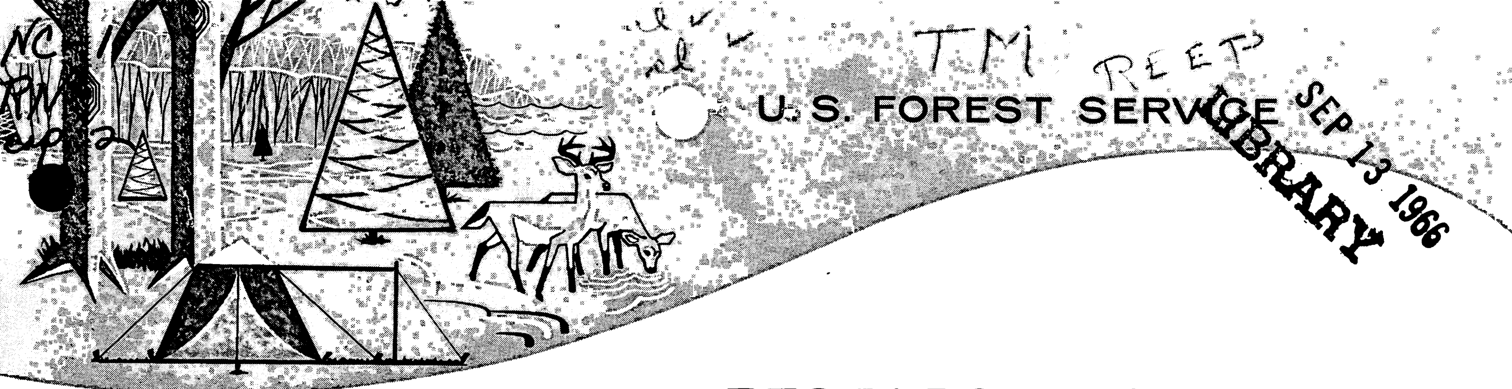

RESEARCH NOTE NC-1

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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A Silvicultural Evaluation of Four Methods of Marking Second-growth Northern Hardwood Stands

Second-growth northern hardwood stands occupy an important segment of the commercial forest land of Upper Michigan and northern Wisconsin. The size- and age-class distributions and species composition of these stands vary considerably, but under all conditions most of the trees are highly defective or poorly formed or of an undesirable species. Forest managers recognize the need for early thinning and improvement cuttings but have hitherto been reluctant to do noncommercial cutting. Now, however, not only are there active noncommercial operations on the National Forests of the region, but also the use of dense hardwoods for pulpwood is making cuttings economically feasible at a much earlier age than was previously possible.

In the Lake States the cut of northern hardwood stands has generally been controlled by marking the individual trees to be removed. In old-growth and regulated stands this management expense is offset by current income. In young second-growth stands, however, the return from the first cutting tends to be submarginal because of the low value of the products removed and the greater expense of examining and marking a large number of trees. On large ownerships, moreover, the time requirements could conceivably place an impossible demand on the technical manpower available.

There are other possibilities for preparing these stands for cutting. The simplest and cheapest would be a diameter-limit designation; but in northern hardwood stands the dollar yield is governed more by species and quality than by fiber production. Other suggested methods involve variable diameter limits for different species, the retention of set numbers of trees within broad diameter classes, mechanically applied spacing factors, and similar rules which the logger is expected to follow. Taylor (1946) analyzed and compared the tree-selection method with three other marking procedures in second-growth Allegheny hardwoods. He concluded that the rules were a makeshift means of preventing destructive cutting and that the rules must be relatively complicated to obtain results comparable with silvicultural marking.

This Note compares four methods of marking or designating the trees to be cut or to be left in the first commercial thinning and improvement cuttings of second-growth northern hardwood stands in the Lake States. Because of the few trees with potential high quality (Eyre and Zillgitt 1953, Hurd 1960), any efficient stand improvement measure should favor the growth and development of these trees. It should also yield adequate returns to cover the costs of cutting and marking.

The study.—In all four techniques described below, the residual density aimed for was 80 square feet of basal area per acre in trees of intermediate crown class and above.

