Some Guidelines for Improving Northern Hardwood Timber Stands
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The northern hardwood forest is Michigan's most extensive forest type, occupying over 5 million acres or nearly 30% of the state's commercial forest area. This type produces some of the most valuable wood products harvested from the Michigan forest, with high quality veneer and sawlogs bringing top prices. The major tree species are sugar (hard) maple, beech and yellow birch, but a variety of other hardwood and coniferous species can be found in most northern hardwood stands.

Even though nature will eventually produce high-quality stands, proper management can increase value. Many northern hardwood stands are overcrowded with poorly formed, low-value, or defective trees that will never produce a high-value product. The growth potential of such stands can be improved by thinning and weeding. Sapling and pole size stands can benefit most by immediate treatment, but even mature stands can be improved.

Woodlot management is designed to give each tree room to grow with none to spare. There must be an adequate number of trees of desirable species, of good form and quality and spaced properly to take full advantage of the site. The number of trees on any acre will vary according to size of trees, age classes, crown development and species. Forests, like field crops, should be weeded and thinned periodically to produce the highest quality timber in a minimum length of time.

Timber Stand Improvement (T.S.I.) is a silvicultural operation to provide adequate growing space for potential crop trees of the more valuable species. The crop tree selection method is recommended for northern hardwood stands. This means selecting the best trees of the highest-valued species as crop trees and eliminating adjacent, competing trees. This frees the crowns of the crop trees and provides greater growing space. Growth on the released trees is often 40 to 60% greater than on unreleased trees. Because this increased growth is on selected, sound, high-value species of good form, the increase in value may well equal far more than 40 to 60%.

Common Terms

1. **Wolf Tree.** A tree with an overdeveloped, wide-spreading crown extending more than two-thirds of the way down the bole of tree.
2. **Cull Tree.** A tree that has not, or will not, produce a merchantable 12-ft. log; a tree with rot or a major defect in the bole that will make it susceptible to breakage before reaching merchantable size; a tree leaning at such an angle (45" or more) that the top cannot catch enough sunlight to maintain normal growth; an extremely crooked or forked tree.
3. **Weed Tree.** A tree of a species that will persist in a stand but never make a merchantable sawlog or veneer log.
4. **Crop Tree.** A tree usually in the pole or large sapling size class, of good form and high commercial value for lumber or veneer, in which an investment is made to accelerate its development and growth beyond what could be expected under natural stand conditions.
5. **Twins and Clumps.** Two or more trees that are joined together, either at or above the ground line, originating from a common stump.
6. **Crown.** The upper part of a tree, including the branches with their foliage.
7. **DBH.** Diameter at breast height, 4½ ft. above the ground.
8. **Basal Area.** The area, espressed in square feet, of the cross section at breast height of a single tree, or of all trees in a stand.
9. **Pole-Size Tree.** A young tree 4 to 11 in. in DBH.
10. **Sapling.** A young tree 2 to 4 in. in DBH.
11. **Dominant Tree.** A tree with the crown extending above the general level of the canopy cover, receiving full sunlight from above and some from the sides. Larger than the average tree in the stand.
12. **Co-dominant Tree.** A tree with a crown that forms the general level of the canopy cover, receiving full light from above but comparatively little from the sides. The medium-sized crowns are more-or-less crowded on the sides.
13. **Intermediate Tree.** A tree with a crown that extends into the canopy formed by dominants and co-dominants, receiving little direct light from above and none from the sides. The small crowns are crowded on the sides.
14. **Suppressed Tree.** A tree with the crown entirely below the general level of canopy cover receiving no direct light from above or the sides.

Crop Tree Method of Thinning

Young stands of northern hardwood respond very well to a thinning based on the crop tree release method. Increased growth on the released trees is 40 to 60% greater than growth on unreleased trees because the total growth potential of the site is placed on a smaller number of higher value trees. Remove weed species and poorly formed, insect damaged, diseased, low quality, and otherwise inferior trees.

Thin as soon as crop trees can be recognized. This is usually when the main stand reaches about 3 in. DBH. It is not necessary to remove aspen and pin cherry unless they are interfering with the growth of a crop tree. Pin cherry does not cast enough shade to slow down

growth of more valuable species, it produces food for wildlife and tends to die out at a relatively young age. Aspen occurring in hardwood stands can be carried to a merchantable size and then be removed as part of a commercial thinning.

Crop tree thinning involves killing or cutting trees competing with selected desirable crop trees. It is applied where fairly heavy advance restocking is present, preferably in the pole and large sapling (3 in. DBH and larger) size classes. At least 40 crop trees per acre are necessary for a stand to be stocked sufficiently to permit crop tree improvement.

