The Society for engineering in agricultural, food, and biological systems

Paper Number: 035014
An ASAE Meeting Presentation

Soil Disturbance Assessment of a Cable Logging Operation Performing Five Silvicultural Prescriptions

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Written for presentation at the
2003 ASAE Annual International Meeting
Sponsored by ASAE
Riviera Hotel and Convention Center
Las Vegas, Nevada, USA
27- 30 July 2003

Abstract.

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Introduction

Evaluating alternative methods for regenerating second-growth Douglas-fir (*Pseudotsuga menziesii*) forests in the Pacific Northwest is an area of interest for resource managers. To meet future demands for timber supply as well as provide stands that are visually acceptable by the public and ecologically viable, a thorough understanding of these alternative silvicultural prescriptions in terms of stand productivity and site impacts from harvesting must exist. In addition, implementing these prescriptions during the harvest phase must be economically feasible. While some areas are located on gentle terrain that can be harvested using conventional ground-based systems, other areas are characterized by steep terrain, which must be harvested with cable systems. Knowledge of site impacts in terms of soil surface disturbance associated with each of these harvest systems is beneficial to resource managers.

This paper reports results of a soil surface disturbance survey conducted on the Capitol State Forest in Washington State where six silvicultural prescriptions were implemented using a cable logging system. The survey evaluated eight disturbance classes and compared percent area disturbed for each class among the six prescriptions.

Study Area and Stand Conditions

Silvicultural Prescriptions

The study evaluated six silvicultural prescriptions for regenerating Douglas-fir (*Pseudotsuga menziesii*) and are described as follows (Klepac and others, 1999):

- Control--no harvesting was prescribed. The area will be allowed to grow, unthinned, for 60-70 years.
- Clearcut--all of the merchantable and unmerchantable trees were cut. The area will be replanted and managed as an even-aged stand on a 60-year rotation schedule.
- Two-age--basal area was reduced by 81 percent, leaving approximately 16 large dominate and co-dominate over-story trees per acre. The area will be under-planted with a mixture of Douglas-fir, western hemlock, and red-cedar. The residual over-story trees will be allowed to grow for 60-70 years.
- Thinning--basal area was reduced by 26 percent, leaving approximately 71 trees per acre. The unit will be repeatedly thinned by a similar amount every 15 years for 60-70 years.
- Group selection with thinning--basal area was reduced by 41 percent, leaving approximately 45 trees per acre. The area was first marked as a regular thinning unit, and then small, scattered areas (up to 1.5 acres) were marked to create openings over approximately 20 percent of the unit. The openings will be planted with a mixture of Douglas-fir, western hemlock, and red-cedar. A similar treatment will be applied every 15 years.
- Patch cut with thinning--approximately 20 percent of the unit was clearcut in four large, scattered patches (1.5-5 acres in size). The remaining area surrounding these patches was thinned. For the entire unit (patches and thinned areas combined), the basal area was reduced by 31 percent, leaving approximately 53 trees per acre. For the areas that were only thinned, the basal area was reduced by 14 percent, leaving approximately 66 trees per acre. The patches will be planted with Douglas-fir. A similar treatment will be applied every 15 years.

Harvest System

Harvesting began in May 2002 and ended the following September. The units were cable logged with a 1974 Washington yarder equipped with a 1600-ft smashed skyline which measured ¾" in diameter. The yarder was powered by a 671? Detriot engine. Merchantable limits included a 12-ft length with a 6-inch small end diameter. Stems were limbed and topped at the landing with a ?processor mounted on a ? carrier. Terrain in some portions of each unit was gentle enough for equipment to operate so these areas were mechanically felled and skidded.

Methods

An assessment of soil surface disturbance was performed using the Point Transect Method (McMahon, 1995) for each of six units. They survey was accomplished during the week of October 14th, 2003. Transect lines were established along unit boundaries at a pre-determined spacing and oriented parallel to each other along the contour. Points were located along each transect at a pre-determined spacing and a visual assessment of the soil surface disturbance was made. Spacing between transect lines and between points along a transect line varied depending on the size of the unit being surveyed, with a goal of obtaining between 600-800 observations per unit. Since it was assumed that soil surface disturbance within the Control unit would have very little variability, a goal of obtaining around 400 observations was targeted. Compass and pacing were used to determine direction of transect lines and distance between points. Soil surface disturbance was classified using the following classes:

1. Undisturbed – no evidence of disturbance
2. Disturbed with litter in place – evidence of disturbance at a point but litter still in place, usually caused by a machine's track marks.
3. Litter removed and soil exposed – litter layer removed by machine or log and bare soil visible.
4. Litter and soil mixed – litter layer and soil mixed together by machine or log.
5. Soil exposed > 10-cm – significant rutting where soil is exposed.
6. Non-soil – stumps, rocks, logs, etc.
7. Slash pile – piles of debris left from the logging operation
8. New litter – ground surface is covered with a litter layer comprised of neddles and/or fine branches.

