Some Guidelines for Improving Northern Hardwood Timber Stands
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Improving Northern Hardwood Timber Stands

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Forest Management is designed to give each tree room in which 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 attain their fullest potential by producing high quality timber in a minimum number of years.

Need for Better Forest Management. To improve the growth potential of thousands of acres of northern hardwood forest, sound management is needed. These forests have high-valued species, many of which are overcrowded with trees of poor form, low-value weed trees, etc. The growth potential can be improved by thinning and weeding these stands. Sapling and pole size stands can benefit most by immediate treatment.

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

Terms Used in Timber Stand Improvement

1. **Wolf Tree.** A tree with an overdeveloped, wide-spreading crown extending more than two-thirds of the way down the bole of the tree.
2. **Deformed Tree.** A tree that has not or will not produce a merchantable 12-foot log; a tree with 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.
3. **Cull Tree.** A tree that does not now have, or cannot be expected to produce in the future, at least one merchantable 12-foot sawlog.
4. **Weed Tree.** A tree of a species that will persist in a stand but never make a merchantable product.
5. **Crop Tree.** A tree usually in the pole or large sapling size class, of good form and high commercial value, in which an investment is made to alter conditions to accelerate its development and growth beyond what could be expected under natural stand conditions.
6. **Twins and Clumps.** Two or more trees that are joined together, either at or above the ground line, originating from a common stump.
7. **Crown.** The upper part of a tree, including the branches with their foliage.
8. **Basal Area.** The area, expressed in square feet, of the cross section at breast height of a single tree, or of all trees in a stand.
9. **D.B.H.** Diameter at breast height, 4½ feet above the ground.
10. **Pole Size Tree.** A young tree 4 to 11 inches in diameter at breast height.
11. **Sapling.** A young tree 2 to 4 inches in diameter at breast height.
12. **Dominant Tree.** A tree with the crown extending above the general level of the crown cover, receiving full sunlight from above and some from the sides. Larger than the average tree in the stand.
13. **Suppressed Tree.** A tree with the crown entirely below the general level of crown cover receiving no direct light either from above or the sides.

I. Improving Young Stands by the 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 is placed on a smaller number of higher value trees. Material to be removed includes weed species and poorly formed, insect damaged, diseased, low quality, and otherwise inferior trees.

Thinning should start as soon as crop trees can be recognized. This is usually when the main stand reaches 3 inches DBH. It is not necessary to remove aspen and pin cherry that occur in the stand 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, 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" d.b.h. and larger)

size classes. In order for a stand to be stocked sufficiently to permit crop tree improvement, crop trees must occur at the rate of at least 40 per acre.

For reasons based on economic returns, crop tree improvement should be limited to a maximum of 80 selected crop trees per acre. Crop tree improvement should 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, codominant 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 inches DBH.

(3) No major cull defect signs.

(4) Not less than 3″ DBH.

c. *Value* (species): The relative desirability, in descending order, of species for long-time management on soils suitable for northern hardwoods is as follows:

Desirable	*Less Desirable*	*Least Desirable*
Yellow Birch	Black Cherry**	Quaking Aspen
Basswood	American Elm**	Bigtooth Aspen
Sugar Maple	Eastern Hemlock	Pin Cherry
Rock Elm	Balsam Fir	Ironwood
White Pine	Red Maple**	
Northern Red Oak	Beech**	
White Ash*		

* White Ash is slow to respond to release.

** In some localities black cherry and American Elm are considered very desirable, and beech and red maple undesirable.

Number of trees to select.

a. A minimum of 40 trees per acre shall be selected. This will provide the desired stocking (stand structure) in the upper size classes (12″ d.b.h. and over) at rotation age as prescribed for uneven aged management. Where 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, we should, where stocking allows, improve growing conditions not to exceed one alternate crop tree for each final crop tree selected. This means that we should seek 40 to 80 crop trees per acre in doing crop tree improvement work. The treating of 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 amount of growing space given each selected crop tree will vary in radius 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″ DBH crop tree
   1.67 x 8 = 13.36 feet or 13 feet.

2. 20 x DBH (in feet) = growing space radius requirement in feet.
   Example: 8″ DBH crop tree
   20 x ⅔ (ft. DBH) = 13⅓ feet 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 Inches	*Growing Space Radius in Feet*	*"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 radius figures should be placed. The stick is read like a Biltmore stick.