For greatest economic returns, limit crop tree improvement to a maximum of 80 selected crop trees per acre. Crop tree improvement may apply to patches within a stand where proper conditions prevail and not necessarily to a stand as a whole.

A. Selection of Crop Trees — in order of importance.

a. Crown position: Must be a dominant, co-dominant or large intermediate.

b. Form:

(1) Good crown vigor and crown/height ratio. (Crown should not exceed two-thirds of the height of the tree.)

(2) Straight bole, no acute fork in the main stem, and no large dead branches if tree is over 9 in. DBH.

(3) No major cull defect signs.

(4) Not less than 3 in. DBH.

c. Value (species): The relative desirability of species for long-time management for sawlogs and veneer logs on soils suitable for northern hardwoods follows:

Desirable	*Less Desirable*	*Least Desirable*
Yellow Birch	Eastern Hemlock	Quaking Aspen
Basswood	Red Maple	Bigtooth Aspen
Sugar Maple	Beech	Pin Cherry
Black Cherry		Ironwood
White Pine		Elms
White Oak		Hickories
N. Red Oak		
White Ash		

Number of trees to select.

a. Select a minimum of 40 trees per acre. This will provide the desired stocking (stand structure) in the upper size classes (12in. DBH, and over) at rotation age, as prescribed for uneven aged management. If less than 40 acceptable trees per acre can be found, no selection should be made and T.S.I. should be limited to cull and weed tree removal.

b. As added insurance against loss of selected crop trees (where stocking allows) identification of additional crop trees is recommended. Up to 80 crop trees per acre should be selected. Treating more than 80 crop trees per acre would increase job costs beyond the point justifiable by silvicultural benefits.

B. Determination of Amount of Growing Space to be Given to Crop Trees. The radius of the growing space given each selected crop tree will vary with the diameter of the crop tree. Methods of determining the required growing space radius are:

1. 1.67 x DBH (in inches) = growing space radius requirement in feet.

   Example: 8 in. DBH crop tree
   1.67 x 8 = 13.36 ft. or 13 ft.

2. 20 x DBH (in feet) = growing space radius requirement in feet.

   Example: 8 in. DBH crop tree
   20 x 2/3 ft.
   = 13½ ft. or 13 ft.

3. Crop tree stick: The growing space radius requirement in feet for each DBH class can be placed on a Biltmore or similar stick for handy field use. The following chart lists the figures used in constructing a crop tree stick:

Crop Tree DBH (In.)	*Growing Space Radius (Ft.)*	*"I"*
.6	1	.59
1.2	2	1.19
1.8- 3.0	4	2.29
3.0- 4.2	6	3.36
4.2- 5.4	8	4.38
5.4- 6.6	10	5.37
6.6- 7.8	12	6.33
7.8- 9.0	13	7.25
9.0-10.2	14	8.14
10.2-11.4	15	9.00
11.4-12.6	16	9.84

The figures under "I" indicate the number of inches from the end of the stick where the release figures should be placed. The stick is read like a Biltmore stick.

A second approach to regulating growing space is that of basal area. Basal area refers to the cross-sectional area in feet at DBH of all trees on a given acre of land. Measure the diameter of each tree and calculate the basal area equivalents for trees of varying diameters from the table:

Basal Area Values (square ft.) for trees of varying diameters (DBH)

Diameter	*Basal Area Value*
2	0.02
3	.05
4	.09
5	.14
6	.20
7	.27
8	.35
9	.44
10	.55
11	.67
12	.79
13	.92
14	1.07
15	1.23
16	1.40
17	1.58
18	1.77
19	1.97
20	2.18
21	2.41
22	2.64
23	2.89
24	3.14
25	3.41
26	3.69
27	3.98
28	4.28
29	4.59
30	4.91

This is an exacting approach and is usually followed only in very small operations or in research studies. In practice, an estimate of total basal area is obtained through use of a concept involving point sampling. Point sampling (Fig. 1) does not require actual measurement of each tree, but a count of the number of stems larger than a projected predetermined angle. Sample points (essen-

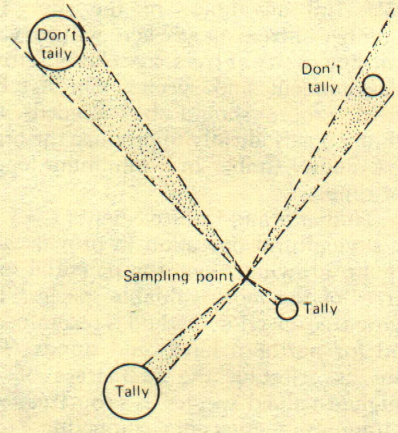

Fig. 1 How point sampling works in the field. Circles represent cross sections of trees at breast height, shaded areas indicate angle gauge projections from sampling point.

tially plot centers) are established and a simple wedge prism or angle gauge is used to "sight-in" each tree. As illustrated in Fig. 1, trees are counted, depending on how they appear through the fixed angle of view of the angle gauge for wedge prism.

