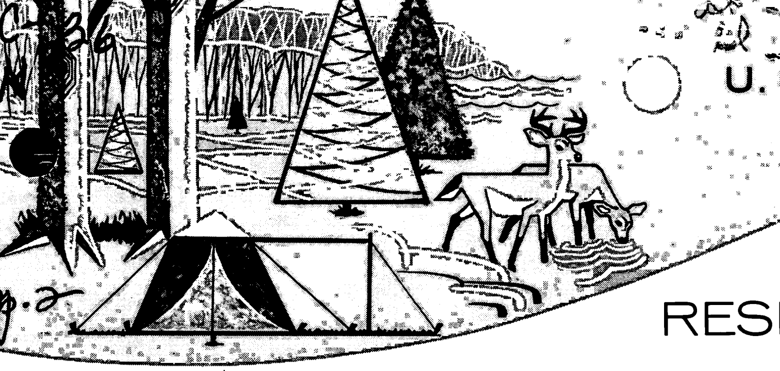

U. S. FOREST SERVICE

RESEARCH NOTE NC-36

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SPRUCE BUDWORM DEFOLIATION IS REDUCED MOST BY COMMERCIAL CLEAR CUTTING

ABSTRACT. — A pilot study in three northern Minnesota spruce-fir stands showed that as cutting intensity increased, defoliation by the spruce budworm decreased. Commercial clear cutting reduced defoliation most.

It has been proposed that forest management has considerable promise in combating epidemics of the spruce budworm. Recommendations made by various authors for reducing susceptibility and vulnerability of spruce-fir stands to spruce budworm have been summarized by Prebble and Morris (1951) and Turner (1952). Two general approaches are proposed: (1) to expedite harvesting of overmature timber as a presalvage measure, and (2) to reduce hazard in young merchantable stands and increase resistance to budworm attack through selection cutting. The first recommendation is consistent with good silviculture because of the high incidence of decay in older stands. The second, however, has been inadequately tested. Partially cut stands have often been subject to excessive windthrow (Morris *et al.* 1955). A test in which "vulnerable" trees were cut to reduce losses from an impending spruce budworm attack in Maine failed when the infestation did not develop (Hart 1956).

In 1956 the impending budworm outbreak in northeastern Minnesota permitted a test of cutting as a management technique to reduce damage. One characteristic in which Lake States spruce-fir stands differ from those in the Northeast and New Brunswick is stand area. Most of the balsam fir in the Lake States is found in blocks of about 5 to 100 acres. These are separated by nonhost types; *i.e.,* aspen, birch, and jack pine. This attribute enhanced the cutting test because: (1) small blocks can be logged in a single season, thereby eliminating treatment time as a variable, and (2) the lack in continuity of the forest type reduces the chance of budworm invasion from adjacent untreated areas.

Methods

The method of study was to compare, within each of three spruce-fir stands, two levels of thinning with an undisturbed check area.

Several criteria were used in selecting the stands: (1) They must have no more than light defoliation so that a budworm population could build up "in place" — an established budworm population might mask the effect of treatment. (2) A stand must be large enough to contain three adjoining 20- to 25-acre blocks of fairly uniform timber; in smaller blocks larvae might move from one treatment to another. (3) Stocking must be dense enough to permit a commercial operation in the area to be partially cut and still leave enough growing stock to minimize windthrow and allow a future cut. (4) Average age at breast height must be less than 60 years to ensure that the remaining growing stock would be relatively free of defect.

All stands selected were predominantly balsam fir but had components of other species. Little defect occurred in any of the stands.

The first one (Stand I), near International Falls on the west end of the Kabetogama Peninsula, had balsam fir averaging 50 years of age, with some trees as old as 103 years; white spruce averaging 82 years, with some trees up to 105 years; some paper birch; and a scattered overstory of aspen and balsam poplar, remnants of a 102-year-old age class. The stand had been lightly defoliated in 1956, and egg surveys indicated a potential medium infestation of budworm in 1957. Treatments were applied the winter of 1956-57.

