

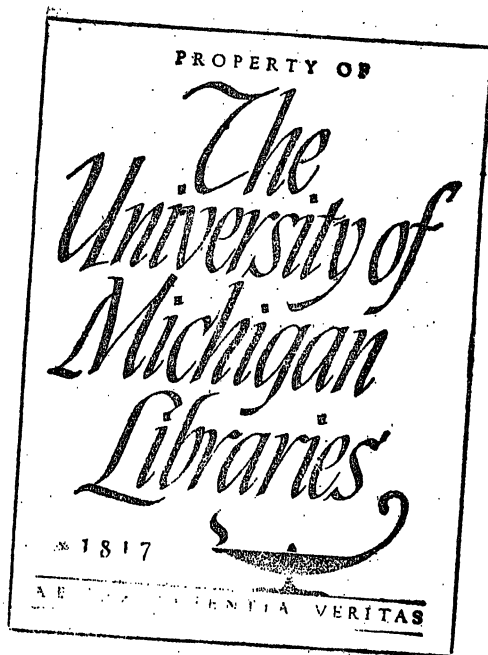
A MANAGEMENT PLAN FOR BLOCK X  
OF THE  
MENOMINEE INDIAN RESERVATION

FOR. 184

JAY A. EMPIE

1948

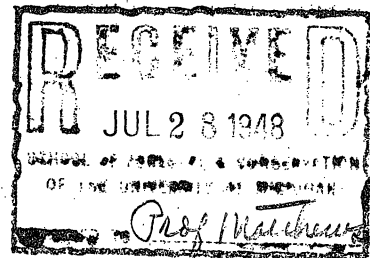
EMPIE, JAY A



UNITED STATES  
DEPARTMENT OF THE INTERIOR

OFFICE OF INDIAN AFFAIRS

Menominee Indian Mills  
Neopit, Wisconsin  
July 26, 1948



Dean S. T. Dana  
School of Forestry and Conservation  
University of Michigan  
Ann Arbor, Michigan

Dear Dean Dana:

We have read with interest the Management Plan for Block "X" submitted by Mr. J. M. Empie. Mr. Empie has done a nice job considering the fact that he has never visited the forest on the Menominee Indian Reservation.

We are returning Mr. Empie's plan herewith.

Yours very truly,

*John W. Libby*

John W. Libby  
Forest Supervisor

JWL:ml

A MANAGEMENT PLAN FOR BLOCK "X"  
OF THE  
MENOMINEE INDIAN RESERVATION  
NEOPIT, WISCONSIN.

DATE:

MAY 10, 1948.

SUBMITTED BY:

JAY A. EMPIE,  
FORESTER.



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## INTRODUCTION

The Menominee Indian Reservation consists of an area of about 230,000 acres located in Shawno and Oconto Counties in the north-eastern part of Wisconsin. The reservation was covered with very valuable stands of timber at the time it was acquired by the Menominee Tribe in 1854. In the early part of the 20th Century clear cutting was characteristic of logging methods in the Lake States Region. Since the reservation's timber resources constituted the principle asset and source of income for the tribe, congress desired to prevent its ruthless destruction and passed an act in 1908 for this purpose. It provided that the cutting would be conducted in such a way that the forests would be preserved and would at the same time furnish an uninterrupted and perpetual source of income for the tribe. It is with this idea in mind that this management plan has been developed for Block X of the reservation. (See the attached map).

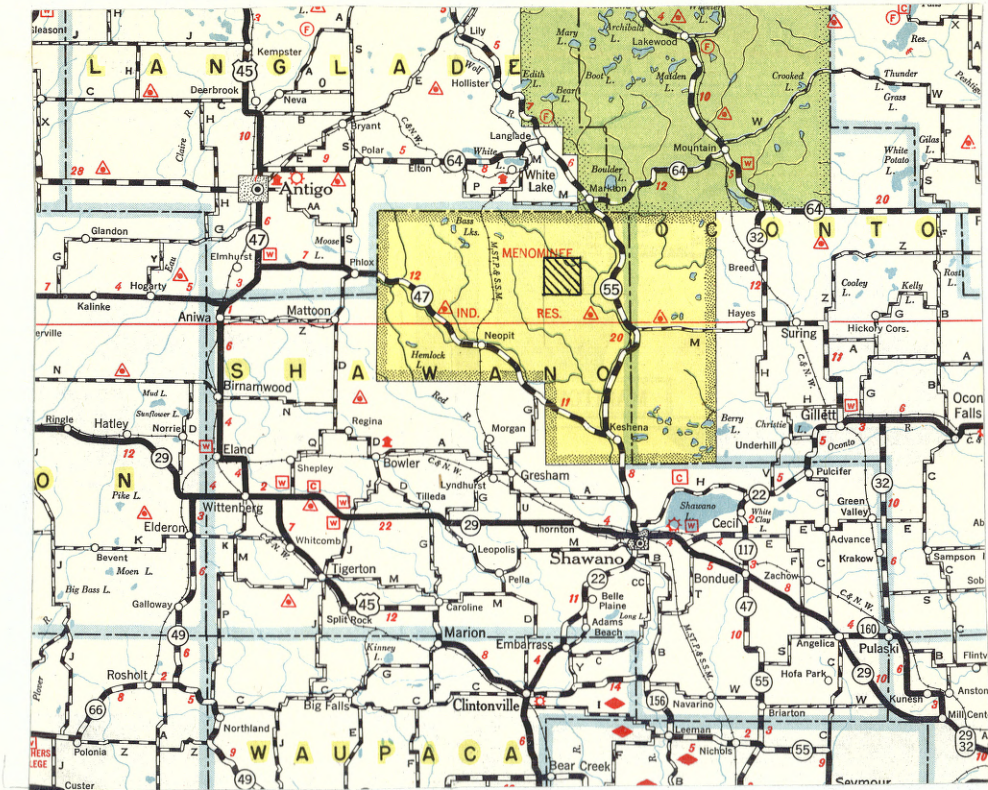
## DESCRIPTION OF BLOCK X.

Block X consists of 5,500 acres of the Menominee Indian Reservation. It comprises Sections 19, 20, 21, 28, 29, 29, 31, 32, and 33 of T 30 N, R 15 E in Shawno County, Wisconsin. The Evergreen River flows through Sections 20 and 21 in the north-eastern corner of Block X, and empties into the Wolf River just east of the area.

The topography is undulating to gently rolling and the slopes are long and gentle for the most part.

The soil of Block X is predominately Vilas fine sand, with a small percentage of Kennan fine sandy loam and peat on the area. The soils are acid and have been formed by the





MAP SHOWING LOCATION OF MENOMINEE INDIAN RESERVATION IN SHAWANO AND OCONTO COUNTIES, STATE OF WISCONSIN. BLOCK "X"-- CROSS HATCHED AREA.

**Scale—1 inch=13 miles**

0 13 26 39

Issued January, 1947  
By the State Highway Commission of Wisconsin—Madison

### ROAD SURFACING

U. S. and State Trunk Highways	County Trunk Highways
	Portland Cement or Bituminous Concrete
	Bituminous
	Gravel, Stone etc.
	Earth

### CONVENTIONAL SIGNS

	Division Offices of State Highway Commission of Wisconsin		State Parks, Scenic or Memorial
	State and Federal Institutions		State Parks, Roadside
	Airports		County or City Parks
	County Seats		Wayside Parks
	Community Under 5000		Fish Hatcheries
	City Over 5000		Lookout Towers
			Forest Ranger Stations
			Public Hunting & Fishing Grounds
			Dams

Mileage Shown Between Towns and Junctions



weathering of glacial drift.

