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ACCUMULATION AND SNOWMELT ON NORTH-SOUTH
VERSUS
EAST-WEST ORIENTED CLEARCUT STRIPS

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Introduction

Within the next ten years, approximately 200,000 acres of red pine in northern Minnesota should be available for thinning (Zasada and Benzie, 1970). One method of thinning that is expanding in Minnesota is strip cutting using mechanized harvesting equipment. The orientation and size of strips harvested in this manner influence snow accumulation and melt within a forest primarily because wind movement and protective shading by the canopy are altered. Therefore, expanded use of strip cuts could have an effect on the timing of spring runoff and, consequently, flood peaks.

Vegetation management by orienting clearcut strips to increase snow accumulation and delay snowmelt has been successful for flood reductions in the western United States (Anderson 1960; Kittredge, 1953). In Minnesota, Bay and Boelter (1960) found that a single east-west oriented clearcut strip was superior to a north-south strip in that it accumulated almost as much snow and also prolonged snowmelt. However, these results may not apply when harvesting is expanded to multiple strips. Therefore, a study was conducted to compare snow accumulation and melt on north-south (N-S) vs. east-west (E-W) directed clearcut strips harvested by mechanized equipment.^{2/3/}

Study Area and Methods

The study site was a 90 to 100-year old red pine stand located in the Chippewa National Forest in Itasca County, Minnesota. This tract had been recently harvested to investigate regeneration of red pine using full tree skidding and provided an opportunity to observe snow accumulation and melt behavior. The trees averaged 70 feet in height and were growing on a level to gently rolling terrain. Thinning was accomplished by alternating a cut strip 50 feet wide with a leave strip 16 feet wide. There were seven N-S and four E-W cut strips (Figure 1).

Snow depth and snow water equivalent, the depth of water that would result from melting, were measured with a Mt. Rose snow tube and tubular scale during the period of peak snow accumulation, March 23, 1971. Snow sampling points were located along transects running perpendicular to the N-S and E-W strips with four sampling points evenly spaced within each cut strip and two points located in each leave strip including the edges of the tract.

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^{3/}This study is part of the project: "The Effect of Mechanized Harvesting on the Forest" at the Cloquet Forestry Center.

Results and Discussion

Table I summarizes the analysis of variance for the snow water equivalent data. A significantly greater snow water equivalent was found on the cut strips, averaging 5.71 inches, than on the leave strips which averaged 4.33 inches of water. Considering orientation, the N-S strips contained a snow water equivalent of 5.35 inches which was significantly greater than the 4.92 inches found within the E-W strips (Figure 2). The greater water content of the N-S strip occurs because the orientation is perpendicular to the prevailing westerly winds, creating a snow trap. No interaction between cutting method and orientation was found.

Highly significant differences in snow water equivalent were detected between strips. Further analysis utilizing multiple range tests reveals the trends (Table II). For reference, the individual strips were lettered as shown in Figures 1 and 2. Across the N-S strips, water equivalent significantly decreased from the western to the eastern border when cut strips were compared, but not for leave strips. The E-W strips were more variable, but for both cut and leave strips there appeared to be more water content in the center strips. The increases in water equivalent are a result of greater snow accumulation.

Extent of snowmelt was observed on April 15, 1971. Photographs show generally more snow for the E-W strips (Figures 3A-C) than for N-S strips (Figures 4A-C). There was less snow in the center strips than in the border strips of both N-S and E-W orientations indicating that there is less protective shading for center strips than for border strips. This is not surprising as the leave strips are only 16 feet wide. A leave strip of one to two tree heights wide (70 to 140 feet) is recommended for delaying snowmelt (Anderson, 1960).

The amount of surface runoff from snowmelt may be altered by strip cutting, as harder and more penetrating freezing of the soil may occur in the cut strips (Pierce and others, 1958). Increased soil freezing may result in more surface runoff and thus higher flood peaks. This question, however, was not within the scope of this study.