In addition to classifying the level of soil disturbance at each point, observations located at landings and in skid corridors were also identified. For the group selection and patch cut units points which fell within a group or patch were identified so that disturbance assessments could be made within thinned areas, within group and patch areas, and for each unit overall.

Analysis and Results

The sample size obtained for each unit is shown in Table 1.

Table 1. Summary of sample size for each unit.

Silvicultural Prescription	Area (ac)	Spacing (ft)	No. of Observations

Thinning	18.7	50 x 20	248
Group Selection	58.4	47 x 48	1059
Patch Cut	96.0	100 x 50	716
2-Age	42.9	66 x 35	711
Clearcut	25.5	66 x 21	637
Control		66 x 25	477

Percent area undisturbed for each silvicultural prescription is displayed in Figure 1. As expected, the control unit contained the highest percentage for this class with 90 percent of the area undisturbed. Comparing the other prescriptions there was basically a general trend of increasing amount of area undisturbed as harvest intensity decreased. However, the thinned unit did not fit this trend since the survey revealed it had less undisturbed area (41 percent) than the group selection (46 percent). This is probably due to the low sample size for the thinning unit. After harvesting on the thinning unit began it was decided that it was not economically feasible to continue so harvesting was stopped. Therefore, only several hectares of the unit were actually harvested.

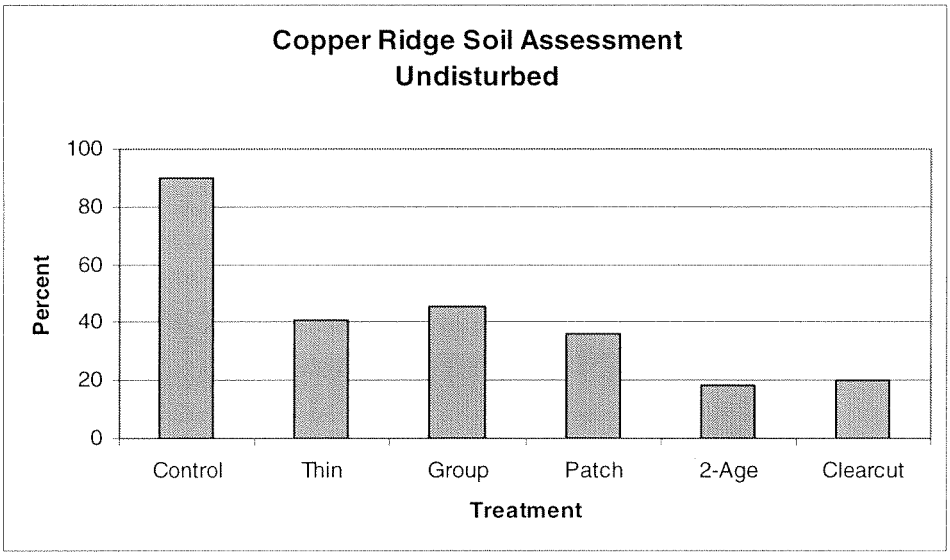

Figure 1. Percent of area undisturbed by silvicultural prescription.

The amount of area disturbed with litter in place did not differ too much among prescriptions and ranged from 9 percent for the group selection to nearly 16 percent for both the patch cut and clearcut prescriptions (Figure 2). This type of disturbance is mainly caused by machine tires or tracks. For this study the machine was a tracked feller-buncher, which was used in areas that were operable.

