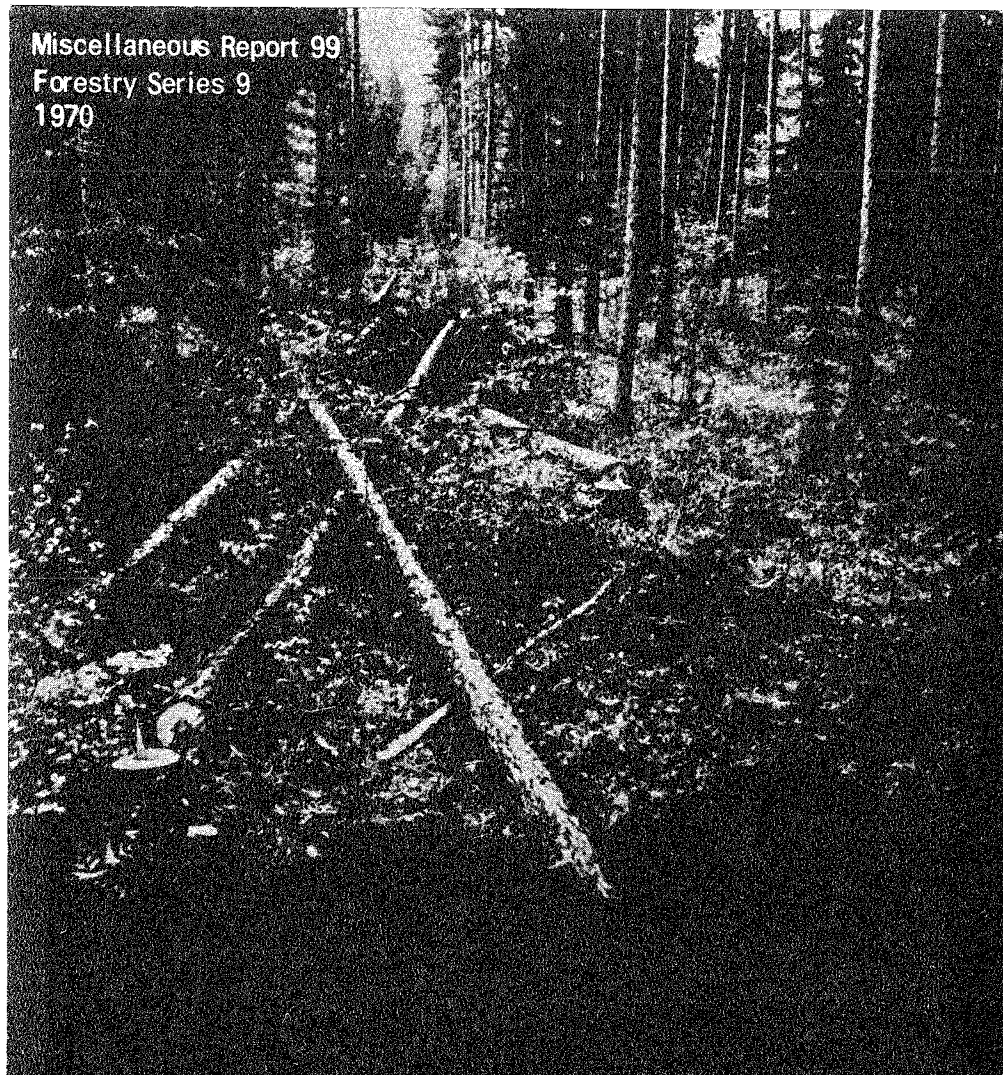
Miscellaneous Report 99
Forestry Series 9
1970



MECHANIZED HARVESTING FOR THINNING SAWTIMBER RED PINE

Z. A. Zasada and John W. Benzie
Cloquet Forest Research Center
School of Forestry

Agricultural Experiment Station
University of Minnesota

Z. A. Zasada is a research associate, University of Minnesota Cloquet Forest Research Center, Cloquet, Minnesota. John W. Benzie is principal silviculturist, U.S. Forest Service, Northern Conifers Laboratory, Grand Rapids, Minnesota.

Assistance for this study was provided by the Chippewa National Forest and the Wheeler Lumber Bridge and Supply Company. The authors especially wish to thank Martin Coyer, Richard DeVries, and Elmer White of the Wheeler Lumber Bridge and Supply Company; Robert Barse, U.S. Forest Service; and Dennis Bodin, graduate student, University of Minnesota, for providing valuable assistance during the study.