Either of these devices is constructed so that the number of "counts" when multiplied by a factor (usually 10) will provide an estimate of the total basal area per acre. Point sampling is based on the relationship between the trees' DBH, distance from the observer and the sighting angle used.

A wedge prism is constructed with a predetermined amount of distortion built in. The angle of the intentional distortion is correlated with a basal area factor or multiplier, with 10 being the most common multiplier. Angle gauges physically establish a critical angle which is also correlated to the basal area factor. A simple angle gauge is shown in Fig. 2

This angle gauge subtends an angle of 104.18 minutes which requires the use of 10 as the multiplier (basal area factor). Multiplying the number of "counts" by 10 will give an estimate of total basal area per acre. In practice, several sampling points are established and the results from all are averaged to obtain a reliable estimate for the forest stand being sampled.

Recommended basal area stocking levels for different-forest types and stands will vary depending on the objectives of management. Most northern hardwood stands will produce maximum sawtimber when basal area values are between 80 and 90 sq. ft. per acre. If stocking levels exceed 135 sq. ft. the stand should be thinned to realize maximum sawtimber production. While the recommended stocking levels for other forest types may vary, a similar concept is followed.

Pruning Northern Hardwoods

Pruning young northern hardwood trees has not been considered economically feasible in the Lake States, although research studies show that Yellow Birch and other hardwoods can be pruned to provide more high quality wood than would result from unpruned stands. These studies indicate that hardwoods can be pruned to 50% of the total height of the tree with no resulting loss in diameter or height growth.

The time necessary for healing of the limb scars is related closely to the size of the scar and the growth rate of the tree. Scars from live limbs heal faster than similar sized scars from dead limbs. Also, scars from trees released from competing growth heal faster than scars on trees not released.

Use a pruning saw so that an oval shaped cut is left flush with the trunk of the tree. Live limb scars, less than ½ in. in diameter, heal over completely in 2 or 3 years. In pruning dead limbs, slightly injure the live tissue surrounding the limb to start callus formation; otherwise dead limb scars heal more slowly, and the chances of rot entering the wound are greater. Very little epicormic branching results on the pruned tree when it is released according to the crop tree spacing formula.

Thinning Twins and Clumps

Trees originating from stump sprounts are generally considered poor risks and not worth an investment of time and money for thinning. Because basswood generally reproduces by sprouts, and is a high value species, clumps can be thinned for faster growth and development.

Thin clumps of basswood so as to leave 2 or 3 stems per clump, giving preference to the best, more widely spaced sprouts originating from the roots or positions low on the stump. Remove clumps of all other species from the stand as soon as possible, as they very seldom develop into high-value products.

Twins should be treated similar to clumps, although they may be kept in the stand if needed for stocking purposes during the early years of management. The general rule-of-thumb followed is to leave both or remove both.

Standard Methods for Removing Unwanted Trees

Eliminate trees by the most economical, effective and safest method for the time of year the work is being done.

A. Girdling. An effective girdle must sever the cambium layer completely to insure kill. A girdled tree will die slowly and tends to come down in pieces, thereby doing less damage to the residual stand. Sprouting from girdled trees is not serious for the northern hardwood species, especially trees over 10 in. in diameter. Methods of girdling are:

1. Ax girdling is done by cutting a double-hack notch completely around the tree stem.
2. Strip peeling a band of bark 2 to 4 in. wide completely around the stem. This method can be used only during the peeling season in the spring.
3. Use of a power girdler. This type of machine is very efficient on