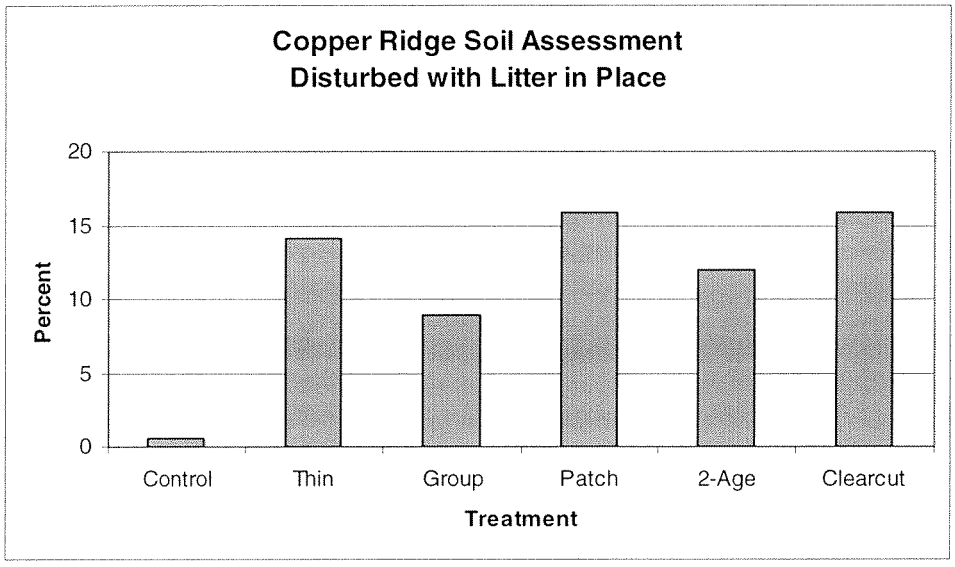

Figure 2. Percent of area disturbed with litter in place by silvicultural prescription.

Disturbance with litter removed and soil exposed is normally a result of heavy trafficability and is an indication of the amount of area occupied by skid trails or skid corridors. For this survey this type of disturbance was mainly located in skid corridors where logs were transported from the stump to the landing by the cable yarder. Results indicated the patch cut had the highest amount of disturbance with soil exposed with 8.8 percent, followed by the clearcut (6.8), 2-age (4.5), group selection (3.7), and the thinning (2.8).

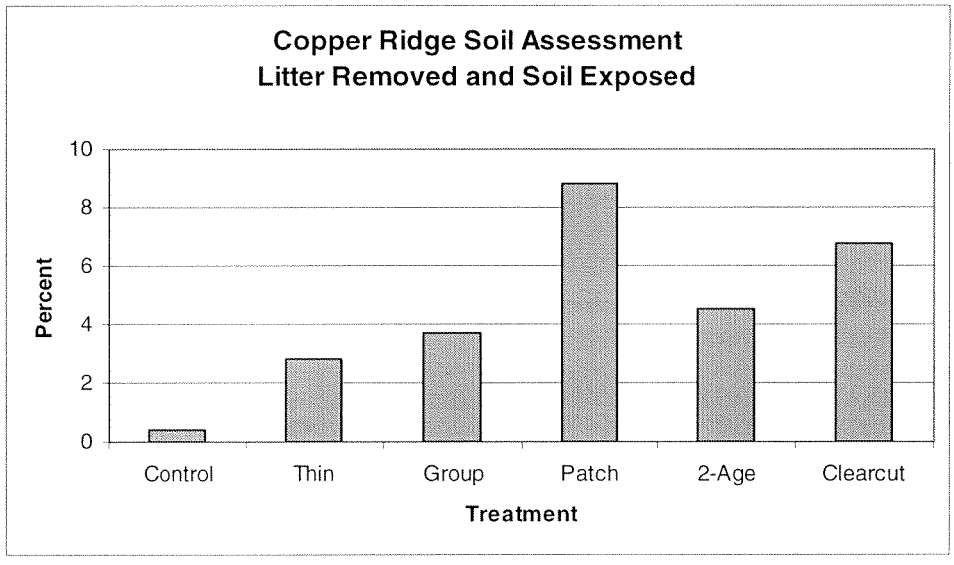

Figure 3. Percent of area disturbed with soil exposed by silvicultural prescription.

The survey revealed that the patch cut also had the highest amount of litter and soil mixed (Figure 4) with 12.4 percent, followed by the clearcut (11), thinning (10.9), 2-age (9.7), and group selection (7.6).

