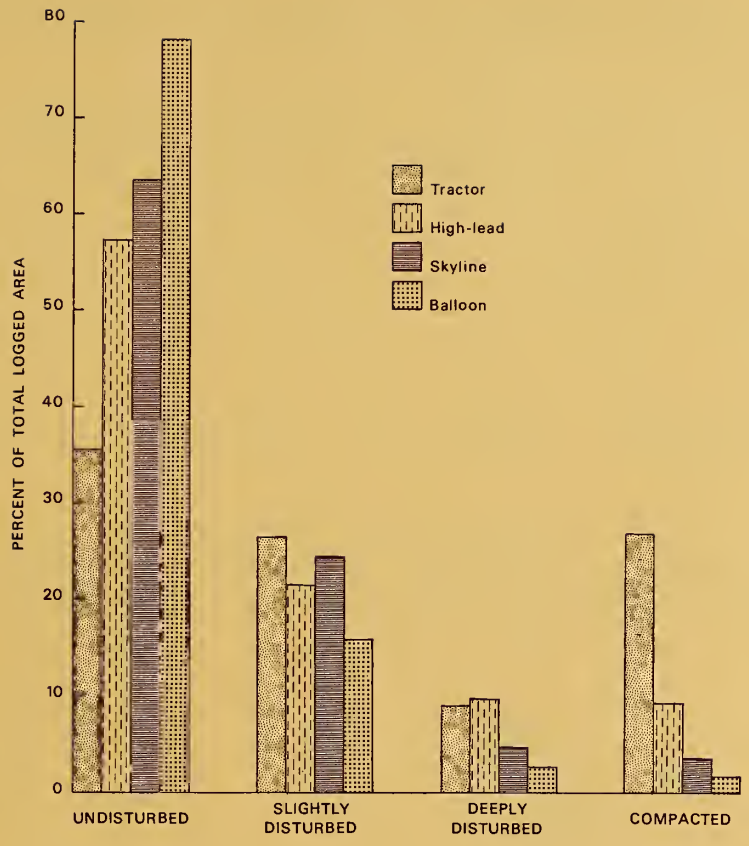

Figure 2.--Soil surface condition following tractor, high-lead, skyline, and balloon logging in the western Cascades of Oregon.

Figure 2 shows appreciably less soil disturbance from balloon logging than from the other three methods. For example, an average of about 57 percent of high-lead logged areas was undisturbed compared with 78 percent for the two balloon-logged units. Likewise, slight disturbance, which averaged about 21 to 26 percent for tractor, high-lead, and skyline logging, was less than 16 percent for balloon logging.

The proportion of bare soil exposed after logging was 14.1 percent for high-lead, 12.1 percent for skyline, and 6.0 percent for balloon yarding. Thus, balloon logging resulted in less than half as much bare soil; since surface erosion occurs almost exclusively in bare soil areas, this method reduces the likelihood of large-scale erosion. It should, of course, be borne in mind that amounts of bare soil may be greatly increased if logging slash is broadcast burned.

For example, broadcast burning of slash on the skyline-logged clearcut increased percent of bare mineral soil from 12 to 55.[7]

Slash accumulation data for each of the four logging methods are shown in figure 3. With the possible exception of a lesser amount of heavy slash following skyline logging, slash distribution patterns are roughly comparable for the four methods. These results are somewhat surprising since one would expect the yarding method to have considerable effect on the distribution of logging residues. For example, we expected a higher proportion of the tractor-logged area to be in heavy slash due to piling. Sampling procedures and the broad class designations for slash may account at least partially for the relative lack of measured differences among logging methods. Thus, although this study failed to show them, real differences may exist which we were simply unable to measure.

Amounts of disturbance caused by balloon logging as reported here are undoubtedly among the lowest reported for clearcut logging operations in the Pacific Northwest. During the course of making our observations, it became

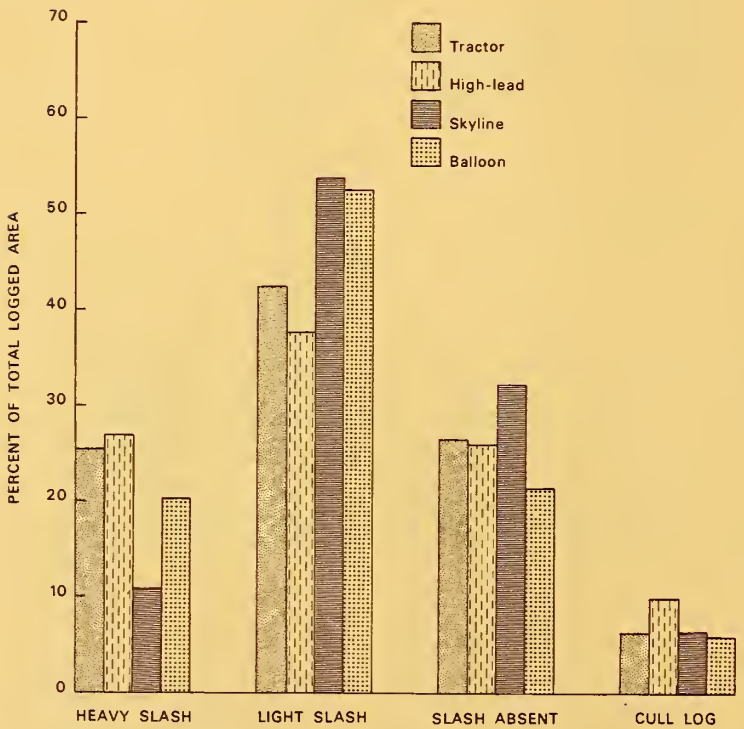

Figure 3.--Distribution of logging slash following tractor, high-lead, skyline, and balloon logging in the western Cascades of Oregon.

[7] R. C. Mersereau and C. T. Dyrness. Accelerated mass wasting after logging and slash burning in western Oregon. J. Soil & Water Conserv. 27: 112-114, 1972.

apparent that most of the slightly disturbed areas were not caused by yarding but rather by disturbance from tree falling and bucking. Thus, any reduction in disturbance might require additional precautions during tree falling. Yarding with the natural-shaped balloon virtually eliminates gouging, dragging, and other types of contact between log and soil which damage the site. Because the balloon provides sufficient lift, the logs are held free of the ground and surface vegetation from the time they are picked up until they reach the landing. In addition to preserving unaltered surface soil conditions, this capability also makes it possible to leave protective ground vegetation and streamside strips in an essentially undisturbed state, and to protect advance tree regeneration.

Perhaps the main advantage of yarding methods, such as skyline and balloon, capable of yarding over long distances is the reduction in necessary road mileage. In the western Cascades of Oregon, conventional high-lead yarding generally requires a midslope road. In steep terrain, these midslope roads are difficult to maintain and are important reoccurring sources of stream sediment. Since balloon yarding can be carried out over distances up to 1 mile, midslope roads are eliminated with obvious cost and water quality benefits. However, downhill balloon yarding, as was done in the present study, still requires roads, landings, and a bedding ground for the balloon in valley bottoms. Unless special precautions are taken, such locations may have a negative effect on water quality. A more ideal arrangement, from the standpoint of maintaining the water resource, would be uphill balloon yarding to suitable landings on or near ridgetops. In this way, disturbance by road construction or landing activities would be well removed from live streams.

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