MECHANIZED HARVESTING FOR THINNING SAWTIMBER RED PINE

Recommended silvicultural practices for red pine are based on even-aged management and include periodic thinnings throughout the rotation. Growth studies have shown that considerable flexibility is possible in choosing which trees to thin out and how dense to leave the residual stand. But the use of mechanized harvesting systems in these thinnings has been very limited because of the difficulty of maneuvering both the machines and the cut trees through the residual stand without causing excessive damage. The objective of this study was to provide information on harvesting systems that permit efficient use of machines compatible with multiple-use forest management.

THE STUDY AREA

A 100-year-old red pine stand in the Chippewa National Forest in Itasca County, Minnesota, was selected for the study (figure 1). This stand was thinned 10 years ago to a density of 100 square feet of basal area per acre using individual tree selection. Ten years' growth increased stand density to 120 square feet of basal area. The recommended harvest was 30 square feet of basal area per acre, or a 25 percent reduction in stand density. The management plan provides for additional thinnings to 120 years.

The trees were 90 feet tall and 6-18 inches in diameter, with an average diameter of 11 inches.

The soil is a loamy sand (Menahga series), and the terrain is level to gently rolling. The site is good; red pine trees average 60 feet high at 50 years. The stand represents a good harvesting chance.

LAYOUT OF STRIPS

The first requirement for mechanized harvesting of thinnings is to make the stand accessible to efficient machine operation compatible with a desirable stocking. Strip thinning was used as a first step to meet this requirement.

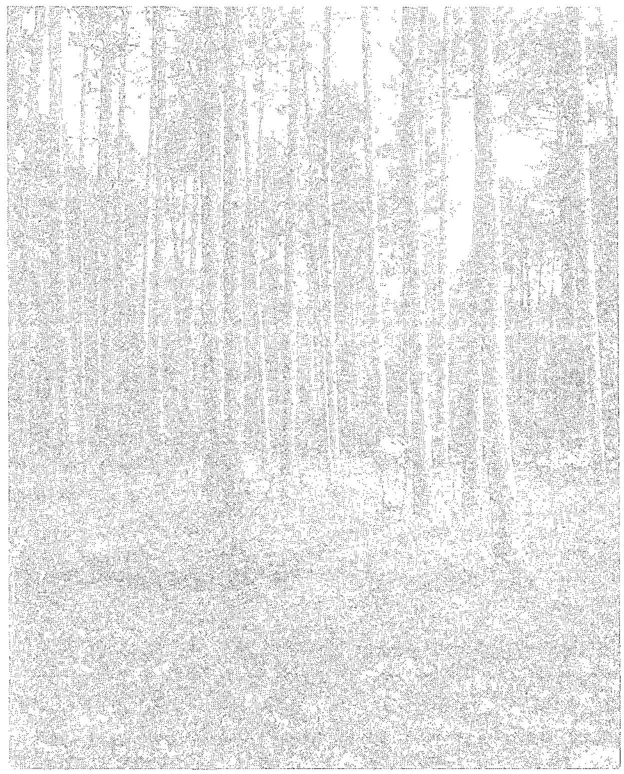


Figure 1. One-hundred-year-old red pine stand selected for study.

Strips, landings, and road accesses were laid out so they could be used for thinnings throughout the life of the stand. The harvesting pattern was a cut strip 16 feet wide alternated with a leave strip 50 feet wide (figure 2). This pattern permitted removing the recommended cut of 25 percent of the basal area. The strips were wide enough for skidders to operate without damaging residual trees and to allow directional tree felling. All strips were straight except at the stand edge and all trees within the strip were marked for cutting.

A landing 200 feet square (approximately 0.9 acre) was cleared along a woods haul road. Half the landing was used for processing tree length logs into products and for decking (figure 3). Stumps were removed from this part of the landing. The forested edge of the landing was to remain clean. No decking was permitted outside the landing area. The other half of the landing was used as a limbing area and a slash storage area for the full tree harvesting system (figure 4).

Because only a portion of the strips ran directly into the landing area, access to the landing from the other strips was provided by a 20 foot wide skid trail (figure 2). This width provided sufficient room for turning with tree length logs and full trees from the strips onto the skid trail.

