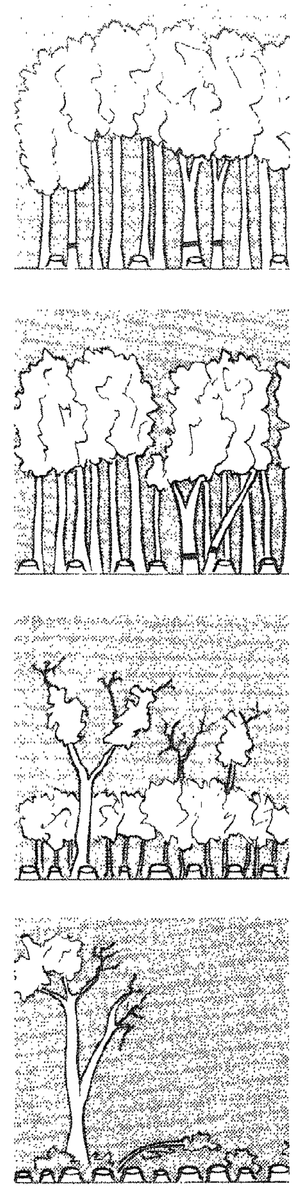
A Demonstration of FOUR INTENSITIES OF MANAGEMENT in Northern Hardwoods



by

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U. S. FOREST SERVICE RESEARCH PAPER NE-4

1963

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.

FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE

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History

MORE than 10 million acres of land in New England are classified as northern hardwood forests.[1] The increasing importance of these beech-birch-maple forests to the economy of the region emphasizes the need for better guides to good management of northern hardwood forests.

High-quality northern hardwoods, particularly sugar maple and yellow birch, have always been in some demand in the Northeast for furniture and specialty products. In the early days inaccessibility of the better timber, difficulties in handling and transporting the heavy hardwood logs, and limited markets prevented better utilization. Except for fuelwood, only the best and most accessible hardwood timber was exploited. By 1950, however, improved technology in logging and transportation, together with the opening of new markets in the veneer and pulp industries, had changed the picture. Heavy equipment and extended road systems had by then lessened the problems of transportation and log handling. The demand for logs for high-grade veneer had grown rapidly, and somewhat later the paper industry had begun to

[1] United States Forest Service. TIMBER RESOURCES FOR AMERICA'S FUTURE. U. S. Dept. Agr. Forest Resource Rpt. 14, 713 pp., illus., 1958.

utilize hardwoods for pulp. Today there is an increased demand for all species of hardwoods; and the demand for large, high-quality logs often exceeds that for many softwoods.

Ironically, it is this increased demand that has led to our present problems in old-growth northern hardwoods, because increased demand has forced us to face the task of rehabilitating these long-neglected forests and stepping up their production in both quantity and quality. Look back a few decades and see what has happened. At the turn of the century most of the northeastern forests were cut over for the first time, and only the best softwoods were taken. Next, as the demand for hardwood lumber increased, the best of the hardwoods were cut. The trees left behind are now the old veterans, usually mixed with young and vigorous recruits that either were present but unmerchantable when the stands were first cut or came in later. This is the so-called typical old-growth northern hardwood forest now found in New England—large volumes of overmature timber, poor in quality and vigor, but interspersed with many young, sound trees.