The average yearly rainfall in the area is 27 inches. The length of the growing season is from 120 to 130 days. The mean temperature during the six growing months from April through September is 57-39.5° F.

The highest monetary returns for Block X will be obtained through its continued use as timberland, since the soil is best adapted to the growth of trees. Block X is forested with a fine stand of Northern Hardwoods at the present time.

The M. St.P & S.S.M. R.R. runs through the reservation and connects Neopit by rail with other portions of the state. The main highway routes through the reservation are State Trunk Highways 47 and 55.

THE NORTHERN HARDWOOD TYPE ON BLOCK X.

Block X is a fine example of the virgin Northern Hardwood forest of the Lake States. This type is also known as the Beech-Birch-Maple type or the Hardwood-Hemlock type. It is a climax forest which has a preponderance of tolerant species, and is uneven aged in character. The average volume per acre for the 5,500 acres of Block X obtained by cruise is 19,680 ft. B.M. (See Table 1 of Appendix for Stand Table of Block X.) The approximate volume composition of the stand is as follows:

<u>Species</u>	<u>Volume Composition in %</u>
Hemlock	48.0%
Maple	15.6
Birch	15.6
Basswood and pine	10.4
Elm and miscellaneous	10.4
Total	100.0%

The present stand is overmature and contains considerable defect. During the first cut the gross woods scale will have to be reduced 20% to obtain the net scale at the mill because

of this defect. The defect on succeeding cuts will be negligible.

It is anticipated that growth will average 0.2 inches D.B.H. per year under management for this type. This growth will easily be obtained under selective cutting with a 15 year cutting cycle. Hemlock is to be discouraged in the residual stand, and the more valuable hardwood species are to be encouraged and favored in the residual stand. Consequently greater volume growth will also result in higher quality growth.

#### OBJECTIVES OF MANAGEMENT.

Timber on Block X of the Menominee Indian Reservation will be harvested under a sustained yield plan of management involving selective cutting and a 15 year cutting cycle, under authorization of congress in the act of 1908. The logs are to be manufactured in the Menominee Mill at Neopit, Wisconsin and the products are to be sold for the benefit of the Menominee Tribe.

#### Required Annual Cut

The Menominee Mill at Neopit requires a minimum of 14,000,000 ft. B.M. per year for full operation. This amount is to be supplied from the timber lands of the reservation, at least for the present.

#### Size of Timber to Be Grown.

Since the area has an excess amount of mature timber available, the objective will be to grow timber from 25 to 30 inches D.B.H.

#### Species to be Favored in the Residual Stand.

Hemlock is the species of low value. Every attempt will be made to reduce its representation in the residual stand. Hardwoods will be favored since they bring a higher return.



SELECTIVE CUTTING AS THE SILVICULTURAL SYSTEM FOR SUSTAINED  
YIELD.

Explanation of Selective Cutting.

Selective cutting is especially suited to harvesting sawtimber in the northern hardwoods. It is a well known and established forestry practice which has been used in the Lake States extensively by the Forest Service on virgin areas of National Forests. The trees are individually selected for removal, and are usually those which are mature or are growing at a slow rate or under unfavorable conditions. The more promising trees are left to put on additional growth between cuts. The method actually requires that each tree in the stand be closely examined before cutting is started, to insure the best silviculture possible. If this practice is not followed, succeeding cuts may not live up to expectations. It is adapted to a market which requires the production of large, high quality timber and gives an opportunity to gradually eliminate low value species, such as hemlock, and to favor more desirable species in the residual stand. It offers the opportunity to remove the overmature and defective timber rapidly, which condition exists in this stand, and consequently speeds up the growth on the forest.

Regulation of the Cut in Allowable Limits.

With selective cutting Hall (1933) believes that the cut must be held below 50% of the total basal area if post logging decadence is to be avoided, and that light selective cuttings of about 40% of the original basal area can be made without any material damage to the remaining stand.

The cut that is planned for the first cutting cycle is

46.2% of the basal area and for the second and subsequent cutting cycles is 34.9%. Consequently the utmost care must be taken in marking during the first cutting cycle so that post logging decadence will be reduced to a minimum. This condition exists only because a larger volume is being removed since the stand is overstocked and overmature. The basal area planned for removal during the second and subsequent cutting cycles falls below the 40% limit set by Hall. The species most susceptible to this post logging decadence are hemlock and birch.

Control of Death Losses Due to Exposure, Diseases, Insects, and Windfall.

It is generally recognized that hemlock and birch of all the species represented in the northern hardwood type are the species which are extremely susceptible to post logging decadence as the result of exposure. This fact must be taken into consideration when the trees are marked for cutting, for otherwise the residual stand may encounter heavy losses. If the trees which comprise the cut are marked so as to carefully consider the reaction to exposure of the trees which are left, hemlock and birch in particular, a relatively heavy cut is possible with little decadence resulting. Graham (1943) conducted a study which enlarged on the findings of Hall (1933). He found that with heavier cuts, more severe post logging effects were likely to occur. Graham made many observations, some of which are given below:

"These observations indicate that both hemlock and yellow birch react to exposure in a similar manner. Usually, neither is able to endure severe exposure. Therefore, neither

of these species can safely be depended upon to provide shelter for the other. Numerous instances may be observed in almost any cut-over area or roadside strip where exposed birches have died, thus exposing other birches or hemlocks to direct insolation so that over a period of years progressive decadence occurs. For this reason groups of birches or hemlocks that are to be left for a subsequent cut should be sheltered, especially from the south and west, by maple, basswood, or other trees that are relatively resistant to exposure. This may of course require leaving some trees that otherwise would be marked for cutting, or conversely, cutting some trees that might be left if it were not for the hazard of excessive exposure.

Clearly, nothing is to be gained by leaving merchantable trees that are likely to die before they can be removed in the next cut. Therefore, if either silviculture or economic considerations demand the removal of exposure-resistant trees that are sheltering birches or hemlocks, it would generally seem advisable to mark the latter trees also, even though they might otherwise be left for a later cut. On north slopes and in cases where the trees exposed have heavy crowns and are growing on a very good site, this rule can probably be relaxed with safety.

Neither hemlock or yellow birch, regardless of crown form, should be completely exposed to the south and west, because such trees are very likely to die. However, as we have seen, hemlocks with a crown spread of 25 feet or more and a crown length of two thirds or more of the height will usually survive exposure to the south or east, or partial exposure to the west. Therefore, such trees may be left without as much protection as would be required for small-crowned trees.

Because they will almost invariably die for exposure, all hemlocks with short or narrow crowns should either be marked for cutting, or, if reserved for a subsequent cut, left completely sheltered from the south, west, and east sides.

Trees with crowns between one-half and two-thirds of the total tree height and less than 25 feet in average width at the widest level may or may not survive exposure. Therefore, if such trees have any immediate value it appears that they should be marked for cutting unless they can be left in a protected position for a later cut.

Most hemlocks with crowns at least 25 feet wide and occupying two-thirds or more of the total height may be exposed without much danger of injury, but, if practicable, even these should be given some protection from the south-west.