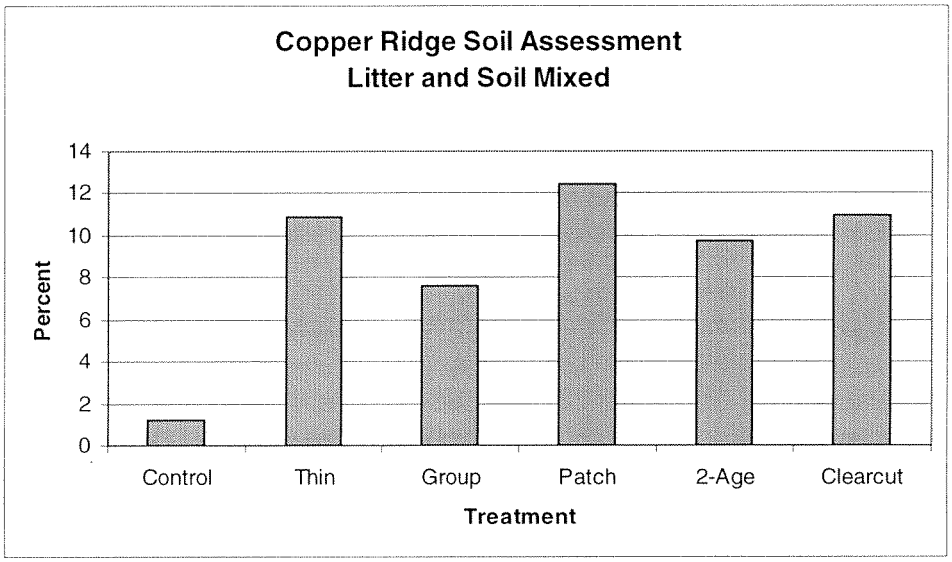

Figure 4. Percent of area with litter and soil mixed by silvicultural prescription.

The clearcut and patch cut both had the same level of disturbance with soil exposed > 4 inches at 2.7 percent (Figure 5), followed by the thinning (1.6), 2-age (1.3), and group selection (0.8).

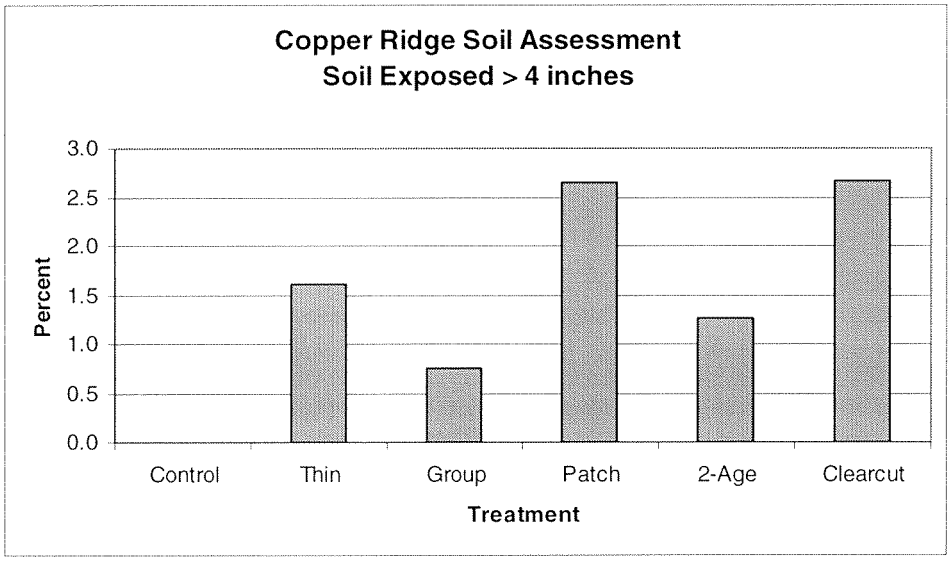

Figure 5. Percent of area with soil exposed > 4 inches by silvicultural prescription.

The non-soil class is not actually a result of the prescriptions but rather a characterization on a stand-by-stand basis. If a stand has a high concentration of rocks and/or rotten logs that existed prior to harvest then it will be reflected in the percentage for this class. Figure 6 summarizes percent area for the non-soil class.