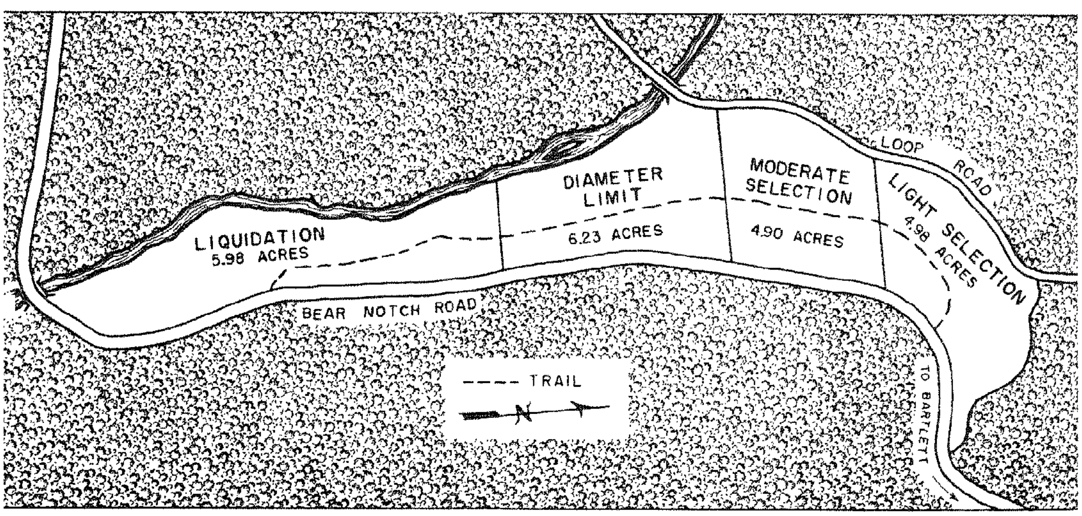

Figure 1.—Plan of the demonstration plots on the Bartlett Experimental Forest.

It is in old-growth stands of this sort that U. S. Forest Service researchers at the Bartlett Experimental Forest, in Bartlett, New Hampshire, have established large-scale studies to provide needed information on northern hardwood management practices. To enable interested visitors to see some of these management practices more conveniently, four small demonstration plots have been established on the Forest (fig. 1). This paper describes those plots and points out their efficacy and value as demonstrations of four specified management programs.

What Is Being Demonstrated?

The management practices demonstrated on the four plots represent the basic management-intensity levels under test in the large study at Bartlett; they also exemplify the different management intensities to be found today in the northern hardwood region.

Method of cutting is the basic component of any program or system of management practices concerned with harvesting and regenerating a timber stand. To a large degree, the method of cutting determines what other practices or cultural measures are possible or feasible. In the general discussion that follows, the basic elements of the cutting methods demonstrated and their advantages and disadvantages are described.

Methods of Cutting

Only three methods of cutting are represented on the four plots. The method discussed first — single-tree selection — was applied according to different specifications on two plots; the other two methods were used on one plot each.

Single-tree selection.—Foresters have long observed that the single-tree selection system of cutting is well adapted for most old-growth northern hardwood stands. This method usually results in the most efficient use of the productive capacity of the land. It is flexible: the forester can keep individual trees for further growth and development, and he can mark others for removal—using tree vigor, amount of defect, and spacing as the major criteria. Since the amount of timber removed under this method usually is small compared to other cutting methods, the time between successive cuttings is relatively short. And, because of this shorter cutting cycle, tree mortality should be at a minimum: low vigor trees that would die over longer cutting cycles are salvaged.

Past experience in old-growth northern hardwood management, as well as trends observed in current studies, indicate that this cutting method has further advantages. It will, for instance, provide income for an owner at fairly short intervals while improving, and later maintaining, timber quality. It permits development and maintenance of a balanced size-class distribution in the growing stock (those trees retained to grow and develop). Moreover, this is the most widely accepted cutting method for watershed management and for aesthetic values.

But there are disadvantages. An owner may have a large investment tied up in his timber that is subject to risk because of fluctuating markets and such natural hazards as fire, wind, insects, and diseases. Then, too, this system tends to perpetuate the shade-tolerant species, which may not always be desirable.[2]

Diameter limit.—The diameter-limit method of cutting, in its simplest form, disregards both species and tree quality; all trees over a minimum size are taken. Consequently, cuttings made by this method usually do not improve the growing stock because many defective trees are left in the lower diameter classes. On the other hand, vigorous, well-formed trees in the larger classes that might greatly increase in value by the time of the next cutting are removed. The length of the cutting cycle will depend on the minimum diameter used.

[2] Tolerant species: beech (*Fagus grandifolia* Ehrh.), sugar maple (*Acer saccharum* Marsh.), hemlock (*Tsuga canadensis* L. Carr.), and red spruce (*Picea rubens* Sarg.). Intolerant or intermediate (those that require direct sunlight): paper birch (*Betula papyrifera* Marsh.), yellow birch (*B. alleghaniensis* Britton), white ash (*Fraxinus americana* L.), red maple (*Acer rubrum* L.), and aspen (*Populus tremuloides* Michx. and *P. grandidentata* Michx.)