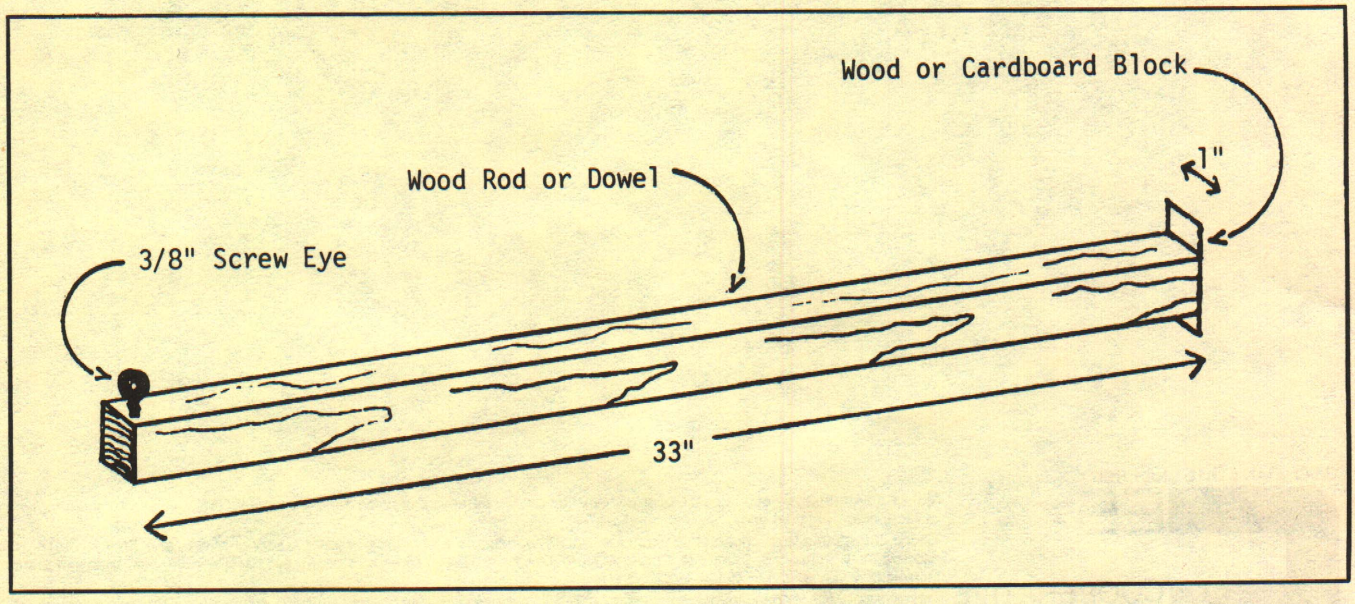

Fig. 2 A simple angle gauge can be easily constructed to determine estimates of basal area.

larger trees. Machines have been found to be twice as fast as ax girdling on both southern and northern hardwoods. Experience in northern hardwoods indicates that mechanical girdling machines work very well when used as part of a 2 or 3 person crew. One person operates the machine and the others use a chain saw to cut out ingrown "seams" and fell smaller trees.

4. Girdling with a chain saw. A small chain saw can be used for killing unwanted trees. It is the most practical tool when T.S.I. work is done at the same time as the logging job. Care must be taken to make a complete girdle; otherwise the tree will continue to live for many years. A double saw ring should be made on large trees with furrowed bark.

B. Cutting.

1. Felling trees with an ax or chain saw is more hazardous than girdling, and in the case of hardwood T.S.I. following logging, may intensify the shock to the stand. However, with increased emphasis on fuelwood production and use, cutting not only benefits the stand but provides substantial amounts of fuelwood as well.
2. Small trees (under 3 in. DBH) can be felled as fast or faster than they can be girdled.

C. Herbicides. Several chemicals are available which can be used to kill unwanted vegetation. These herbicides vary in effectiveness depending on time and method of application; some are selective and may be suitable for removing hardwoods from a predominantly coniferous stand, where as others are equally effective on both hardwoods and conifers. Chemical herbicides are not used as frequently today for killing unwanted hardwoods as a few years ago. This is due to use of harvested material for fuel and increased environmental restrictions on the availability and use of herbicides. For current herbicide recommendations, contact your local County Cooperative Extension Office or the MSU Department of Forestry.

If herbicides are used, note the following:

1. Some unwanted vegetation may be killed using a foliar or basal spray. Basal sprays are restricted to small diameter (1 to 2 in.) stems, and to treating stumps, provided the stump is treated immediately after cutting.
2. Some herbicide solutions can also be applied in frills which have been cut into the bark of larger trees. Other formations, including concentrated pellets and liquid sprays, can be applied to the soil area beneath the tree. The amount of herbicide material to use in either the frill or soil treatment depends on the species and size of trees present. Some herbicides are available in pelleted or liquid formulations which can be used to kill hardwoods but will not result in injury to selected conifers. Recommended rates are influenced by species present, soil types and time of application.
3. Always follow the instructions on the label for use of all herbicides. Especially important is information regarding rate of application, safety concerns and precautions relating to protection of the environment. Certain forestry herbicides are registered under the restricted-use category, so anyone applying such chemicals must be a certified pesticide applicator. Contact your local Extension office for information on certification.

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