II. Pruning Northern Hardwoods

The practice of pruning young northern hardwood trees has not been considered economically feasible in the Lake States. Recent research studies have indicated that Yellow Birch can be pruned to provide more high quality wood than would result from unpruned stands. These studies show that Yellow Birch can be pruned to 50 percent 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 healed faster than similar sized scars from dead limbs. Also, scars from trees released from competing growth healed faster than scars on trees not released.

All pruning should be done with a pruning saw which results in an oval shaped cut flush with the stem of the tree. Live limb scars, less than ½ inch in diameter, completely heal over in 2 or 3 years. In pruning dead limbs the live tissue surrounding the limb should be injured slightly to start callous 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.

III. Thinning Twins and Clumps

Trees originating from stump sprouts 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.

Clumps of basswood should be thinned 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. Clumps of all other species should be removed 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 earlier years of management. The general rule of thumb followed is to leave both or remove both.

IV. Standard Methods for Removing Unwanted Trees

Elimination of trees should be done 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 inches 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″-4″ wide completely around the stem. This method can be used only during the peeling season.
3. Use of a power girdler. This type of machine is very efficient on the larger areas and on the larger trees. The most popular machine which is manufactured by a Texas firm (Little Beaver Girdler) was found to be twice as fast as ax girdling on both southern and northern hardwoods. This machine weighs approximately 35 pounds and is carried on the operator's back. The cutting wheel is on the end of a flexible shaft. Experience in northern hardwoods indicates that this machine works very well when used as part of a 2 or 3 man crew. One man operates the machine and the others use axes to chop out ingrown "seams" and fell smaller trees. The number of axmen should depend on the amount of cutting to be done.
4. Girdling with a one-man chain saw. A one-man chain saw can be used for killing unwanted trees, providing the chain has a chipper type tooth. It may be the most practical tool when the 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, it intensifies the shock to the stand. Also, it often intensifies the slash problem.
2. Small trees (under 3″ DBH) can be felled as fast or faster than they can be girdled.
3. Where an extensive area is to be worked, a crew equipped with both a power girdler and axes makes an efficient organization. The power girdler girdles the larger trees and the ax is used for cutting the smaller trees and vines and cutting out ingrowing seams.

C. *Herbicides*

Two different chemicals may be used to kill unwanted trees in northern hardwoods. These chemicals are 2,4,5,T and Ammate. Ammate gives best results in the North when used only during the growing season, while 2,4,5,T can be used successfully at any time of the year when the surfaces to be treated are dry.

1. **Basal Sprays:** Unwanted trees less than four inches in diameter may be killed by basal spraying with 2,4,5,T in the concentration of 4 to 16 pounds a.h.g. in oil solution. This is applied to the entire circumference of the lower 12 to 18 inches of the trunk and root collar to the point of run-off. Basal sprays can be used effectively for treating fresh cut stumps, if the stump is sprayed immediately after cutting.
2. **Frill Treatment:** Herbicides applied in frills can be used on trees larger than four inches in diameter to provide excellent kill at any time of the year. A single-hack frill is made through the bark around the entire stem below stump height, and the chemical applied to the fresh cut to the point of run-off. The mixture for frill treatment is 4 to 16 pounds a.h.g. in either oil or water. However, 4 pounds a.h.g. in oil generally gives better results than 8 to 40 pounds in water. Ammate is mixed to a concentration of 4 lbs. of Ammate to one gallon water. Ammate crystals can also be applied dry by placing the crystals in "cups" chopped out at the base of the tree. Recommended procedure is one tablespoon of crystals in one cup for each two inches of diameter of the base of the tree.
3. **Precautions in Using Herbicides:** The hormone type sprays and Ammate are not directly poisonous to man or animals; although some people do suffer indirect effects because they are allergic to the hormone-type sprays. Also, gloves soaked with Ammate solution can cause skin irritation. Wildlife and domestic stock do not appear to suffer ill effects from hormone or Ammate type sprays.

   Herbicides should not be used where wind drift or volitation of the chemical will come in contact with trees that are wanted for the residual stand. Spray equipment used for spraying herbicides should not be used to spray insecticides, as the herbicide is very difficult to remove entirely from the sprayer. Ammate is corrosive to metals and should not be stored in metal containers. Sprayers used for Ammate should be cleaned thoroughly after use to prevent corrosion.