The second stand (Stand II), located about 9 miles north of Grand Marais and bisected by the Gunflint Trail, had balsam fir averaging 47 years, with some trees as old as 67 years; white spruce averaging 54 years, with some trees as old as 77 years; occasional upland black spruce, aspen, and paper birch; and a scattered overstory of overmature white pine. No noticeable defoliation had occurred in 1957, but eggs collected that summer indicated a possible light-to-medium infestation the next year. A heavy infestation was present about 9 miles west of the area. Treatments were applied during the winter of 1957-58.

The third stand (Stand III), about 1¼ miles east of Isabella, had essentially even-aged, 35-year-old balsam fir and white spruce, although about five balsam fir trees per acre were in the 80-year age class. There were also occasional upland black spruce and a scattered overstory of overmature paper birch, the snags of which were conspicuous throughout the area. In 1958, the area had not been noticeably defoliated by the budworm, but some infestation was present about 15 miles to the north. Egg-mass collections indicated a possible light infestation for 1959. Treatments were applied during the winter of 1958-59.

The treatments, randomly assigned to the three 20- to 25-acre blocks with each stand, were: (1) commercial clear cutting — removing all host trees having two or more 8-foot bolts, (2) partial cutting — removing 30 percent of the basal area in host species by cutting from above, and (3) no cutting — check (fig. 1). No vulnerability rating scheme was used in marking trees for cutting because none was felt to be adequate.

Within each block, 9 to 12 circular 1/10-acre plots were located on a 4x5-chain grid. Every year after the season's defoliation had been completed, the amount of defoliation for each tree was estimated with the aid of binoculars. Detailed records were kept for 5 years by individual trees.

Analysis and Results

During the study, defoliation in each area gradually increased for 3 years and then declined. During the fifth year there was no noticeable defoliation.

Very little mortality and top killing occurred in any of the plots. Inasmuch as defoliation is a precursor to tree mortality and the defoliation index for balsam fir is highly correlated with the percentage basal area of the stand in dead and damaged trees,[1] defoliation index was used as a measurement of treatment effects.

The average weighted defoliation index for each block was computed as follows:

1. The current defoliation for each of the 5 years was summed for each balsam fir tree. Defoliation was coded as 0, 50, 88, 150 (100 percent of the current foliage removed plus

[1] *Unpublished information from another study made by the author at the same time as the one reported here.*

25 to 75 percent of the previous year's foliage), or 188 (100 percent of the current foliage plus 76 to 100 percent of the previous year's foliage removed).

2. The cumulative defoliation value for each tree was multiplied by its basal area.

3. The cumulative weighted defoliation values for all balsam fir trees on a plot were summed.

4. Each summed value was divided by the total basal area in balsam fir on the plot, giving an average cumulative weighted defoliation index per square foot of basal area.

5. An average was struck for all plots in each block. This defoliation index permitted comparison of blocks having unequal numbers of trees and different basal areas.

The defoliation index values (table 1), when analyzed by a randomization test (Kempthorne 1952), indicated that the treatment effect was significant at the .028 level of probability. One standard error about each block mean indicates no overlapping among treatments of the first two stands, but this was not so for the third stand. There was a trend toward reduced defoliation with increased cutting at all locations. This was evident even though the intensity of defoliation at the different locations was not the same.

Conclusions

The undisturbed, mature, spruce-fir forest represents the maximum potential for spruce budworm injury in the northern Lake States. Various factors such as the intensity and duration of an outbreak, size of the area concerned, and other considerations not accounted for in this study could influence the degree of absolute damage that might be expected. It is clear, however, that as cutting intensity increased there was a corresponding reduction in the amount of defoliation on the residual stands. Though partial cutting did reduce defoliation somewhat, commercial clear cutting reduced it much more.