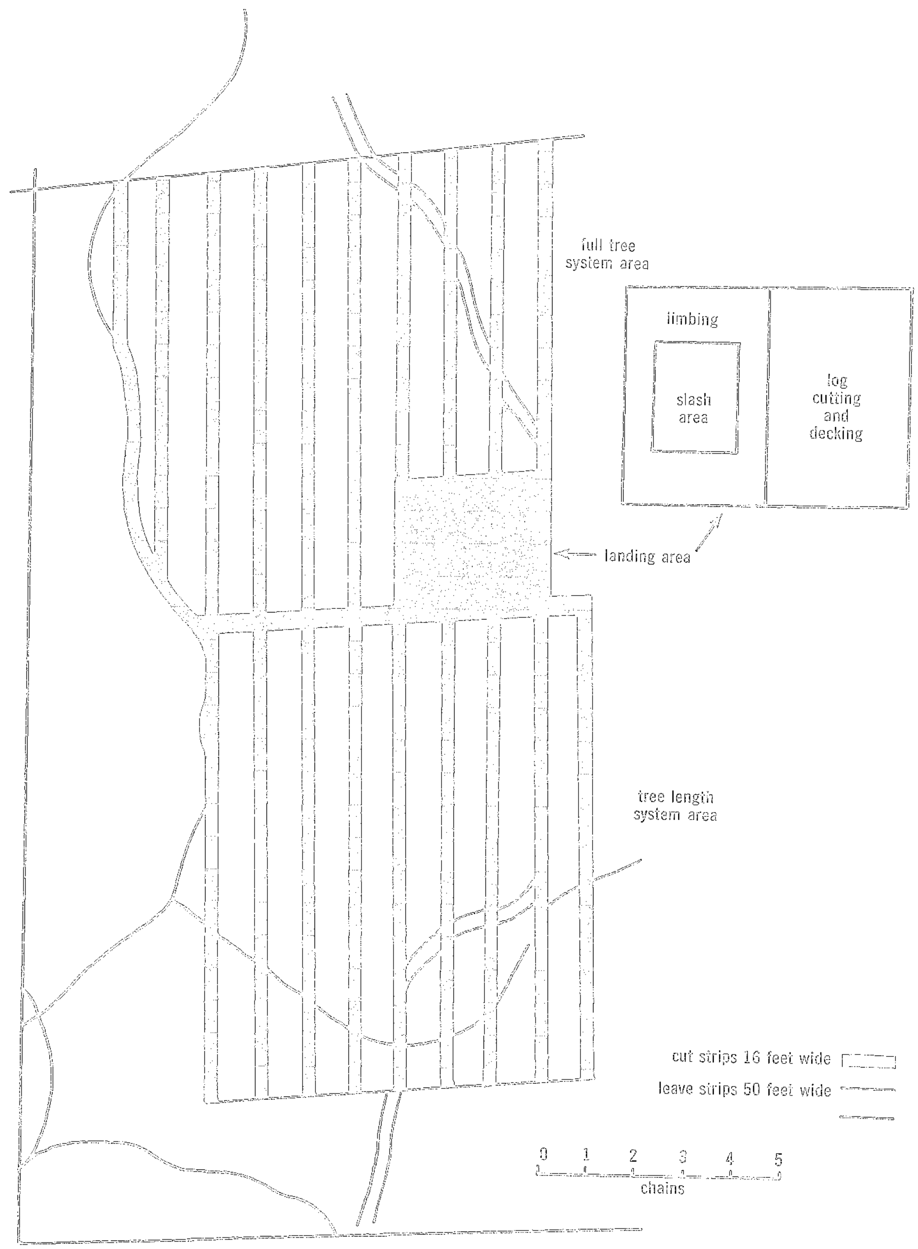


Figure 2. Mechanized harvesting pattern for the red pine stand.


Figure 3. Part of landing used for decking and processing products.

Figure 4. Part of landing used for piling slash from full tree harvesting.


HARVESTING OPERATION

Harvesting was done in the summer by commercial operators. The same crew did the work for both the tree length and full tree systems. The crew consisted of one man felling, one man skidding, and three men on the landing.