It is usually unsafe to leave any yellow birch trees entirely exposed to the south, east, or west even though they should, according to size and vigor, form a part of later cuttings. Mortality of this species has frequently been observed on lands where a light cut had not disturbed the hemlock appreciably. Nevertheless, thrifty, relatively young trees with heavy crowns and growing on good sites may endure considerable exposure.

Because the results of this study of hemlock indicate that post-logging mortality is directly correlated with excessive exposure to direct solar radiation, it seems safe to cut any tree to the north, north-east, or north-west of hemlocks or birches."

Selective cutting maintains the all aged character of the virgin stands. It offers the maximum protection to the site and site conditions will change very little. Consequently,

there is little danger from fire, disease, and insects. Windfall damage will be reduced to a minimum by selective cutting.

#### Natural Reestablishment of the Forest.

Natural reproduction is almost certain to result under selective cutting. Most of the species desired are tolerant of shade and usually reproduce well under a canopy of moderate density. Yellow birch is an exception for it is intolerant. However, there should be sufficient openings in the forest as the result of selective cutting for it to seed in.

#### REGULATION OF THE CUT.

##### Fifteen Year Cutting Cycle.

A fifteen year cutting cycle will be employed, so after Block X is cut over the first time, the next cut will occur in fifteen years. A cutting cycle as short as 15 years means lighter cuts per acre than with longer cutting cycles, but it permits a better treatment of the stand, since the cuts will occur more frequently. The planned cuts of 9.69 M. ft. B.M. for the 1st cutting cycle and of 5.86M. ft. B.M. for the 2nd cutting cycle and subsequent cutting cycles is sufficiently large per acre to make reasonable logging costs possible.

Since it is the objective to grow timber between 25 and 30 inches D.B.H., and a growth of 0.2 inch D.B.H. is anticipated per year under management, the rotation will be in the neighborhood of 150 years.

##### Basal Area Control as a Basis for Determining the Cut.

The present stand is overmature with a stocking of 123.36 sq. ft. B.A. per acre. This is in excess of adequate

stocking of 100.0 sq. ft. B.A. for comparable stands on good sites (See Appendix-page 6). Consequently a reduction in stocking is in order.

The cut in basal area must be within certain limits so that post logging decadence will not occur. Hall (1933) set a maximum limit of 50% of the basal area for the cut if post logging decadence was to be avoided. He considered that lighter cuts of about 40% of the basal area per preferable. In view of the above the residual stand after a selective cut would contain a minimum of 60.0 sq. ft. of basal area.

Estimated Basal Area and Volume Cut per Acre During First Cutting Cycle.

The following tabulation gives the estimated thinning cut and harvest cut per acre for the 1st cutting cycle. The detailed method of arriving at these figures is given in the appendix (See Appendix - page 9).

	<u>Total</u>			<u>Hemlock</u>		<u>Other Species</u>	
	No. Trees	B. A. Sq. Ft.	Volume Ft.B.M.	No. Trees	Volume Ft.B.M.	No. Trees	Volume Ft.B.M.
Thinning Cut	25.8	37.60	5680	25.5	5665	0.3	15
Harvest Cut	4.2	20.36	4010	2.1	2185	2.1	1825
<b>Total Thinning &amp; Harvest Cut</b>	<b>30.0</b>	<b>57.96</b>	<b>9690</b>	<b>27.6</b>	<b>7850</b>	<b>2.4</b>	<b>1840</b>

Since 57.96 sq. ft. B.A. is designated for removal during the first cutting cycle and since the stand contains 123.36 sq. ft. B.A. per acre before the initial cut, the anticipated cut is 46.9% of the basal area. Similarly 9690 ft. B.M. to be cut is 49.3% of the total volume per acre of the stand of 19680 ft. B.M.

The cut of 46.9% of the basal area is within the allowable limits providing much care is taken in marking the trees for removal so that the residual stand will not be damaged by exposure. The best of silviculture must be used during this first cut.

Area Required to Furnish Needed Volume During First Cutting Cycle.

Block X contains 5500 acres of the northern hardwood type. One third of this area or approximately 1833 acres must be cut each year to supply the mill at Neopit with the required volume. (See Appendix - page 20). An easy division of the Block X into cutting areas would be by sections. One cutting area would consist of Sections 19, 20, and 21; another of Sections 28, 29, and 30; and a third of Sections 31, 32, and 33. This division is only approximate since the spacing of roads at 1615 feet will necessitate some juggling so that the cutting area boundaries will coincide with the branch roads, as nearly as possible. (See Appendix pages 23 and 25).

Total Cut for the First Cutting Cycle from Block X.

The cut per acre during the first cutting cycle is expected to be 9,690 ft. B.M. Since the area to be cut is 1833 acres, the total gross cut will be 17,765,000 ft. B.M. for each cutting area, for a grand total of 53,295,000 ft. B.M. for Block X, over the three year period. Since the gross cut is subject to 20% cull, the mill tally or net cut from each cutting area will be 14,212,000 ft. B.M., for a grand total for Block X of 42,636,000 ft. B.M. over the three year period of the first cycle.

Estimated Basal Area and Volume Cut per Acre During Second and Subsequent Cutting Cycles.

The following tabulation gives the estimated thinning cut and harvest cut on an acre basis for the second and subsequent cutting cycles. The method of arriving at these figures is given in the appendix (See Appendix-page 15).

	<u>Total</u>			<u>Hemlock</u>		<u>Other Species</u>	
	No. Trees	B.A. Sq. Ft.	Volume Ft.B.M.	No. Trees	Volume Ft.B.M.	No. Trees	Volume Ft.B.M.
Thinning Cut	13.2	18.42	2855	9.0	2145	4.2	710
Harvest Cut	3.8	16.50	3005	0.9	830	2.9	2175
Total Thinning & Harvest Cut	17.0	34.92	5860	9.9	2975	7.1	2885

The cut of 34.92 sq. ft. B.A. during the second and subsequent cutting cycles is 34.9% of the estimated total basal area of 100.00 sq. ft. before the second or subsequent cut. The cut of 5860 ft. BM. is 37.2% of the total volume before the second or subsequent cut of 15740 ft. B.M.

The cut of 34.9% of the basal area is within the allowable limits provided. The cut for the subsequent cycles will easily fall below the allowable 40% set by Hall (1933). However, good silviculture must be used in marking to reduce the possibility of post logging decadence due to exposure.

Area of Cut During Second And Subsequent Cutting Cycles.

The cutting areas for the second and subsequent cutting cycles will be the same as for the first cutting cycle, at approximately 1833 acres per year. Each cutting area will be cut over at 15 year intervals.



Total Cut for Second and Subsequent Cutting Cycles from Block X.

The estimated cut of 5,860 ft. B.M. per acre over a cutting area of 1833 acres provides a yearly cut of 10,743,000 ft. B.M. Since during the second and subsequent cutting cycles the cull will be negligible, this cut is considered as net. Since the mill at Neopit requires 14,212,000 ft. B.M. for full operation at the present time, there is a deficit of 3,469,000 ft. B.M. per year while Block X is being cut over the second and subsequent times. This deficit will have to be made up from cuts off of other cutting areas on the Reservation.