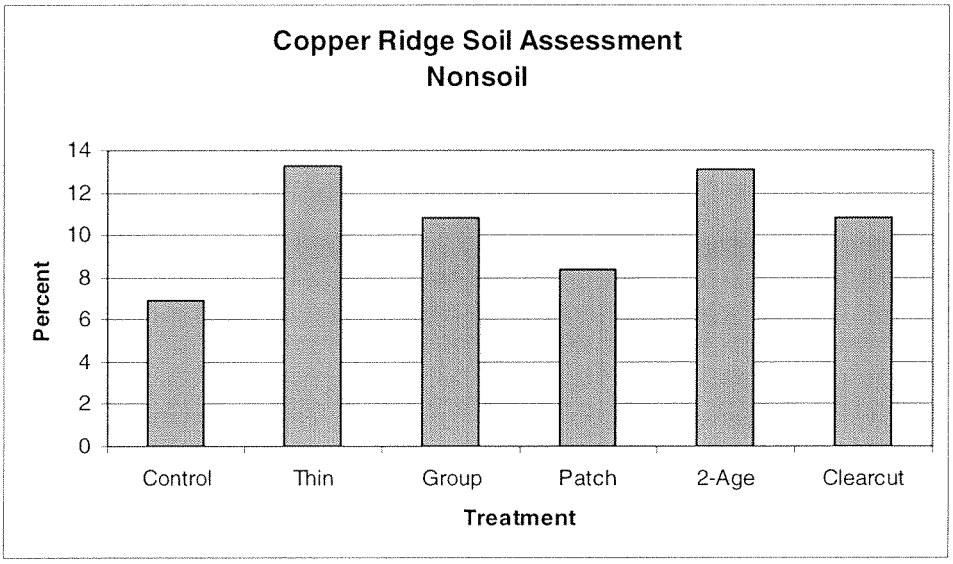

Figure 6. Percent of area with non-soil categories by silvicultural prescription.

The percentage of observations which landed on slash piles (piles of limbs and tops from harvesting) was 2.5 percent for the patch cut and 2.4 percent for the thinning, followed by the 2-age at 1.1 percent. The clearcut and group selection were nearly the same with 0.6 and 0.7 percent, respectively.

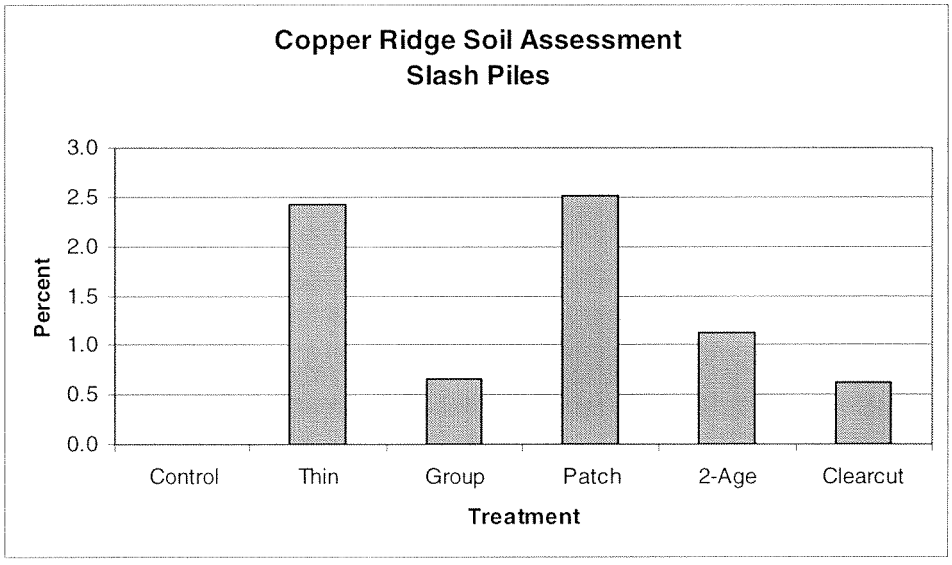

Figure 7. Percent of area with slash piles by silvicultural prescription.

During the harvest operation fine branches and needles from harvested trees are distributed on the forest floor. For the survey these fine branches and needles were classified as new litter and results are summarized in Figure 7. The 2-age prescription had the highest amount of area with new litter at nearly 40 percent, followed by the clearcut with 32 percent. This is typical

since these two treatments are the most intense. The group selection resulted in nearly 22 percent of the area having new litter, followed by the thinning (14) and the patch cut (13).