LIGHT SELECTION
4.98 acres

Basal area, square feet	
Original:	128.4
Harvested:	23.1
Girdled:	10.5
Residual:	94.8
Removed:	26%

MODERATE SELECTION
4.90 acres

Basal area, square feet	
Original:	123.6
Harvested:	34.2
Girdled:	6.7
Residual:	82.7
Removed:	33%

DIAMETER LIMIT
5.23 acres

Basal area, square feet	
Original:	117.9
Harvested:	45.3
Girdled:	8.7
Residual:	63.9
Removed:	46%

LIQUIDATION
5.98 acres

Basal area, square feet	
Original:	122.5
Harvested:	84.4
Girdled:	—
Residual:	38.1
Removed:	69%

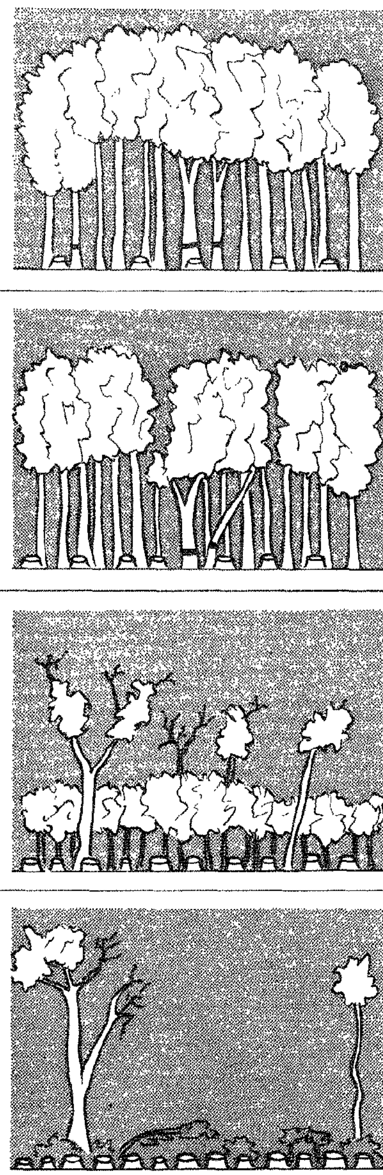

Figure 2.—Specifications for the Management-Intensity Demonstration Plots. Basal-area figures are in square feet per acre for trees 4.5 inches d.b.h. and larger.

Experience with the diameter-limit method of cutting has shown that ordinarily it will provide a larger income from the first cutting than the single-tree selection system. The landowner will materially reduce his investment in standing timber. Handling costs will be lower and the logging will be more attractive to operators because, volume for volume, the average size of the trees cut will be larger than under the selection system. Average quality of the products will be higher because, other things being equal, the larger trees and larger logs yield a larger percentage of high-grade lumber. A further advantage is the ease with which diameter-limit cutting can be applied.

Opposed to these advantages are several serious disadvantages. The general quality of the residual growing stock is lowered by diameter-limit cutting; the next cutting is likely to yield less quality material than the first cutting, whereas under the selection cutting the growing stock and product quality improve with successive cuttings. Residual stands after diameter-limit cutting often are irregular, with some portions well stocked and others practically clearcut. Aesthetic values are altered, usually adversely. Under diameter-limit cutting an individual woodlot or stand yields income only at relatively long intervals; at least 20 to 30 years ordinarily must elapse after the first cutting before another cutting of similar volume can be made.

Liquidation.—This is a commercial clearcutting that removes all merchantable products—ordinarily a very heavy cutting. The residual stand will vary according to the products the local market will accept and the product objectives of the operator.

On the surface, a liquidation cutting seems to have few advantages. However, it may be the best course to take in stands with poor growing stock or in relatively inaccessible stands where road construction costs are high. Or, for various reasons, an owner may need to convert his investment into ready cash. Then too, the first liquidation cutting in old-growth northern hardwoods usually leaves conditions favorable for regeneration of the more valuable intolerant species.