The total cut from Block X during the second and subsequent cutting cycles will be 32,230,000 ft. B.M.

SPECIFIC MANAGEMENT DETAILS.

Marking the Timber

A close examination of each tree in the stand is required before any cutting is begun with selective cutting. The trees designated for removal must be marked or blazed so that there will be no doubt that only these are to be cut. Many trees will have minor undesirable characteristics and there may be a tendency, especially during the first cutting cycle, to designate the stands for a too heavy cut. It is necessary that the cut remain within the basal area designations at all times, so that sufficient forest capital as the residual stand is left. The choices of trees for removal must be silviculturally correct also as discussed previously.

The marking must be done by a forester or men trained to make competent decisions as to which trees are safe to remove and which trees are best left for subsequent cuts. Table 4 of the appendix will be a valuable aid in marking during the first cutting cycle and Table 5 of the appendix during the second cycle.

### Minimizing Logging Damage.

Every effort should be made by the crews when felling trees to prevent them from falling onto or damaging trees that are to be left. This will require careful notching and felling trees into natural openings as much as possible.

Skidding trails should avoid dense patches of young growth. Sharp angles in them should be avoided since they are likely to be the cause of bark damage to remaining trees. Skidding damage to the residual stand will be slight if the teamster or tractor operators exercise ordinary precautions.

Roads and landings should be made with as little damage to the residual stand as possible.

The only trees that will be cut are those which are marked for removal prior to logging.

### Disposal of Slash.

It may be advisable to lop off branches on large tops so that they will lie close to the ground, and to scatter piles and wind rows that may be formed. Generally hardwood tops and branches rot after a few years and do not increase the danger from fire, insects, fungi, and diseases. The slash actually aids in the building up of the soil, since decaying branches add to the humus layer.

There may be cases where it is advisable to gather slash into piles during winter operations and burning it.

### Fire Protection.

The success of sustained yield management on Block X depends on the degree to which fires are kept out of the area. The Menominee Indian Reservation, The Nicolet National

Forest to the north of it, and the surrounding area is woven into an adequate forest fire protection system. There are three fire towers located on the Reservation itself. Damage due to forest fires on the area can be kept at a minimum.

#### Reproduction.

Selective cutting favors the natural reestablishment of the forest. Under selective cutting planting of trees is unnecessary. The exception would be, of course, after an area has been burned over so as to quickly establish desired species.

#### FINANCIAL CONSIDERATIONS

##### The Logging Plan and Forest Improvements.

Block X comprises the timbered portions of Sections 19, 20, 21, 28, 29, 30, 31, 32, and 33 of T30N, R15E. It will be generally divided into three cutting areas consisting of Sections 19, 20, and 21; sections 28, 29, and 30; and Sections 31, 32, and 33. The actual boundaries of the cutting areas will conform to the branch roads constructed into the area rather than on the section lines concerned.

Seven miles of main logging road have been constructed from the mill at Neopit to the southwest corner of Section 31. An additional three miles of main road will be constructed from the southwest corner of Section 31 along the west boundary of Sections 31, 30, and 19 to the northwest corner of Section 19 in order to log the area.

Spur roads on a spacing of about 1615 feet will be constructed east into the sections mentioned above from the main road on the west. (See Appendix - page 23). Bridges and culverts will be of a permanent nature so the roads can be

utilized between cuts for access to the area in case of fire.

The landings will be closely spaced along the spur roads. The timber will be skidded by tractors and teams to the spur roads. The logs will be loaded on trucks for transport to the mill with A frame jammers which will be powered by teams.

Logging Costs for the First Cutting Cycle.

The calculation of the logging costs is given in the appendix. (See Appendix - pages 21-29). These costs are summarized as follows per M. ft. B.M. net or mill scale:

	<u>Hemlock</u>	<u>Other Species</u>
Felling and bucking	\$4.125	\$5.500
Skidding	1.986	1.986
Branch roads	0.661	0.661
Loading	0.656	0.656
Hauling	1.787	2.235
Loading and unloading delay	0.871	0.933
Main road	0.563	0.563
Overhead	<u>2.111</u>	<u>2.111</u>
Total costs per M.ft. B.M. net scale	\$12.761	\$14.645

Logging Costs for the Second and Subsequent Cutting Cycles.

The calculation of the logging costs for the second and subsequent cutting cycles is also given in the appendix. (See Appendix - page 30). The costs are somewhat lower than for the first cutting cycle since no cull is anticipated after the first cutting cycle. These costs are summarized as follows per M. ft. B.M. net or mill scale, which in this case is the same as gross scale:

	<u>Hemlock</u>	<u>Other Species</u>
Felling and bucking	\$3.300	\$4.400
Skidding	1.589	1.589
Branch roads	0.175	0.175
Loading	0.525	0.525
Hauling	1.430	1.787
Loading and unloading delay	0.697	0.747
Main road	0.563	0.563
Overhead	<u>2.111</u>	<u>2.111</u>
Total costs per M. ft. B.M. net scale.	\$10.390	\$11.897

Stumpage Recovery for the First Cutting Cycle.

Schedule A shows the method of arriving at the stumpage recovery value for each species in the stand and for the entire block for the three years of the first cutting cycle. A brief description of the method of arriving at the figures in the columns is in order:

Hemlock accounts for 81.0% of the cut for the first cutting cycle, which leaves 19.0% of the volume for other species. This 19.0% is proportioned among the other species according to their respective percentage composition in the original stand, ie. 30% maple, 30% birch, 20% basswood and pine, and 20% elm and miscellaneous.

The log values for the purpose of appraising the value of block X are charged at the mill on net log scale at the prices current, ie. Hemlock \$18.00, Maple \$27.00, Birch \$32.00, Basswood and Pine \$35.00, and Elm and miscellaneous \$25.00.

The total costs per M. ft. B.M. were determined previously at \$12.76 for hemlock and \$14.65 for other species.

The stumpage recovery per M. ft. B.M. net scale is determined by subtracting the total costs from the value at the mill. The derived stumpage recovery values are Hemlock \$5.24, Maple \$12.35, Birch \$17.35, Basswood and Pine \$20.35, and Elm and miscellaneous \$10.35.

The total cut gross scale for the three years of the cutting cycle on Block X is obtained by multiplying the total acreage of 5,500 acres by the gross cut per acre of 9.69 M. ft. B.M. for a total of 53,295 M. ft. B.M. However, a cull of 20% is expected at the mill due to defect, so the net scale is 80% of 53,295 M. ft. B.M. or 42,636 M. ft. B.M. The volume in M. ft. BM for each species is determined by multiplying the total volume net scale

SCHEDULE A

STUMPAGE RECOVERY FOR THE FIRST CUTTING CYCLE

SPECIES	PERCENT OF VOL. IN CUT	VALUE AT MILL PER M. NET SCALE	TOTAL COSTS PER M. NET SCALE	STUMPAGE RECOVERY PER M. NET SCALE	VOLUME CUT M. FT. B.M. NET SCALE	TOTAL STUMPAGE RECOVERY
Hemlock	81.0	\$18.00	\$12.76	\$5.24	34,536	\$180,970
Maple	5.7	27.00	14.65	12.35	2,430	30,010
Birch	5.7	32.00	14.65	17.35	2,430	42,160
Basswood & Pine	3.8	35.00	14.65	20.35	1,620	32,970
Elm & Misc.	3.8	25.00	14.65	10.35	1,620	16,770
Total	100.0	-----	-----	-----	42,636	\$302,880

SCHEDULE B

STUMPAGE RECOVERY FOR THE SECOND AND SUBSEQUENT CUTTING CYCLES.