Directional felling was done manually with a chain saw so that the tree tops pointed away from the landing and butts were toward the direction of skidding (figure 5). Felling in the strip was started at the point farthest from the landing. In the tree length system, limbing was done as the trees were felled and all slash was left in the strip. The cutter averaged 63 trees per day (approximately 15 cords). In the full tree operation, where no limbing was required in the strip, the cutter averaged 130 trees per day (approximately 36 cords) (figure 6). Directional felling was successful: of the 729 trees felled, only 5 dropped outside the strip.

Skidding was done with a four wheel drive rubber-tired skidder (figures 7-8). The skidder operator set the chokers on the trees. All skidder travel was confined to the strip, and no trouble was experienced maneuvering the skidder in the strips. In the tree length system the average load skidded was 3.8 trees (0.9 cord), with a production of 3.94 cords per hour. The maximum skidding distance was approximately 1,100 feet; the average was about 450 feet. In this system the lopped slash often interfered with setting chokers.

In the full tree system the average load was 2.2 trees (0.6 cord), with a production rate of 3.04 cords per hour. The absence of slash in the strips facilitated choker setting, and the round trip time was faster than in the tree length area. The maximum skidding distance was approximately 1,150 feet; the average was about 600 feet.

In the full tree operation, limbing was done by the crew on the landing (figure 9). The skidder or the landing crawler tractor was used to push slash into a pile.

RESULTS

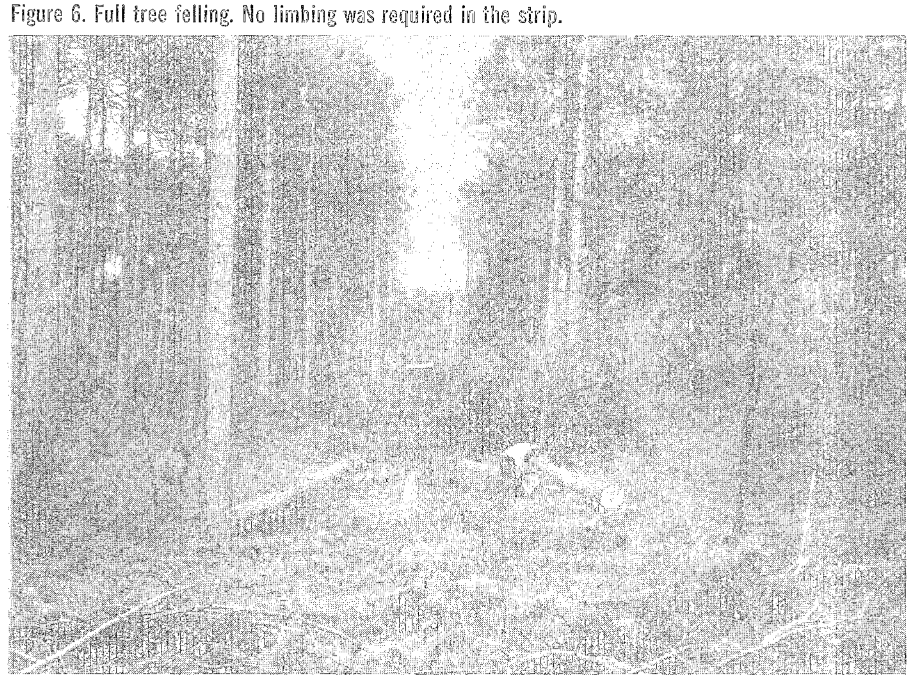
This study showed that strip thinnings in red pine can be made late in the rotation using mechanized methods with a minimum effect on the forest. Harvesting full trees or tree length logs resulted in little disturbance. Only seven residual trees were visibly injured in the 20 acre stand after harvesting 100 thousand board feet.

Stand conditions after harvesting differed between the systems only on the cut strips, or 25 percent of the area. Slash covered about 40 percent of the ground in the tree length strips, whereas there was essentially no slash where full trees were removed (figures 10-11). Full tree skidding exposed mineral soil on approximately 50 percent of the strip area, compared to less than 10 percent exposed by tree length skidding. These differences are not expected to affect the growth of residual trees.

The machine travel and skidding did have an immediate effect on the soil. About 3½ acres, or 17 percent, of the total area was affected. Full tree

Figure 5. Directional felling in strips. Trees were limbed and topped for tree length harvesting.

Figure 6. Full tree felling. No limbing was required in the strip.