Among the disadvantages are the long time required for another merchantable stand to develop, and the temporary reduction of aesthetic values. Perhaps the greatest disadvantage is the removal of prime, fast-growing trees that are just beginning to produce high-value wood.

All three cutting methods discussed have some advantages, and some disadvantages. The choice of cutting method will be determined largely by the landowner's management objectives, as governed by ecõnomic and aesthetic considerations. The practicability of attaining these objectives will be affected in turn by site, accessibility, and general stand conditions.

The Demonstration Plots

It was for the purpose of demonstrating several distinctly different management practices, based upon the methods of cutting described above, that the four Management Intensity Demonstration plots were established. Two of the practices, or management intensities, were based upon single-tree selection cutting —one representing a light cutting and one a moderate cutting. The third intensity was based upon diameter-limit cutting and the fourth upon liquidation cutting.

The demonstration plots are approximately 5-acre stands situated on a gentle to moderately steep northerly slope. The very stony soils are derived from glaciated material. Early hardwood logging removed the best of the sugar maple and birch and left a high proportion (nearly half) of beech in the residual stands. Besides the beech, other major species growing on the plots included sugar maple, yellow birch, and eastern hemlock, with lesser amounts of paper birch, white ash, red maple, aspen, and spruce. Before treatment the stands were uneven-aged, with relatively young saplings and poles growing among sawtimber trees, some several hundred years old. Seedlings of the tolerant species were plentiful, and the tolerants made up a large proportion of the growing stock in all size classes.

The Treatments

The first step was to inventory all trees at least 4.5 inches in diameter at breast height (4.5 feet from the ground) to determine the volume of wood on each plot. Then the plots were logged, each according to one of the methods of cutting previously described (fig. 2). This was done in 1952. Reinventories were made immediately after logging and again in 1959 in order to obtain growth and mortality data.

In addition to the harvest cutting, some unmerchantable trees in the plots treated by selection and diameter-limit cuttings were eliminated by girdling. This work, done in 1953, raised the average quality and vigor of the growing stock by ridding the stand of poor quality trees, released potentially merchantable trees, and provided growing space for reproduction.

The light selection plot.—On this plot trees were marked for either cutting or girdling. In keeping with the above-described criteria of the single-tree selection system, a short cutting cycle—5 to 7 years—was prescribed, with a growing-stock level objective of 100 square feet of basal area[3] per acre to be retained after each cutting. This means a comparatively heavy residual stand will be maintained. More unmerchantable trees were girdled on this plot than on any of the others.

A second cutting was made, as scheduled, on this plot in 1959. However, no data from this second cutting are included in this report.

The moderate selection plot.—The treatment on this plot was similar basically to that on the light selection plot; it differed in that less cultural work (girdling) was done, and the prescribed cutting cycle was 10-15 years, with a somewhat lower growing-stock level objective—80 square feet of basal area per acre. Figure 3 illustrates the types of trees cut and girdled on both selection plots.

The diameter-limit plot.—Again in keeping with the specifications for this cutting method, trees on this plot were not marked individually; instead, all merchantable trees larger than

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[3] Basal area is the area of the cross section of a tree measured at breast height (4.5 feet from the ground) and expressed in square feet. As a unit of stand measurement, it commonly is expressed as square feet per acre. Unmanaged stands of old-growth northern hardwoods at Bartlett will reach a maximum basal area per acre of about 125 to 130 square feet. For converting to cubic feet or board feet, 1 square foot averages 23 cubic feet; or, for sawtimber trees only, 1 square foot is equivalent to about 140 board feet (International ¼-inch log rule).