SPECIES	PERCENT OF VOL. IN CUT	VALUE AT MILL PER M. NET SCALE	TOTAL COSTS PER M. NET SCALE	STUMPAGE RECOVERY PER M. NET SCALE	VOLUME CUT M. FT. B.M. NET SCALE	TOTAL STUMPAGE RECOVERY
Hemlock	50.8	\$18.00	\$10.39	\$7.61	16,373	\$124,600
Maple	14.8	27.00	11.90	15.10	4,770	72,030
Birch	14.8	32.00	11.90	20.10	4,770	95,880
Basswood & Pine	9.8	35.00	11.90	23.10	3,158	72,950
Elm & Misc.	9.8	25.00	11.90	13.10	3,159	41,380
Total	100.0	-----	-----	-----	32,230	\$406,840

by the calculated percentages.

The total stumpage recovery is obtained by multiplying the volume to be cut in M. ft. B.M. net scale for each species by the stumpage recovery per M. ft. B.M. net scale for that species.

The stumpage recovery for the entire cut from Block X during the three years of the first cutting cycle when the area is selectively cut amounts to \$302,880. This is \$100,960 per year.

Hemlock, the species of low value, comprises 81.0% of the volume to be removed during the first cutting cycle so as to reduce its representation in the residual stand somewhat. A higher stumpage recovery for the block could have been obtained for the entire block if a larger portion of the cut was composed of other higher value species and if a reduction of 20% for defect during the first cycle was not necessary.

#### Stumpage Recovery for the Second and Subsequent Cutting Cycles.

Schedule B shows the method of arriving at the stumpage recovery value for each species in the stand and for the entire Block X for the three year period of the second or subsequent cutting cycles. A discussion of the schedule follows.

Hemlock comprises 50.8% of the cut and other species comprise 49.2% of the cut, so the percentages are calculated in the same way as for the first cutting cycle. This is under the assumption that the stand composition for other species has retained the same percentages as before.

The value at the mill for each species is assumed to be the same as for the first cutting cycle.

The total costs per M. ft. B.M. net scale are somewhat different than for the first cutting cycle. They are \$10.39

per M. for Hemlock and \$11.90 per M for other species.

The stumpage recovery per M. ft. B.M. is obtained as before by subtracting the total costs from the value at the mill on the per M. ft. B.M. basis net scale. They are \$7.61 for hemlock, \$15.10 for maple, \$20.10 for birch, \$23.10 for Basswood and Pine, and \$13.10 for Elm and miscellaneous.

The total cut is found by multiplying the total acreage of 5,500 acres by the cut per acre of 5.86 M. ft. B.M. for the second and subsequent cutting cycles, or 32,230 M. ft. BM.. Since no reduction in gross scale is necessary for defect, the gross scale and net scale are the same. As before the volume cut in M. ft. B.M. for each species is found by multiplying the total volume by the percentage of volume in the cut for that species.

The total stumpage recovery is found by multiplying the volume to be cut for each species by the stumpage recovery for that species.

The total stumpage recovery for all species for the three years of the cutting cycle is \$406,840, which is equivalent to \$135,610 per year. These revenues can be obtained for the second cycle and subsequent cycles.

There is a considerable rise in the total stumpage recovery value for the second and subsequent cutting cycles. This is due to the larger percentage of other species in the cut and their greater value per M. ft. B.M.

However, there is an apparent deficit in volume from Block X for the second and subsequent cutting cycles. In order to furnish the mill with the required amount of 14,212 M. ft. B.M., 3,469 M. ft. B.M. must be obtained from some other cutting area



on the Menominee Indian Reservation for each of the three years that cutting is done on Block X.

Recommendations as to the Amount of Stumpage Recovery per M. Ft. B.M. to be Credited During the First Cutting Cycle to the Tribal Profit Fund.

It is recommended that 90 cents out of every sale dollar be allocated to the cost of production and stumpage and that the remaining 10 cents out of every sale dollar be set aside to protect the logging and milling operations from possible reverses. This 10 cents on every income dollar should generally be sufficient protection in order to allow the operation considerable leeway. Under this circumstance the operating ratio, or the relationship of unit cost to unit sale value, is 90.0%.

On the basis of this 90.0% operating ratio, it is recommended that the following amounts be set aside per M. ft. B.M. for the species given: Hemlock \$3.50, Maple \$9.50, Birch \$14.00, Basswood and Pine \$17.00, and Elm and miscellaneous \$8.00. These were rounded off to the nearest fifty cents. Schedule C is a tabulation showing the method of arriving at these figures. A short description of this schedule is in order:

The method of arriving at the stumpage recovery or conversion return per M. ft. B.M. for each species has been discussed previously.

The costs as a percent of value are the costs per M. ft. B.M. divided by the sales value per M. ft. B.M. expressed as a decimal.

The valuation factor is discussed in the appendix. (See Appendix - page 32). The figures for the table are found by

SCHEDULE C

CALCULATION OF THE STUMPAGE RECOVERY TO BE CREDITED TO THE TRIBAL PROFIT FUND DURING THE FIRST CUTTING CYCLE FOR DISTRIBUTION.

	Hemlock	Maple	Birch	Basswood & Pine	Elm & Misc.
Sale value per M.-----	\$18.00	\$27.00	\$32.00	\$35.00	\$25.00
Costs per M.-----	<u>12.76</u>	<u>14.65</u>	<u>14.65</u>	<u>14.65</u>	<u>14.65</u>
Stumpage Recovery per M.----	\$5.24	\$12.35	\$17.35	\$20.35	\$10.35
Costs as a Percent of Value-	.708	.543	.458	.418	.586
Valuation Factor-----	.654	.781	.815	.828	.758
Stumpage to be Credited to Tribal Profit Fund.-----	\$3.44	\$9.65	\$14.05	\$16.85	\$7.85
Stumpage to be Credited To Tribal Profit Fund. (Rounded Off)	\$3.50	\$9.50	\$14.00	\$17.00	\$8.00

SCHEDULE D

CALCULATION OF THE STUMPAGE RECOVERY TO BE CREDITED TO THE TRIBAL PROFIT FUND DURING THE SECOND AND SUBSEQUENT CUTTING CYCLES FOR DISTRIBUTION.

	Hemlock	Other Species
Sale value per M.-----	\$18.00	\$29.70
Costs per M.-----	<u>10.39</u>	<u>11.90</u>
Stumpage Recovery per M.-----	\$7.61	\$17.80
Costs as a percent of Value-----	.578	.400
Valuation factor.-----	.763	.833
Stumpage to be Credited to Tribal Profit Fund.-----	\$5.81	\$14.83
Stumpage to be Credited to Tribal Profit Fund----- (Rounded Off)	\$6.00	\$15.00

substituting in the following formula:

$$\text{Valuation factor} = \frac{\text{Operating ratio} - (\text{Costs} / \text{Sales value})}{1 - (\text{Costs} / \text{Sales value})}$$

Where:

Operating ratio decided upon was 0.90 and

Costs as a percent of value ~~are as~~ determined.