Conclusions

North-south oriented strip cuts accumulated more snow but melted faster than east-west strips for the first year after cutting. Therefore, it would be expected that N-S strips would cause higher flood peaks than E-W strips. Snow within center strips melted sooner than border strips indicating that a 16 foot wide leave strip is of insufficient width for protective shading and delayed melt. East-west oriented cut strips of one to two tree heights in width with a leave strip of the same size is recommended when using this mechanized thinning technique for delayed snowmelt and smaller flood peaks.

References

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Table I. Analysis of Variance for Snow Water Equivalent Data

Source of Variation	df	MS	F
Cut vs. Leave (C)	1	30.41	64.06**
Orientation (O)	1	2.86	5.90*
C x O	1	0.70	1.44n.s.
Between strips	21	90.85	188.28**
Error: within strips	44	0.48	

**Significant at 1% level

*Significant at 5% level

n.s. = Not significant

Table II: Multiple Range Tests of Snow Water Equivalent on N-S and E-W oriented strips with data arranged in increasing magnitude. 1/

North-South		East-West	
Cut	Leave	Cut	Leave
G	E	A	A
E	F	C	D
F	G	D	B
C	A	B	C
B	C		
D	D		
A	B		

1/Strips connected by the same line are not significantly different at the 5% level.

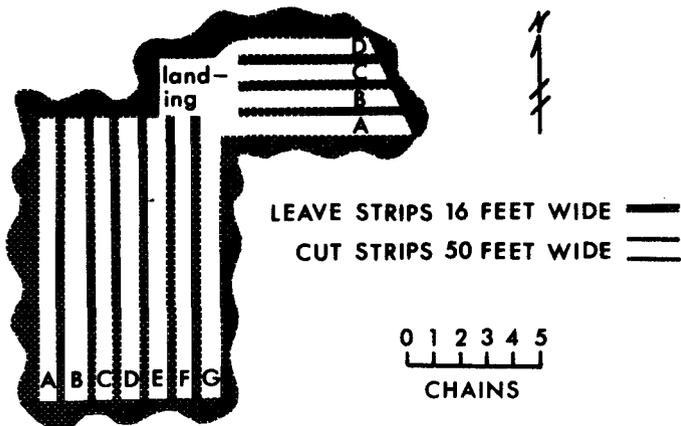


Figure 1

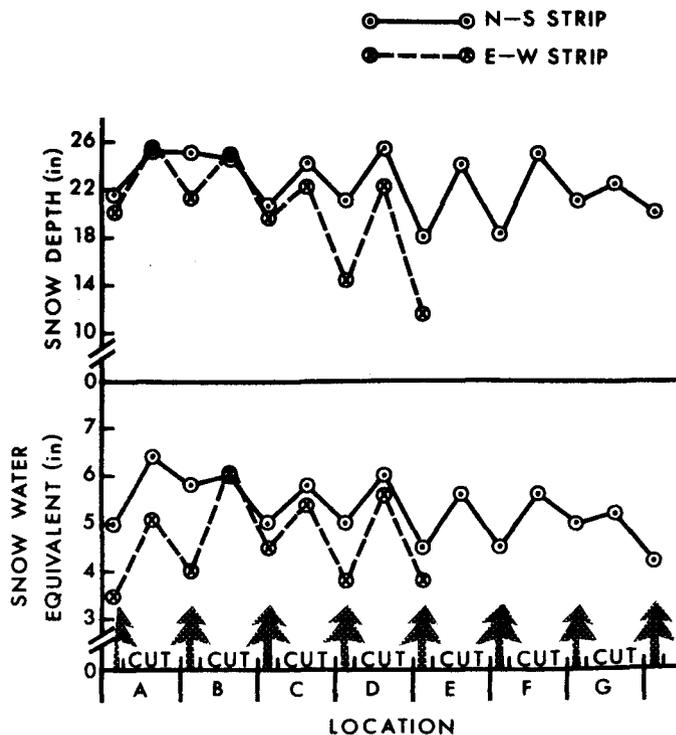


Figure 2



Figure 3A: North-side strip of E-W oriented strips.



Figure 4A: East-side strip of N-S oriented strips.



Figure 3B: Center strip of E-W oriented strips.



Figure 4B: Center strip of N-S oriented strips.



Figure 3C: South-side strip of E-W oriented strips.



Figure 4C: West-side strip of N-S oriented strips.