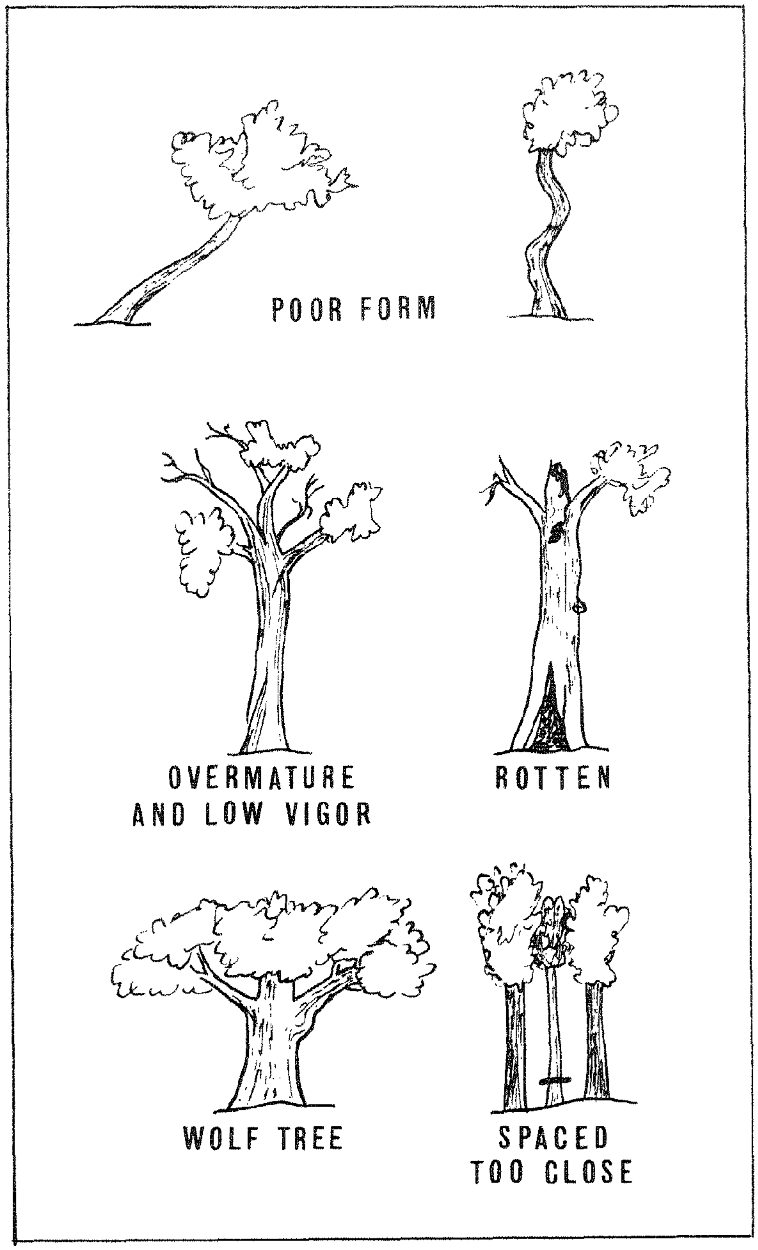


Figure 3.—The types of trees marked for cutting and girdling on the selection plots.

14.5 inches in diameter were cut by the loggers. The growing-stock level objective is 60 square feet of basal area per acre after each cutting, and the cutting cycle is estimated at 20 to 30 years. A cutting cycle of this length will not produce future cuttings with as large trees as in the initial cutting.

Some of the cull trees left by the loggers on this plot were girdled. Girdled trees were all larger than the diameter limit of 14.5 inches and were removed only if they interfered with reproduction or competed with promising trees.

The liquidation plot.—On this plot, cutting removed all merchantable products, including pulpwood. No girdling of cull or wolf trees was done to improve the residual stand. Another commercial cutting will not be possible until a new stand has developed.

On both selection plots, logging roads were located only on gentle grades, and water bars were installed at the end of the job to prevent soil erosion and gullying. Logging damage to the residual stands was minimized by avoiding sharp turns in laying out skid-trails, and by close supervision of the logging. No such measures were taken on the diameter-limit and liquidation plots.

Validity of the Demonstrations

For the Management Intensity Demonstration plots to fulfill their primary objective as demonstrations, the treatments used on the plots must be valid examples of the four specified intensities of management and, particularly, of the cutting methods on which they are based. The 7-year results presented below show that the treatments have exemplified those management intensities reasonably well.