The stumpage to be credited to the Tribal Profit Fund is found by multiplying the stumpage recovery by the valuation factor. This recommended amount per M. ft. B.M. for the species concerned was rounded off to the nearest fifty cents.

Disposition of the Stumpage Recovery Revenue over and above the Amount set aside for Crediting to the Tribal Profit Fund.

With an operating ratio of .90, 90 cents out of every revenue dollar goes for costs and stumpage and 10 cents will be set aside to protect the logging and milling operations from possible reverses. The 10 cents out of every dollar or 10% will actually be the stumpage recovery left over after the revenues per M. ft.B.M. for all the processed timber have been credited to the Tribal Profit Fund for distribution. This 10% is in no way to be considered as a profit ratio, for its only purpose is to protect the operation from possible losses.

Value of Block X After Cutting.

Calculations similar to those made for the first cutting cycle can be made for the second and subsequent cutting cycles to determine the stumpage recovery to be credited to the tribal profit fund. However, it seems advisable to evaluate the Hemlock on a per M. basis separately and to lump the other species into an average per M. basis. Hemlock retains its per M. value of \$18.00. Other species are considered to be worth \$29.70 per M. ft. B.M., derived as follows on the assumption the the stand composition for other species remains the same:

Maple	30% @ \$27.00-----	\$8.10
Birch	30% @ \$32.00-----	\$9.60
Basswood & Pine	20% @ \$35.00-----	\$7.00
Elm & Misc.	20% @ \$25.00e-----	<u>\$5.00</u>
Average for Other Species----		\$29.70

The recommended amount per M. to be credited to the Tribal Profit Fund is \$6.00 per M. for Hemlock and \$15.00 per M. for other Species, during the second and subsequent cutting cycles. These figures are as nearly accurate as can be determined at the present time. They have been rounded off to the nearest fifty cents.

Schedule D gives the method of arriving at these figures. Explanations are the same as for the first cutting cycle.

Schedule B shows that the anticipated cut in Hemlock is 16,373 M. ft. B.M. and in other species is 15,875 M. ft. B.M. for the three years of the second and subsequent cutting cycles. The probable amounts which can be set aside for the Tribal Profit Fund for each year that cutting is done after the first cutting cycle are determined as follows:

Hemlock--	$\frac{16,373 \text{ M}}{3 \text{ years}}$	x \$6.00 per M.	= \$32,700
Other Species--	$\frac{15,857 \text{ M}}{3 \text{ years}}$	x \$15.00 per M.	= <u>\$79,300</u>
Total-----			\$112,000.

The capitalization of this income from Block X is found by substituting in the formula for this purpose which is as follows: (See Appendix - page 32).

$$C_0 = \frac{a (1.0p^n - 1)}{0.0p \times \frac{1.0p^n}{(1.0p^t - 1)}}$$

Where:  $C_0$  is the Capitalization of income to be found.  
 a is the annual income of \$112,000  
 p is 4% interest rate at which the reservation can borrow money at any time.  
 n is 3 years, the number of years the income is obtained from Block X during any one cycle.  
 t is 15 years, the interval between cuts or the length of the cutting cycle.

$$\begin{aligned} \text{Total Capitalized Value of Block X} &= \frac{112,000 \times \frac{(1.04^3 - 1)}{0.04 \times 1.04^3}}{(1.04^{15} - 1)} \\ &= \frac{112,000 \times \frac{(1.125 - 1)}{0.04 \times 1.125}}{(1.801 - 1)} \\ &= \frac{112,000 \times (0.125 / 0.045)}{0.801} \\ &= \frac{112,000 \times 2.7777}{0.801} = \frac{311,000}{0.801} \\ &= \$388,000 \text{ Total capitalized value of Block X after cutting.} \end{aligned}$$

The value per acre is found by dividing this total capitalized value by the number of acres in Block X, as follows:

$$\text{Value per acre} = \$388,00 / 5,500 \text{ acres} = \$70.60 \text{ per Acre}$$

Therefore, the value of the residual stand after a cut, rounded off to the nearest fifty cents, is \$70.50 per acre, under selective cutting with a fifteen year cutting cycle. It can be carried on the books of the Menominee Tribe at this amount.

SUMMARY

1. The 5500 acres of Northern Hardwoods in Block X of the Menominee Indian Reservation is adapted to sustained yield management with selective cutting on a 15 year cutting cycle.
2. Block X will be divided into three cutting areas of about 1833 acres each so as to supply a net cut of over 14,000 M. ft. B.M. to the Menominee Mill at Neopit during the first cutting cycle. The actual boundaries of the cutting areas will be determined by the branch road layout which will be on a spacing of slightly over 1600 feet.
3. The short 15 year cutting cycle will permit the continuous harvesting of timber between 25 inches and 30 inches D.B.H. Timber will grow to that size in approximately 150 years with the anticipated growth of 0.2 inch D.B.H. per year.
4. The representation of hemlock in the residual stand can be reduced somewhat by selecting hemlock for the cut whenever possible and by leaving other species.
5. The gross cut per acre during the first cutting cycle will be 9.69 M. ft. B.M. per acre. With the estimated 20% cull during the first cutting cycle, this reduces to a net cut of 7.75 M. ft. B.M. The stand is overstocked and this cut represents 57.96 sq. ft. B.A., or 46.2% of the B.A. of the original stand. With this cut the basal area will grow to an estimated 100.00 sq. ft. during the interval of 15 years before the second cut.
6. The allowable cut during the second and subsequent cutting cycles is 5.86 M. ft. B.M.. This is represented by 34.92 sq. ft. B.A. or 34.9% of the B.A. The stand will grow to an estimated stocking of 100.00 sq. ft. B.A. per acre by the time of the following cut.

7. Cuts in basal area of about 40% are possible without encountering post logging decadence for hemlock and birch when care is taken so that these species in the residual stand are not exposed to the direct rays of the sun. The cut during the first cutting cycle exceeds this limit so special care must be taken in marking the stand at that time. Such a cut is justified in order to remove the overmature and defective timber in the virgin stand.
8. Block X can supply 14,212 M. ft. B.M. to Menominee Mills for only a three year period during the first cutting cycle. During the second cutting cycle and subsequent cutting cycles the allowable cut will be 10,743 M. ft. B.M. The difference of 3,569 M. ft. B.M. must be supplied from some other cutting area on the Reservation at the time Block X is logged.
9. The total logging costs are anticipated to be \$12.76 for hemlock and \$14.65 for other species on a per M. ft. B.M. basis net scale during the first cutting cycle. The sale values of the several species are as follows: Hemlock \$18.00, Maple \$27.00, Birch \$32.00, Basswood and Pine \$35.00, and Elm and Miscellaneous \$25.00. Stumpage recovery values for the species during the first cutting cycle are found to be as follows: Hemlock \$5.24, Maple \$12.35, Birch \$17.35, Basswood and Pine \$20.35, and Elm and Miscellaneous \$10.35.
10. The total logging costs are anticipated to be \$10.39 for hemlock and \$11.90 for other species on a per M. basis for the second and subsequent cutting cycles. With the same assumed sale values as for the first cutting cycle, the stumpage recovery values are as follows: Hemlock \$7.61, Maple \$15.10, Birch \$20.10, Basswood and Pine \$23.10, and Elm and Miscellaneous \$13.10 per M.

