RESEARCH NOTE NC-133

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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BALSAM FIR DOMINANT SPECIES UNDER RETHINNED NORTHERN WHITE-CEDAR

ABSTRACT.—A 20-year thinning study in a Wisconsin swamp stand of middle-aged northern white-cedar indicates that advance tree reproduction and shrubs grow little until after a second thinning to less than 150 square feet of basal area per acre. Balsam fir will probably dominate this undergrowth, particularly if the area is used heavily by snowshoe hare or white-tailed deer.

OXFORD: 242:156:174.7(775) *Abies balsamea, thuja occidentalis.* KEY WORDS: *Thuja occidentalis, Abies balsamea,* undergrowth, snowshoe hare, browsing.

Before thinning northern white-cedar (*Thuja occidentalis* L.), timber and wildlife managers should know what effect various stand densities have on advance tree reproduction and shrubs, as well as the effect on basal area growth reported earlier (Foltz and Johnston 1968). Data on undergrowth were obtained from the same Wisconsin swamp stand as were the data on basal area growth.

Ten years after an initial thinning, conifer reproduction was abundant except where the stand density had exceeded 210 square feet of basal area per acre (Skilling 1959). However, most stems were only 1 or 2 years old. At the end of 20 years, 10 years after a second thinning, advance conifer and hardwood reproduction and shrubs were more than 2 feet tall only where the stand was rethinned. But the density of this undergrowth was unaffected by residual basal areas ranging from 90 to 150 square feet per acre. Interestingly, balsam fir (*Abies balsamea* (L.) Mill.) was the dominant species, perhaps partly because snowshoe hare (*Lepus americanus* Erxleben) severely browsed white-cedar seedlings.

PROCEDURE

The study area is in a fertile swamp near Pembine in northeastern Wisconsin.[1] The area is dominated by an essentially even-aged stand of northern white-cedar and a few balsam fir and black spruce (*Picea mariana* (Mill.) B.S.P.). Before the stand was first thinned in 1947, the trees averaged about 65 years old, 5 inches in diameter, and 30 feet tall. Site index is 37 feet at 100 years, about average for swamp stands of white-cedar. The study area has a history of heavy use by snowshoe hare and light use by white-tailed deer (*Odocoileus virginianus* (Boddart)) (Skilling 1959).

The stand contains twenty ½-acre plots. Four plots were thinned in 1947 to each of four average basal areas: 90, 110, 130, and 150 square feet per acre. These 16 plots were rethinned in 1957 to the same levels. The four remaining plots were left unthinned for check areas. Their basal area averaged 181 square feet per acre in 1947 and 224 square feet in 1957. Balsam fir accounted for

[1] *Thanks are due Wisconsin's Department of Natural Resources for providing part of the Miscauno Wildlife Area as the study area.*

about 30 square feet of basal area per acre in these unthinned plots both years, but was reduced to an average of 12 square feet per acre after the first thinning and nearly eliminated after the second thinning.

All undergrowth (tree reproduction and shrubs) more than 2 feet tall was sampled in 1967, 10 years after the second thinning. Data were obtained from 10 milacre quadrats systematically located in each plot. The effect of hare and deer on undergrowth was assessed by noting the degree of browsing in each quadrat and by comparing the species and condition of stems inside and adjacent to 10 small exclosures. These exclosures were established throughout the stand in 1957 after the second thinning.

RESULTS

Undergrowth in the *thinned* plots was much taller than that in the *unthinned* plots 10 years after the second thinning. The various basal area levels among the thinned plots had no apparent effect on density of undergrowth, however. Stems more than 2 feet tall (mostly 2 to 7 feet) averaged about 4,400 per acre and 74 percent milacre stocking in the thinned plots. In contrast, no undergrowth was 2 feet tall in the unthinned plots and most stems were only a few inches tall.

Balsam fir was the dominant undergrowth species in the thinned plots. Fir reproduction more than 2 feet tall averaged about 2,750 stems per acre and 60 percent milacre stocking; it accounted for 99 percent of the conifers, 62 percent of all species, and was the dominant vegetation on half the milacre quadrats (fig. 1). In contrast, northern white-cedar 2 to 7 feet tall was almost completely absent. About ¼ of the larger fir reproduction originated before the first thinning, ½ between the first and second thinning, and ¼ after the second thinning.