Stand Growth and Quality

The important factors in the evaluation of any management practice are the quantity of wood produced, the quality of that wood, and the degree of success attained in perpetuating desired

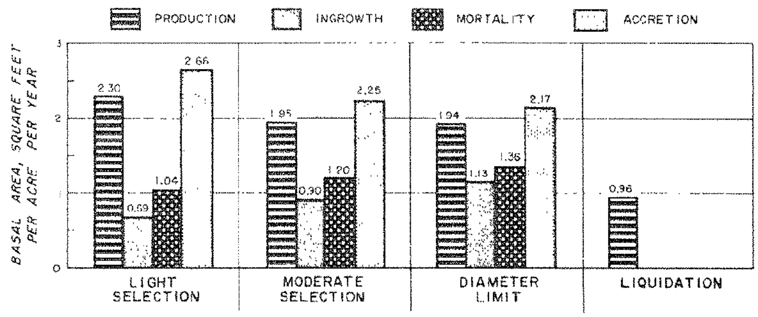
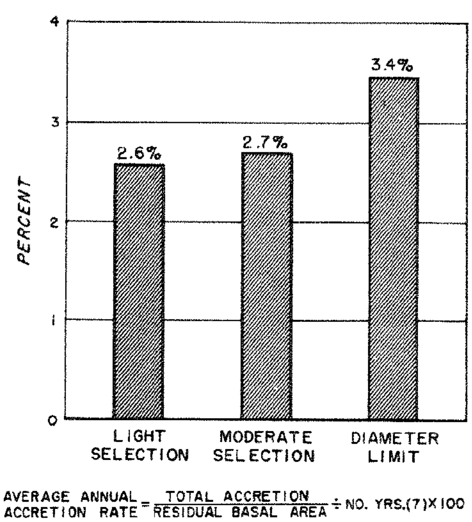


Figure 4.—Growth data for the demonstration plots, based on 100-percent inventories of all trees 4.5 inches d.b.h. and larger.

species. To aid in evaluating the treatments used on the demonstration plots, the growth data are presented in figure 4. The terms used are defined as follows:

Accretion is the growth on those trees in the residual stand that were large enough to be measured in the inventory taken immediately after logging; that is, all trees 4.5 inches and larger in diameter at breast height.

Figure 5. — Average annual accretion rates for the three partially cut plots.



Ingrowth comprises those trees that were too small to be measured in the after-logging inventory but attained measurable size during the period of observation.

Mortality comprises those trees that were alive and measured in the after-logging inventory but then died during the period of observation.

Production is accretion plus ingrowth minus mortality. It is a measure of net growth in a stand or area; it is the growth that can be harvested.

Figure 5 shows average annual accretion rates for the three partially cut plots (the liquidation plot had no significant accretion during the 7-year period). Accretion rate is the annual accretion expressed as a percentage of the residual growing stock. It is a good measure of growing-stock response to a cutting method or other treatment.

What kind of trees are accruing this growth? Quality is an important factor in managing northern hardwoods. Quality is related to tree size, as well as to form and defect; other factors being equal, larger trees produce more high-grade lumber. Figure 6 presents the plot data for accretion and production on the sawlog-size trees (all softwoods 9.5 inches and larger, and all hardwoods 10.5 inches and larger). Accretion and production