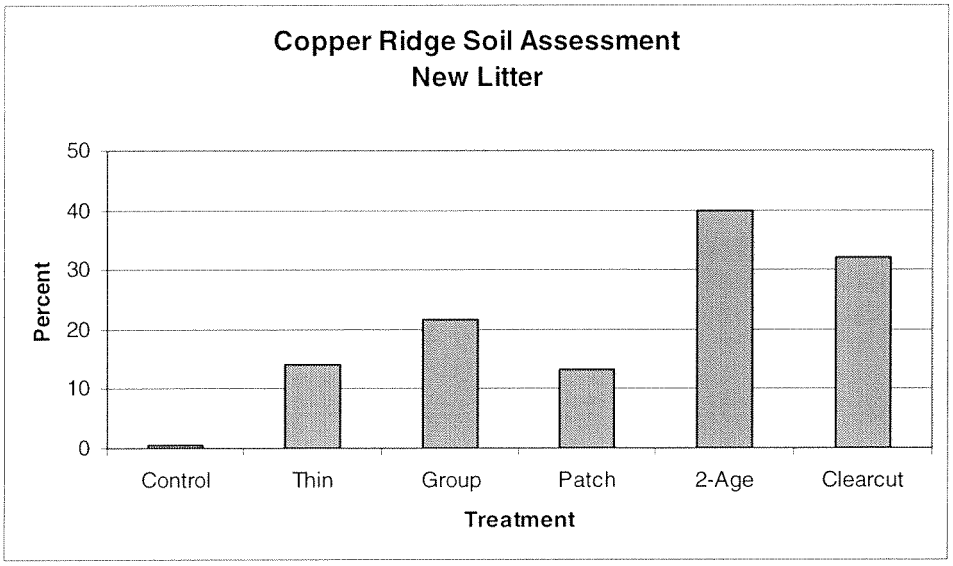

Figure 8. Percent of area with newly deposited litter by silvicultural prescription.

As displayed in Figure 8 the percent area in landings was similar among prescriptions, ranging from 0.2 percent for the clearcut to 1.6 percent for the 2-age. No observations were recorded on landings for the thinning. Percent area in corridors was also similar among prescriptions and ranged from nearly 3 percent for the clearcut to 6.6 percent for the 2-age. The amount of area trafficked by the feller-buncher is highly variable among prescriptions. However, this is more of a slope effect rather than a prescription effect. The group selection and 2-age units had more challenging terrain than the clearcut, thinning, and patch cut units, which is reflected in the low percentage of feller-buncher traffic for these two units.

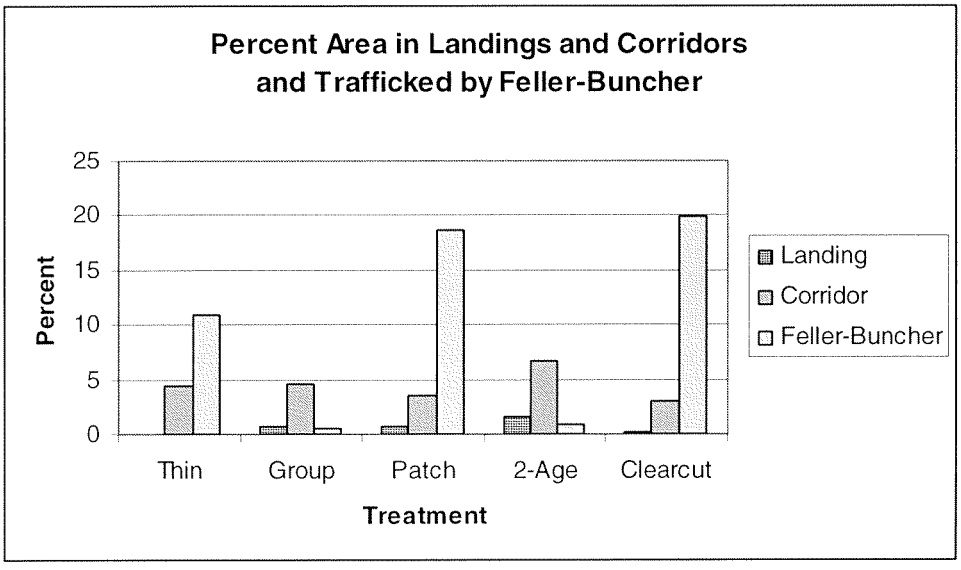

Figure 9. Percent of area in landings, corridors and trafficked by feller-buncher by silvicultural prescription.

Conclusion

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Acknowledgements

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Appendix or Nomenclature

This optional section can include lists of nomenclature or abbreviations, reference data, or tables that are too long to include in the body of the article.