Hardwood reproduction and shrubs made up the rest of the undergrowth in the thinned plots.

Figure 1.—Typical undergrowth of balsam fir in the northern white-cedar stand 10 years after the second thinning.

Hardwoods more than 2 feet tall averaged about 350 stems per acre and 18 percent milacre stocking. About two-thirds of the stems were paper birch (*Betula papyrifera* Marsh.). Shrubs more than 2 feet tall averaged about 1,300 stems per acre and 35 percent milacre stocking. Half the stems were mountain maple (*Acer spicatum* Lam.) and about one-fourth were red raspberry (*Rubus strigosus* Michx.).

Browsing by snowshoe hare was much greater than that by white-tailed deer 10 years after the second thinning. Hare had browsed undergrowth on 56 percent of the milacre quadrats in the thinned plots, whereas deer had browsed on only 9 percent. However, hare and deer browsing severe enough to stunt stem growth was limited to 14 and 2 percent of the quadrats, respectively. Although only a few exclosures were still hare-proof, they demonstrated that white-cedar reproduction is especially susceptible to damage by hare. Many white-cedar stems 2 to 4 feet tall were present inside these exclosures, whereas adjacent stems outside were severely browsed by hare (fig. 2).

DISCUSSION

The results of this study indicate that undergrowth grows little in dense, middle-aged, swamp stands of northern white-cedar until after a second thinning to less than 150 square feet of basal area per acre. Because the white-cedar canopy gradually closes after thinning, stands apparently must be rethinned periodically to maintain enough light for advance tree reproduction and shrubs to continue height growth. In contrast, most undergrowth in stands thinned only once or not at all seems to grow just a few inches and then dies.

Figure 2.—Northern white-cedar stems outside an exclosure dead from snowshoe hare browsing (left), whereas adjacent stems inside were 2 to 4 feet tall 10 years after the second thinning (right).

It also appears that balsam fir will dominate the undergrowth in rethinned stands that: (1) include or are near even a few seed-bearing firs *and* (2) are used heavily by hare or deer. Fir becomes dominant probably not only because it reproduces and grows in shade as well or better than its associates (Fowells 1965), but also because it is not preferred browse for hare and deer as are white-cedar and some swamp hardwoods and shrubs (Erickson *et al.* 1961).

The dominance of fir reproduction means the quantity of preferred browse for deer or hare is small and will likely decrease as the fir grows and shades the hardwood reproduction and shrubs more. It also means the fir must be killed if rethinned stands are to be reproduced to white-cedar. This might be done by broadcast burning slash after the final harvest, and then using natural or direct seeding of white-cedar. But first, efficient techniques for burning and seeding in white-cedar stands should be developed as they have been for black spruce stands (Johnston 1971).

The results further indicate that if hare are abundant, they could compete strongly with deer for what preferred browse is available. A good example of this was observed in a Minnesota deeryard where new white-cedar growth appearing after severe deer browsing was clipped off at the snow level by hare (Erickson *et al.* 1961). It is also evident that deer and hare browsing must be reduced to a low level to successfully establish new white-cedar stands.

In terms of practice, the combined results on timber growth (Foltz and Johnston 1968) and undergrowth indicate that the following thinning alternatives are applicable, and the accompanying conclusions valid, for northern white-cedar growing in dense, middle-aged, swamp stands:

1. *Repeated thinning* to residual basal areas ranging from 90 to 150 square feet per acre will produce the maximum yield of high-quality timber and good cover for deer but only a small quantity of preferred browse. Lower basal areas would presumably result in less timber and cover but more browse. Where possible, balsam fir reproduction and overstory trees should be eliminated during each thinning.

2. *One thinning* will not increase the timber value much and will produce practically no browse. However, since deer apparently avoid some unthinned stands because movement is difficult, even one thinning would improve the quality of cover by making it easier for deer to move about.[2]

3. *No thinning* is appropriate where little demand exists for increasing the quality of white-cedar timber or wildlife habitat.

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