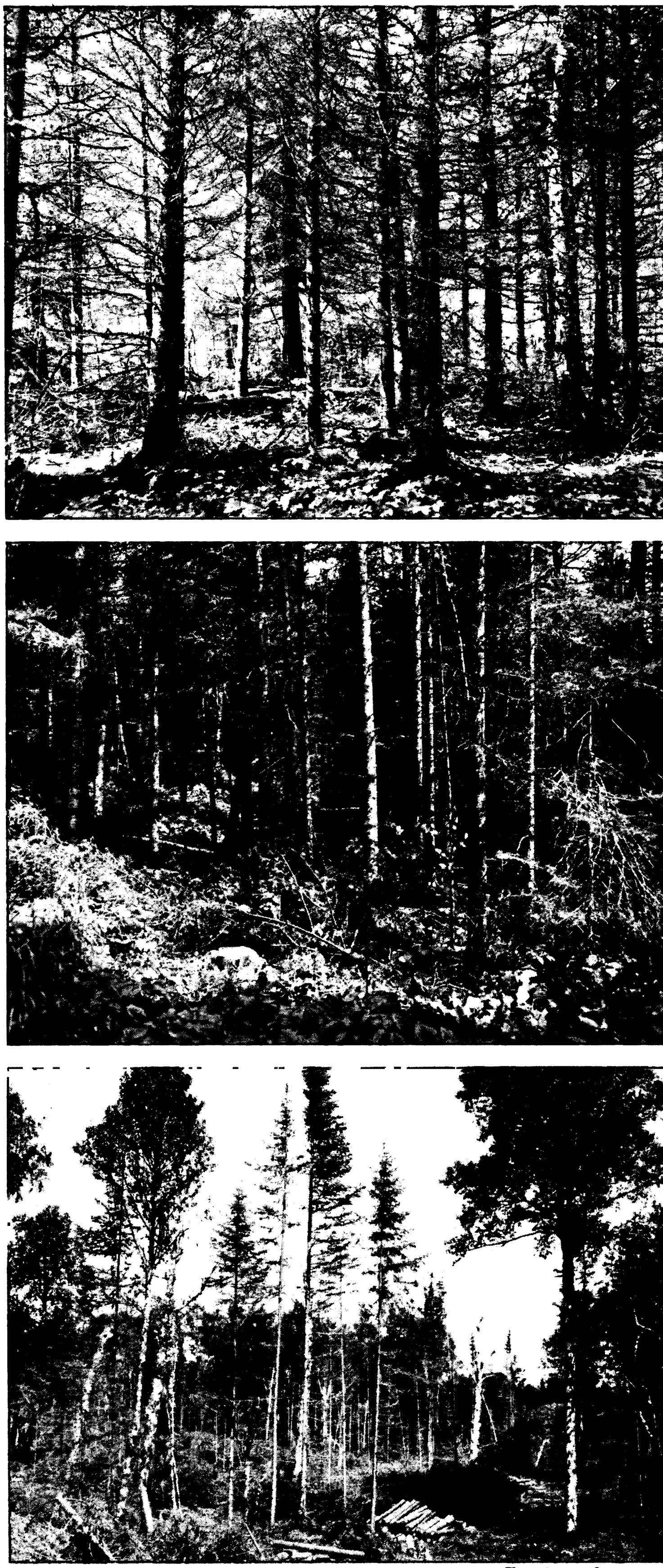

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Figure 1.—Spruce-fir stands in the study area. Top to bottom: uncut, partial cut, clear cut.

Table 1.—Pilot cutting study: average cumulative weighted defoliation index per square foot of balsam fir basal area by cutting intensity levels.

Stand and treatment	Percent cut	Defoliation index and standard error
Stand I		
Commercial clear cut	83	103 ± 39
Partial cut	27	176 ± 20
Uncut	0	270 ± 11
Stand II		
Commercial clear cut	70	48 ± 12
Partial cut	29	84 ± 12
Uncut	0	144 ± 10
Stand III		
Commercial clear cut	72	87 ± 20
Partial cut	31	98 ± 4
Uncut	0	109 ± 10
Average, all stands		
Commercial clear cut	75	79
Partial cut	29	119
Uncut	0	174

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