V. Multiple Table of Basal Areas in Square Feet

Diameter (inches)	Number of Trees									
	1	2	3	4	5	6	7	8	9	10
2	0.02	0.04	0.07	0.09	0.11	0.13	0.15	0.17	0.20	0.22
3	.05	.10	.15	.20	.25	.29	.34	.39	.44	.49
4	.09	.17	.26	.35	.44	.52	.61	.70	.79	.87
5	.14	.27	.41	.55	.68	.82	.95	1.09	1.23	1.36
6	.20	.39	.59	.79	.98	1.18	1.37	1.57	1.77	1.96
7	.27	.53	.80	1.07	1.34	1.60	1.87	2.14	2.41	2.67
8	.35	.70	1.05	1.40	1.75	2.09	2.44	2.79	3.14	3.49
9	.44	.88	1.33	1.77	2.21	2.65	3.09	3.53	3.98	4.42
10	.55	1.09	1.64	2.18	2.73	3.27	3.82	4.36	4.91	5.45
11	.67	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.94	6.00
12	.79	1.57	2.36	3.14	3.93	4.71	5.50	6.68	7.07	7.85
13	.92	1.84	2.77	3.69	4.61	5.53	6.45	7.37	8.30	9.22
14	1.07	2.14	3.21	4.28	5.35	6.41	7.48	8.55	9.62	10.69
15	1.23	2.45	3.68	4.91	6.14	7.36	8.59	9.82	11.04	12.27
16	1.40	2.79	4.19	5.59	6.98	8.38	9.77	11.17	12.57	13.96
17	1.58	3.15	4.73	6.31	7.88	9.46	11.03	12.61	14.19	15.76
18	1.77	3.53	5.30	7.07	8.84	10.60	12.37	14.14	15.90	17.67
19	1.97	3.94	5.91	7.88	9.84	11.81	13.78	15.75	17.72	19.69
20	2.18	4.36	6.54	8.73	10.91	13.09	15.27	17.45	19.63	21.82
21	2.41	4.81	7.22	9.62	12.03	14.43	16.84	19.24	21.65	24.05
22	2.64	5.28	7.92	10.56	13.20	15.84	18.48	21.12	23.76	26.40
23	2.89	5.77	8.66	11.54	14.43	17.31	20.20	23.08	25.97	28.85
24	3.14	6.28	9.42	12.57	15.71	18.85	21.99	25.13	28.27	31.42
25	3.41	6.82	10.23	13.64	17.04	20.45	23.86	27.27	30.08	34.09
26	3.69	7.37	11.06	14.75	18.44	22.12	25.81	29.50	33.18	36.87
27	3.98	7.95	11.93	15.90	19.88	23.86	27.83	31.81	35.78	39.76
28	4.28	8.55	12.83	17.10	21.38	25.66	29.93	34.21	38.48	42.76
29	4.59	9.17	13.76	18.35	22.93	27.52	32.11	36.70	41.28	45.87
30	4.91	9.82	14.73	19.63	24.54	29.45	34.36	39.27	44.18	49.09

Source: Adapted by E. T. Hawes, U. S. Forest Service, from H. H. Chapman and D. B. Demeritt, Elements of Forest Mensuration. J. B. Lyon Co., 1936.

VI. T.S.I. Cost of Deadening Undesirable Hardwoods

(Based on Point Sampling with a Basal Area Factor of 10)

Av. DBH	*No. of trees per sq. ft. Basal Area*	*Cost Per Acre Average Cost Factor Treating 1 Sq. Ft. of Basal Area*
2″	45.87	1.713
4″	11.45	.868
6″	5.10	.588
8″	2.87	.447
10″	1.83	.362
12″	1.27	.306
14″	.94	.267
16″	.72	.237
18″	.57	.214
20″	.46	.194
22″	.38	.179
24″	.32	.167
26″	.27	.155
28″	.23	.144
30″	.20	.136
32″	.18	.131
34″	.16	.125
36″	.14	.118
38″	.13	.116
40″	.11	.106

Instructions:

1. Costs based on $2.00 per m.h. for labor plus $2.00 per m.h. for transportation, equipment, materials and overhead. *Local adjustments should be made* for unusually high or low labor costs.
2. Total number trees tallied in each D.B.H. class x 10 ÷ number of points taken = Av. Basal Area per acre in that D.B.H. class.
3. Avg. Basal Area per acre in each D.B.H. class x Avg. Cost Factor = total cost per acre for that D.B.H. class.
4. Sum of per acre costs for each D.B.H. class = total cost per acre for job.

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