1. *Marking by individual tree selection.* The trees to be removed were selected and paint marked.

2. *Setting a diameter limit from above.* All trees larger than the minimum diameter needed to leave 80 square feet of basal area were designated for cutting.

3. *Setting a diameter limit from above with good growing stock marked to leave.* All trees which met the specifications as good growing stock (adapted from Arbogast 1957) were paint marked to leave. As in Treatment 2, trees larger than the minimum diameter were designated for cutting.

4. *Setting a diameter limit from below with good growing stock marked to leave.* This technique is similar to Treatment 3 except that the trees smaller than a maximum diameter were designated for cutting.

Test areas were established in four widely separated second-growth stands in Upper Michigan. Each stand was typical of its geographical location and needed a thinning and improvement cut. Without markets for hardwood pulpwood the returns would not have covered the cost of the cuttings.

Three of the stands were essentially uneven-aged and had densities between 101 and 112 square feet of basal area per acre. These were stocked with a scattering of large and highly defective sawtimber trees left on the area at the time of the original cuttings, some small sawtimber trees that developed from the poles of the original stand, and smaller trees that became established following the cutting. The fourth stand (136 square feet per acre) originated after a clear cut for charcoal wood and was heavily stocked to poles; 88 percent of the trees were between 5 and 9 inches in d.b.h.

The tests involved no cutting, and all techniques were applied in the same 4-acre plot. The plots were first marked on the individual tree-selection method by a crew of two foresters experienced in northern hardwood marking for that particular area.[1] Next, the good growing stock was marked to leave; the same 2-man crew of research foresters did this on all areas because foresters experienced in this type of marking were not available in all locations. The diameter limits were then set to leave the desired residual density. These were based on a 100-percent cruise of all trees of intermediate crown class and better.

Under the selection method the three uneven-aged stands were marked to 71, 75, and 77 square feet of basal area per acre and the dense pole stand to 100 square feet. The latter residual density is considerably higher than recommended, but it was considered desirable because of the diameter distribution and generally vigorous crowns.

Item	*Basal area (square feet) in study area—* 1	2	3	4
Before marking	112	116	101	136
After marking by:				
Selection	77	75	71	100
DBH limit from above	82	80	74	92
DBH limit from above plus crop trees	78	80	74	94
DBH limit from below plus crop trees	79	82	75	94

[1] *The author is indebted to the following for their assistance in locating, cruising, and marking the study areas: Clark Lebo and John Walstrom, Calumet-Hecla, Inc.; Goodman Lumber Division, Calumet, Mich.; and Leon Anderson, Phillip Jaquith, Malcolm McIver, and Richard Ruppenthal, U.S. Forest Service.*

The residual densities for the diameter-limit techniques differed by as much as 8 square feet per acre from those resulting from the selection markings. The differences are not considered critical for the silvicultural evaluation.

Results and evaluation.—The number of crop trees ranged from 8 to 28 per acre and averaged 17. This is similar to the results obtained by Hurd (1960) in Wisconsin. The species distribution of the crop trees closely followed that of the stand as a whole. Of the 288 crop trees, 45 percent were sugar maple, 42 percent were red maple, and 13 percent were yellow birch, basswood, or beech. Their diameters ranged from 4 to 14 inches, with 94 percent less than 9.6 inches d.b.h. Five percent were in the intermediate crown class, 75 percent were codominants, and 20 percent were dominants.

Treatment effectiveness was judged mainly by the degree of release that would have been given the good growing stock. The degree of release was estimated by the number of adjacent trees of intermediate crown class or better marked around each crop tree by each cutting method. These data are shown in table 1.

The basis for comparing results is this: Judicious thinning of northern hardwood poles generally calls for the removal of one or two, and occasionally three, competitors. Further release increases the likelihood of persistent epicormic shoots and sunscald injury. On the other hand, no release means no alteration of the growth of the desirable trees. (Some trees, of course, need no release—for example, those with full and vigorous crowns.)