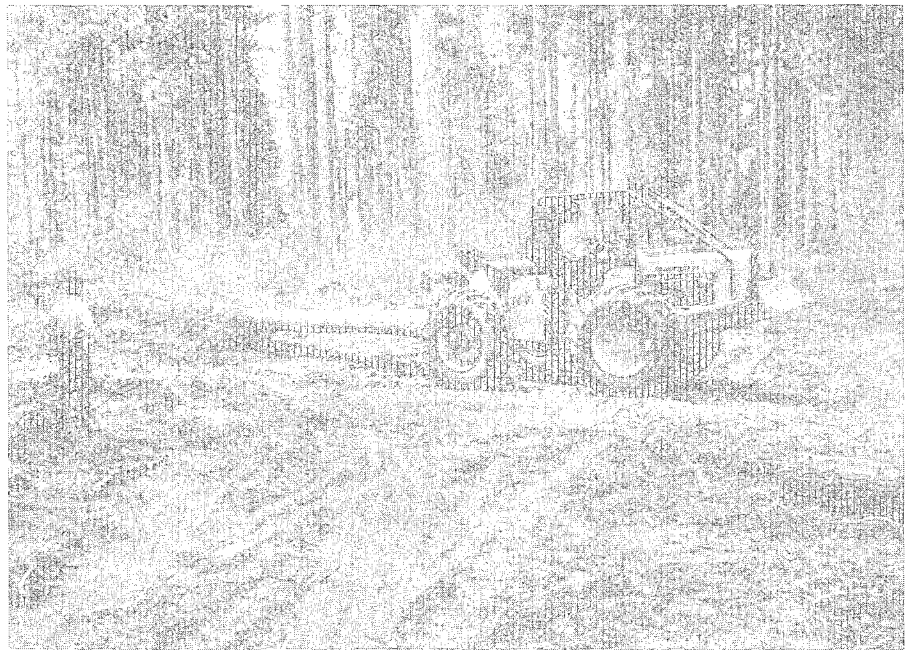


Figure 7. Skidding full trees onto landing.

Figure 8. Skidding tree length logs onto landing.

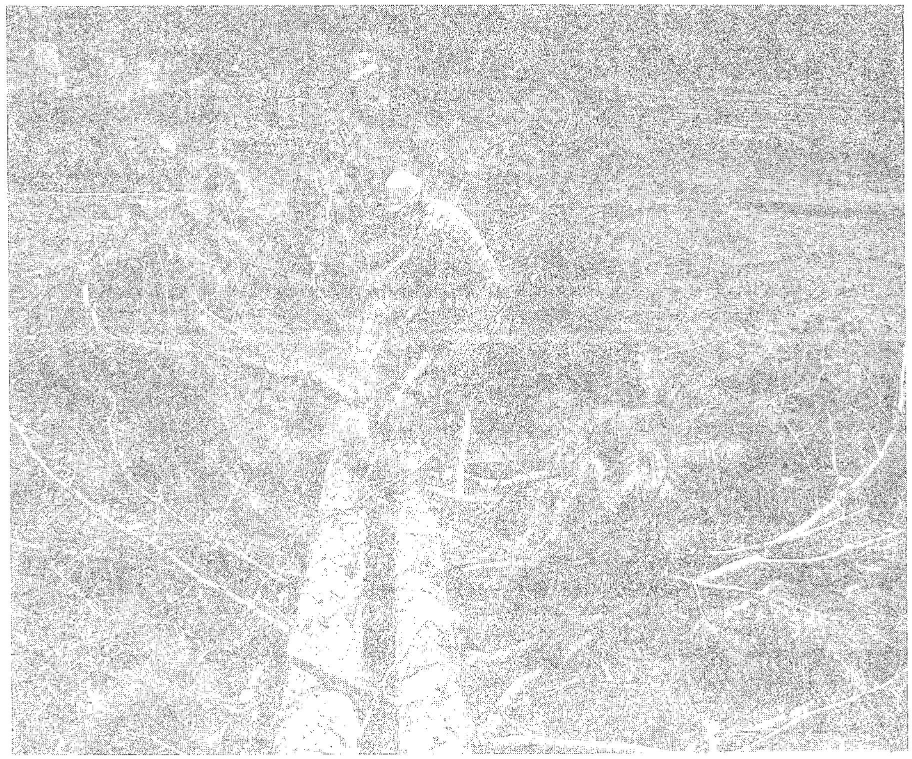


Figure 9. Limbing on landing in full tree harvesting system.

skidding increased bulk density an average of 11 percent in the 0-6 inch zone (figure 12).