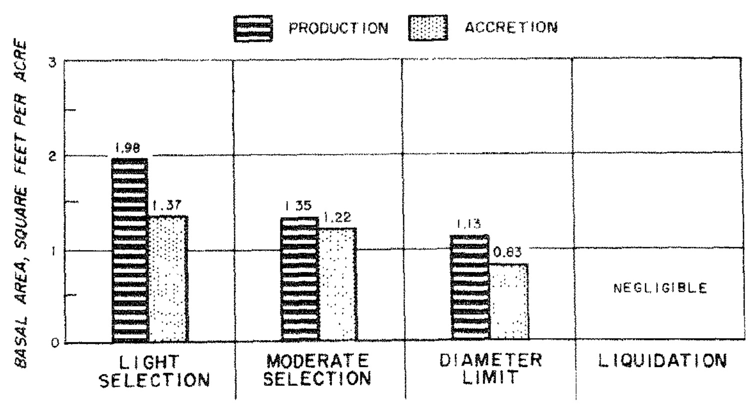
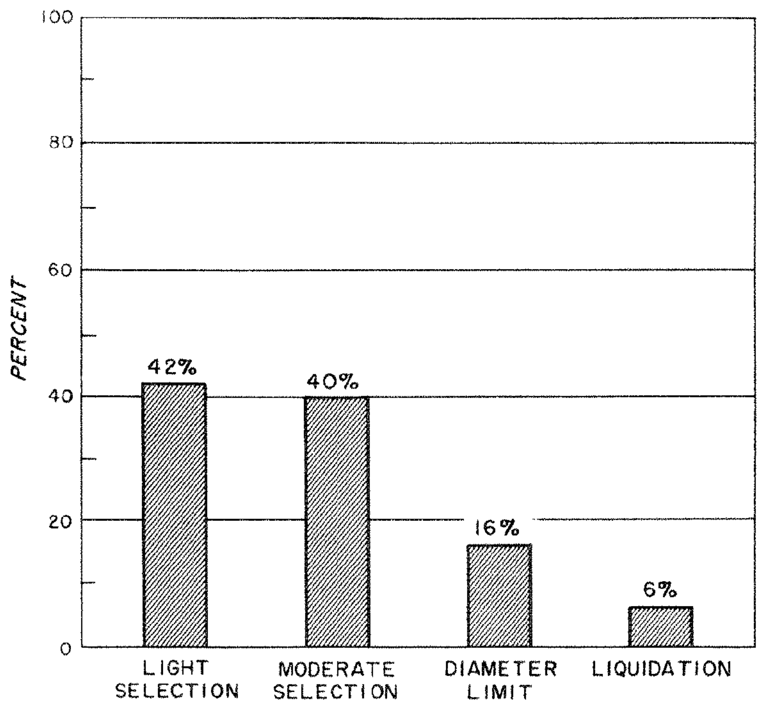


Figure 6.—Annual production and accretion on sawlog trees.

Figure 7.—Proportion of the total growing stock in trees with butt logs of grades 1, 2, or 3. Grades adapted from U. S. Forest Products Laboratory hardwood log grades. (U. S. Forest Prod. Lab. Rpt. D1737, 1953).



were greater on the selection plots where sawlog diameter classes up to 27 inches d.b.h. were represented in the growing stock.

The percentages of better quality trees (those with grade 1, 2, or 3 butt logs[4]) are shown in figure 7 for each plot as of 1959, or 7 years after the initial cutting. Both of the selection plots had a higher percentage of large, better-grade trees than the diameter-limit plot because such trees were favored when the

[4] The grades for butt logs in standing trees were adapted from: HARDWOOD LOG GRADES FOR STANDARD LUMBER: PROPOSALS AND RESULTS. U. S. Forest Prod. Lab. Rpt. D1737, 15 pp., 1953. Such log grades segregate logs into high, medium, and low groups as determined by the lumber grade yield and gross lumber yield. Thus, a grade 1 log is a high-grade log and will produce a high yield of quality lumber; grades 2 and 3 are lower on the scale, respectively, and will yield smaller proportions of high-quality lumber.

selection plots were marked for cutting; that is, the cutting was concentrated on the lower-grade trees. Also, more culls were girdled on the selection plots.

Mortality on the demonstration plots has been excessive, mainly because of heavy losses of beech and yellow birch. These two species accounted for almost 80 percent of the total. Beech losses were due largely to the beech scale-Nectria complex—an insect and disease combination. Yellow birch suffered mainly from exposure. This species is very sensitive to the environmental changes that result from logging operations.