11. It is recommended that 90 cents out of every sale dollar be allocated to logging costs and stumpage, and that the remaining 10 cents out of every dollar be designated to protect the logging and milling operation from possible reverses. This would permit the crediting of the following amounts from stumpage recovery values to the Tribal Profit Fund for Distribution for each M. ft. B.M. net scale: Hemlock \$3.50, Maple \$9.50, Birch \$14.00, Basswood and Pine \$17.00, and Elm and Miscellaneous \$8.00. What is left over after crediting these amounts per M. for the first cutting cycle to the Tribal Profit Fund is the allowance to cover possible losses in the logging and milling operation.

12. Similarly, the estimated amounts to be credited to the Tribal Profit Fund during the second and subsequent cutting cycles is \$6.00 for each M. of Hemlock and \$15.00 for each M. of other species. It is estimated that under the production anticipated during the second and subsequent cutting cycles that approximately \$112,000 will be credited to the Tribal Profit Fund for each of the three years during any one cutting cycle. Using 4% as the interest rate, this income from Block X has a capital value of \$388,000, after cutting. This is equivalent to \$70.50 per acre and can be entered on the Books of the Menominee Tribe at this amount.



**APPENDIX**

APPENDIX

DETERMINATION OF THE CUT FOR THE FIRST CUTTING CYCLE

Stand Table

Table 1 represents the average conditions of stocking on Block X and is based on the actual cruise of this area of 5,500 acres. The species are listed as "Hemlock" and "Other Species". Hemlock is the species of low value and it is proposed to reduce its composition in the stand as much as possible. "Other Species" consist of the following: 30% - maple, 30% - birch, 20% - basswood and pine, and 20% - elm and miscellaneous.

Basal Area Control

A 15 year cutting cycle is to be used over the entire Menominee Indian Reservation. It is anticipated that the northern hardwood type in this area will under management have a growth rate of 0.2 inches per year. Therefore the increment growth during each cutting cycle will be this 0.2 inches per year multiplied by 15 years in the cutting cycle to give 3.0 inches.

The minimum size of the timber measured by the cruise is 10 inches and it is desirable to grow timber up to 30 inches D.B.H. The number of age groups which will be found on each acre would be 30 inches minus 10 inches or 20 inches divided by 3.0 inches of growth or approximately 7 age groups.

Gevorkiantz and Duerr (1937) published a "Yield Table for Average Well Stocked Stands of Northern Hardwoods in the Lake States". The following data was obtained from that table for a good site:

TABLE 1

PER ACRE STAND TABLE FOR BLOCK X  
OF THE  
MENOMINEE INDIAN RESERVATION.

D. B. H.	TOTAL STAND			HEMLOCK			OTHER SPECIES			
	NUMBER TREES	BASAL AREA SQ. FT.	VOLUME FT. B.M. (TOTAL)	NUMBER TREES	BASAL AREA SQ. FT.	VOLUME PER TREE FT. B.M.	NUMBER TREES	BASAL AREA SQ. FT.	VOLUME PER TREE FT. B.M. (TOTAL)	
10	13.5	7.36	405	5.5	3.00	30	8.0	4.36	30	240
12	10.0	7.85	860	4.0	3.14	80	6.0	4.71	90	540
14	9.0	9.62	1270	4.0	4.28	130	5.0	5.34	150	750
16	8.5	11.90	1705	4.0	5.60	190	4.5	6.30	210	945
18	7.8	13.77	2145	3.8	6.71	270	4.0	7.06	280	1120
20	6.4	14.00	2300	3.2	7.00	360	3.2	7.00	360	1150
22	5.5	14.53	2535	2.8	7.40	480	2.7	7.13	440	1190
24	4.3	13.51	2470	2.1	6.60	620	2.2	6.91	530	1170
26	3.0	11.08	2100	1.5	5.54	770	1.5	5.54	630	945
28	2.0	8.56	1650	1.0	4.28	910	1.0	4.28	740	740
30+ (Avg. 32)	2.0	11.18	2240	1.0	5.59	1210	1.0	5.59	1030	1030
TOTALS	72.0	123.36	19680	32.9	59.14	--	39.1	64.22	--	9820

AVERAGE MAIN STAND DIAMETER (IN.)	BASAL AREA PER ACRE (SQ. FT.)
7.4	86
9.6	102
11.6	115
13.3	127
15.1	137
16.8	146
18.6	155
20.4	162
22.1	168

The basal area figures given represent the basal area per acre in square feet under even aged conditions for stands with the average diameters as given. The data was plotted and a curve was drawn through the points and extended at the upper diameter limits so that basal area figures for any average diameter could be determined. This graph (Figure 1) was used in constructing the basal area control table (Table 2) which is given below in its completed form:

TABLE 2

BASAL AREA CONTROL TABLE

AGE GROUP	PROBABLE DIAMETER RANGE IN INCHES	AVERAGE D.B.H. INCHES	BASAL AREA SQUARE FEET FOR FULLY STOCKED ACRE	INDICATED DISTRIBUTION OF B. A. IN PERCENT
I	10-13	11.5	115	10.5
II	13-16	14.5	134	12.3
III	16-19	17.5	150	13.7
IV	19-22	20.5	162	14.9
V	22-25	23.5	172	15.9
VI	25-28	26.5	177	16.2
VII	28-31	29.5	180	16.5
TOTALS			1090	100.0