Soil compaction in the tree length system was observed in the 2-6 inch zone, but was not detected in the 0-2 inch zone. Slash left as a result of limbing apparently prevented much direct contact of the skidder tires with the soil. Bulk density increased an average of 5 percent. Compaction was concentrated in the zone of the wheel tracks (figure 13). No differences were observed among areas subjected to different frequencies of travel; e.g., two trips vs. twelve trips. Followup observations will be made to determine duration of this compaction. The effect of soil compaction on tree growth will require additional studies.

The cost of harvesting was slightly higher for the full tree system (see the table). However, this study may not reflect actual differences between the two systems because cutting products on the landing limited the amount of material handled per day by the whole crew. If the operation on the landing consisted only of limbing and decking tree length logs for hauling, the cost comparison could be different.

This study showed a lower cost of limbing on the landing: 0.20 man-hour per cord for the tree length system, compared with 0.16 man-hour per

Figure 10. In tree length harvesting, slash is left in the woods.

Figure 11. In full tree harvesting, strips are slash free after trees have been removed.

Figure 12. Ground disturbance following full tree skidding. Note that mineral soil is exposed the full width of the skidder from dragging trees with crowns, and that mineral soil is exposed in the wheel tracks.

Figure 13. Ground disturbance following tree length skidding. Note that slash is broken in skidding and that mineral soil is exposed where trees are dragged, but that mineral soil is not exposed in the wheel tracks.

Man-hours, machine-hours, and cost per cord by harvesting system in strip thinning red pine

Operation	Tree length system	Full tree system
Man-hours per cord		
Felling and limbing	0.43	—
Felling	—	0.23
Skidding	0.27	0.33
Limbing on landing	—	0.16
Processing trees into products on landing	0.82	0.82
Total man-hours	1.52	1.54
Machine-hours per cord		
Skidder	0.24	0.28
Tractor on landing	0.72	0.72
Cost per cord (dollars)*	9.14	9.37
Basis		
Volume cut (cords)	84	106
Trees cut (number)	347	382
Trees per cord	4.1	3.6

* Rates: Labor — $4.00 per hour
Skidder — $3.75 per hour
Tractor — $3.00 per hour

cord for the full tree system. Machine limbing on the landing might result in even lower costs.

The difference in production cost between the systems was not large. Either method should be acceptable to the industry on a cost basis.

DISCUSSION

About 200,000 acres of red pine 30-100 years old in northern Minnesota are expected to be available for thinning during the next 10 years. Strip thinning is a method of making mechanized harvesting adaptable to the management of these stands. The first cut, using tree length or full tree harvesting, can be made with minimum disturbance to the forest. These systems provide for efficient operation and removal of the harvest from the forest as tree length logs for processing at the mill. This strip thinning will leave the forest in a condition adaptable to future thinnings by individual tree selection or additional strips.

The layout of strips and landings can be used for the life of this stand, thus reducing future operation costs. If carefully planned, strips and landings can make the forest more adaptable to multiple use. Landings have potential use for wildlife openings, overflow campgrounds, and hunting sites. Strips can be oriented to increase snow accumulation and delay snowmelt for watershed purposes.

Although a systematic layout of straight strips was used, the system has enough flexibility to meet the varied conditions in the forest. For example, the 16 foot width is not mandatory for maneuverability of skidders on the strip. A 12 foot width would have been acceptable over a large part of the area. Strips need not be perfectly straight: slight curving can be used to take advantage of openings. Some selective cutting may be possible in the area adjacent to strips.

Mechanized harvesting that permits removal of full trees, coupled with strip cutting that limits disturbance to 25 percent or less of the forest area, can be used for harvesting timber in sensitive areas, such as scenic zones and recreational areas. Careful harvesting under winter conditions would cause less disturbance than summer logging.

Further trials are planned to determine the full potential of these harvesting systems. Different age classes and species mixtures as well as additional harvesting patterns will be included.

These systems offer the forest manager a powerful tool in controlling forest conditions. Besides prescribing the trees to be cut, he also prescribes the removal method, slash placement, and clearing of landings. He can control forest conditions for tree growth, esthetics, wildlife, water, or any special use for which required forest conditions can be prescribed. Of course, skill in selecting landings and laying out strips that can be effectively used in all future thinnings is required.

29516