This method of evaluation has some obvious weaknesses. Mainly, *which* trees are cut is often more important than *how many*. Nevertheless, the results were so clear that a complicated evaluation seemed unnecessary. We think that, upon studying the data, most hardwood managers will agree with the conclusions.

The diameter-limit designations left the crop trees in highly contrasting environments. In both of the diameter-limit-from-above methods, more than 50 percent of the crop trees would have had no release (table 1). On the other hand, in the diameter-limit-from-below method 54 percent had four or more adjacent trees designated for cutting. This release would have been far too severe for quality increment.

When marking from above, it made little difference whether the crop trees were marked. Most of them were less than 9 inches d.b.h. and therefore had little effect on limits which were 10 inches or above. Actually, it would have been impractical to mark the crop trees because only 5.2 percent would have

Table 1.—Degree of release of crop trees by marking technique

Marking technique	Number of adjacent trees marked for cutting 0	1	2	3	4+
	(Percent of crop trees)				
Selection	15	29	33	16	7
DBH limit from above	51	34	12	3	0
DBH limit from above plus crop trees	53	35	10	2	0
DBH limit from below plus crop trees	2	10	14	20	54

been cut. On the other hand, if the crop trees had not been marked in the diameter-limit-from-below, more than half of them would have been cut.

The basic reason for the results in the diameter-limit marking is that trees of like size tended to grow in groups. Thus, either most of the group would have been cut or few or none would have been cut. Moreover, the good growing stock also tended to be in a group of like-size trees. This environment may be a necessity for the development of trees of good quality in unregulated northern hardwood stands. Trees that become dominant early generally develop coarse branching characteristics. On the other hand, trees not reasonably free to grow in height will set low crowns. In both cases, natural pruning will be slow.

Another objection to the diameter-limit cuttings is illustrated by the diameter distribution of the cut and leave trees. In the cuttings from below, the maximum diameter of the trees to be cut varied from 6.0 to 7.6 inches. This size tree is not likely to attract competent cutters. In the diameter-limit-from-above, on the other hand, only sawtimber trees would have been cut. In the stand heavily stocked to poles, 100 percent of the trees above 9.6 inches would have been removed whereas the selection cut would have removed only 21 percent. Although many of the larger trees in the other stands were marked in the selection method, skillful manipulation of the harvesting of the remainder would help finance the series of cuttings required to develop a productive forest.

The selection marking clearly created the best environment for the future growth and development of the good growing stock. Of the crop trees 78 percent had between one and three adjacent trees cut. For the four study areas, the crop trees released in this manner ranged from 76 to 82 percent even though the marking was done by four different crews and previous to the marking of the good growing stock.

Time requirements.—The time required to prepare the stands for cutting was recorded on three of the study areas. The small sample and the study conditions rule out absolute time requirements, but the results indicate that crop tree marking (0.48 man-hours per acre) can be almost as time consuming as marking the trees to cut by the selection technique (0.61 man-hours).

In both methods all trees in the stand must be examined; apparently this tends to offset the advantage of marking the much smaller number of trees classified as good growing stock.

The diameter-limit designations also require a cruise to establish the cutting diameters that would leave the desired residual stand density. The evaluation here was based on 100-percent samples, but a partial-cruise technique was also tested. The technique employed systematically spaced point samples for estimating total basal area per acre, and a transect tally between points for estimating the diameter and species distribution. The sample points gave good estimates of the average stand density (the largest discrepancy was 6 square feet per acre), but the transect tally gave generally unsatisfactory estimates of the diameter distributions. Undoubtedly more efficient cruising techniques could be devised, but a fairly intensive sample probably would be required.

The diameter-limit-from-above without marking crop trees would naturally be the most economical method of preparing the stand for cutting. The only task would be a cruise to establish the cutting diameter. However, the land manager would have to accept the release of only half the crop trees and the other unfavorable features of this system.

In summary.—Considering the silvicultural aspects and the physical application of the techniques, any control other than marking the individual trees to be cut would be hard to justify if the management goal is the production of high-quality saw logs. The forester must evaluate the requirements of each tree rather than those of the stand as a whole.

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