Regeneration

Fortunately, getting adequate reproduction in old-growth northern hardwood stands under any management practice seldom is a problem. However, getting adequate numbers of desired species is another story. A regeneration survey conducted on the demonstration plots at Bartlett in 1959 bore this out. Figure 8 gives the number of milacre[5] sample plots measured in each demonstration plot and the percentages of these sample plots that were stocked with a potential crop tree.[6]

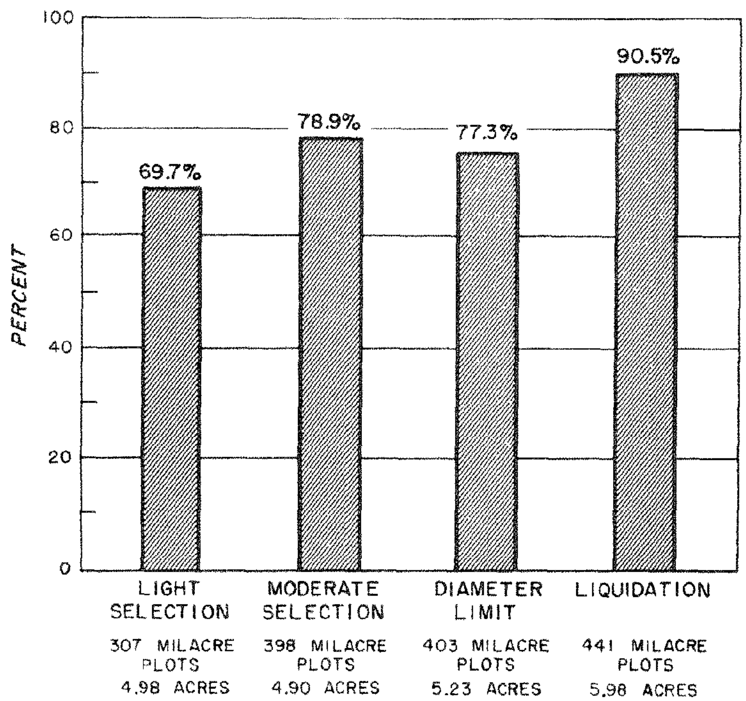
The stocking is adequate on all of the demonstration plots, including the light-selection plot where regeneration is gradual and continuous. The abundance of regeneration on the more heavily cut plots is due to improved growing conditions, particularly the increased light resulting from removal of the overstory.

Species composition of the regeneration varied considerably among plots. The lighter cuttings consistently favored the tolerant species such as sugar maple and beech. As silvuculturists often have observed, regeneration after light cuttings in northern hardwoods develops mostly from tolerant advance reproduction; that is, seedlings that already were established when the cutting was done. Light cuttings thus perpetuate the tolerant species. The heavier cuttings favored larger percentages of intermediate and

[5] Milacre = 1/1,000 acre.

[6] Potential crop tree: A tree of a commercial-species that is between 3 feet tall and 1.5 inches d.b.h. Where 2 or more trees in this size range are found on a plot, the tallest 1 is considered to be the potential crop tree.

Figure 8.—Percentage of milacre plots stocked with a potential crop tree—the tallest tree of a commercial species between 3 feet tall and 1½ inches d.b.h.



intolerant species such as red maple, yellow birch, paper birch, and white ash. These species can become established in the larger openings after cutting, and they can compete there more or less successfully with the tolerants. However, the greater the number of tolerants in the advance reproduction, the smaller will be the proportion of intolerants in the new reproduction, regardless of how heavily the stand was cut.

The crux of the reproduction problem faced by most northern hardwood timber managers when choosing a management practice is not so much the amount as it is the kind of reproduction obtained. Though advance reproduction cannot be altered, the species composition of the regeneration can be partially controlled by the degree of cutting employed.

Appraisal

The responses to stand treatments on the Management Intensity Demonstration plots 7 years after cutting are in accord with expectations derived from other experience in the northern hardwood type. In short, the plots are considered good demonstrations of the management practices they were designed to demonstrate.

However, because of the small size of the plots and the lack of replications, final judgments on the merits of the different management practices should not be based on these plot results alone. Conclusive information of this sort must and will come from the larger, long-term studies now under way.

But in the interim, cutting in the northern hardwood region will continue at its present or at an even faster rate, and forest managers urgently need at least tentative guides now on which to base their management decisions. The results from the demonstration plots, coupled with trends observed in other studies, and tempered by past experience, do give an indication of the different treatment possibilities and, if used with discretion, should provide reasonably good guidance for managing similar old-growth northern hardwood stands.

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