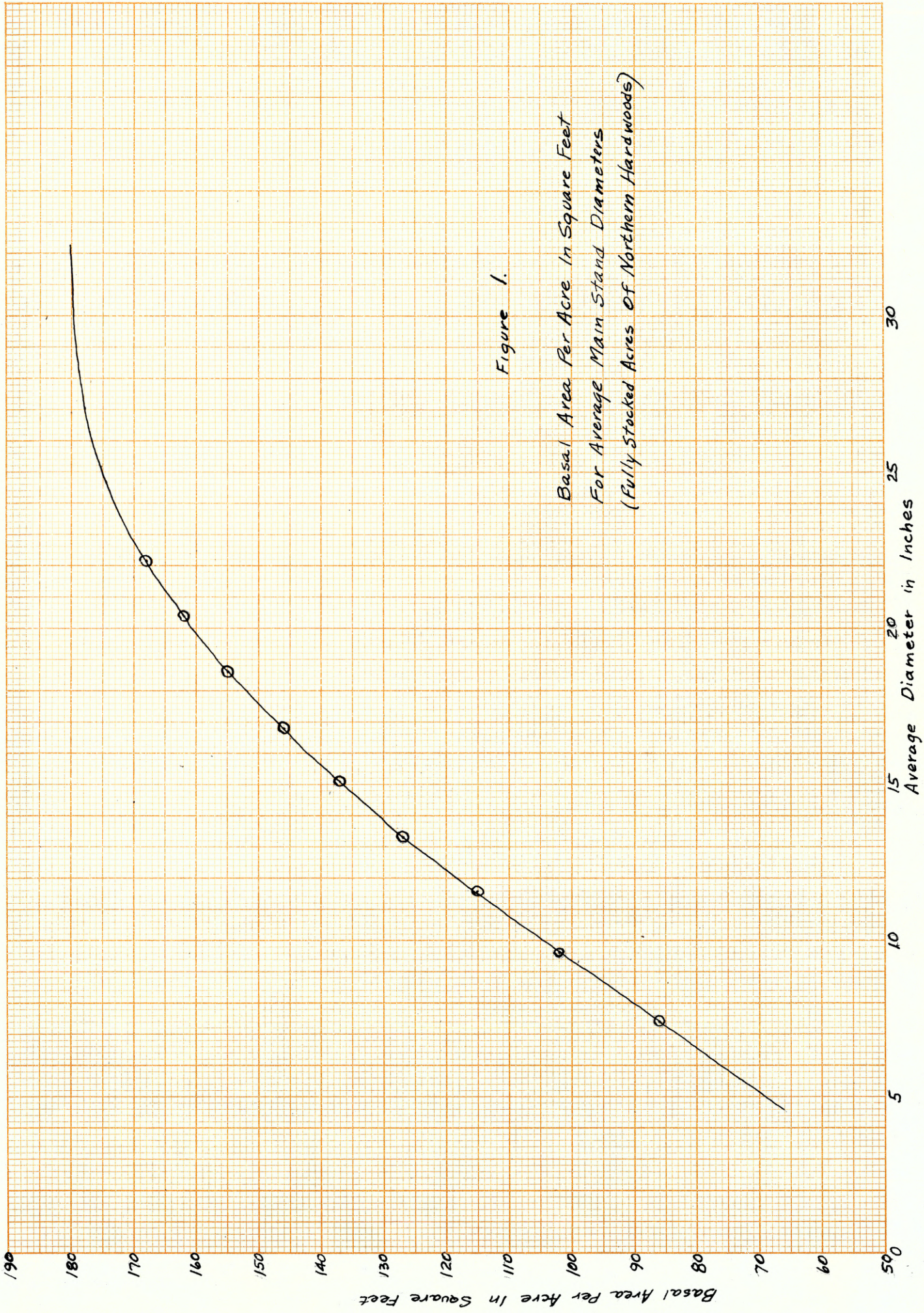


Figure 1.

Basal Area Per Acre In Square Feet  
For Average Main Stand Diameters  
(Fully Stocked Acres of Northern Hardwoods)



The basal area control table was made up as follows:

1. The seven cyclic age groups as determined above were listed.
2. The probable diameter range was calculated for each age group. Group I has a range from the lower limit of 10 inches to an upper limit of 13 inches, since growth will be 3 inches during the 15 year period. Group II will have a range from the upper limit of 13 inches for Group I to its own upper limit of 16 inches. The other probable diameter ranges were calculated in a similar manner.
3. The average D.B.H. is the average of the upper and the lower range of each age group.
4. The basal area of a fully stocked acre for each age group in square feet is found by reading the basal area for each average D.B.H. from the graph (Figure 1 ).
5. The indicated distribution of basal area in percent for each age group is computed by dividing the basal area for each age group by the total for the seven age groups.

The basal area of a fully stocked acre in square feet is listed for each age group, so the totals of all the age groups represent the equivalent of 7 fully stocked acres. The basal area occupied by all age groups on an average acre is the total of 1090 square feet divided by 7 or 155.7 square feet.

The minimum size of trees recorded in the cruise was 10 inches. Since 155.7 square feet represents the basal area occupied by all age groups on an average acre, it must also include the basal area occupied by trees 10 inches and below. It will take about 50 years for trees to reach a

diameter of 10 inches with the anticipated rate of growth, and another 100 years to grow from 10 inches to around 30 inches. If this is true it can be assumed that the basal area occupied by the measured portion of the stand as recorded by the cruise is two thirds of the basal area for the entire stand. Therefore within the limits of the cruise, the basal area for a fully stocked acre would be two thirds of 155.7 square feet or 103.8 square feet.

#### Adequate Stocking.

The actual basal area determined for a fully stocked acre was 103.8 square feet. This is very close to 100.0 square feet, so it is assumed that 100.0 square feet of basal area represents the desired fully stocked condition for trees 10 inches and above D.B.H.

The stand table based on the cruise shows that Block X has an average of 123.36 square feet of basal area per acre. This uncut virgin stand of northern hardwoods is heavily stocked in view of the fact that full stocking only requires 100.0 square feet. Therefore a reduction to about 100.0 square feet of basal area is desirable in view of the existing overmaturity of the stand and anticipated growth under selective cutting.

#### Classified Stand Table Before Initial Cut.

The original tabulation of the stand was grouped according to D.B.H. classes. With the division of the stand into age groups it becomes possible to develop a classified stand table using the percentage distribution of basal area as a base. The completed table is attached (Table 3 ).

TABLE 3

CLASSIFIED STAND TABLE BEFORE INITIAL CUT

AGE GROUP	D.B.H. RANGE	AVG. DIAM.	TOTAL		HEMLOCK		OTHER SPECIES				
			NUMBER TREES	BASAL AREA SQ. FT.	NUMBER TREES	BASAL AREA SQ. FT.	NUMBER TREES	BASAL AREA SQ. FT.			
I	10-12	10.7	20.6	12.95	1017	8.3	5.25	391	12.3	7.70	626
II	12-16	14.0	14.3	15.18	1991	6.3	6.72	825	8.0	8.46	1166
III	16-18	16.9	10.8	16.90	2525	5.2	8.09	1167	5.6	8.81	1358
IV	18-20	19.3	9.0	18.38	2972	4.5	9.13	1467	4.5	9.25	1505
V	20-24	22.2	7.3	19.61	3445	3.6	9.89	1819	3.7	9.72	1626
VI	24-26	25.1	5.8	19.98	3720	2.9	9.88	2006	2.9	10.10	1714
VII	26-30		4.2	20.36	4010	2.1	10.18	2185	2.1	10.18	1825
TOTAL			72.0	123.36	19680	32.9	59.14	9860	39.1	64.22	9820



The method of arriving at the figures given in the classified stand table before the initial cut is in order.

Age group I is to be represented by 10.5% of the total basal area as shown in Table 2 . 10.5% of 123.36 sq. ft. (the total B.A.) is 12.95 Sq. ft. which figure is recorded in the table. The stand table (Table 1 ) shows that D.B.H. class 10 in. has 7.36 sq. ft. B.A., so 12.95 sq. ft. less 7.36 sq. ft. gives 5.59 sq. ft. which must come from the 12 inch class. D.B.H. class 12 inches contains 7.85 sq. ft. B.A., so age group I will require 5.59 sq. ft. divided by 7.85 sq. ft. or 71.2% of the 12 in. D.B.H. class. This represents 71.2% of 10 trees or 7.1 trees, and 71.2% of 860 ft. B.M. or 612 ft. B.M. from the 12 in. class. These figures are recorded in the table. Calculations to determine the breakdown into hemlock and other species are made in the same manner.

Age group II is to be represented by 12.3% of 123.36 sq. ft. (the total B.A.) or 15.18 sq. ft. B.A. The basal area left over from the 12 in. D.B.H. class was 7.85 sq. ft. less 5.59 sq. ft. or 2.26 sq. ft. The number of trees left over were 10.0 trees less 7.1 trees or 2.9 trees. The volume left over was 860 ft. B.M. less 612 ft. B.M. or 248 ft. B.M. It is seen that the entire 14 inch class will fall into age group II, so the totals for the 14 in. class are added to the totals left over from the 12 in. class to give 11.88 sq. ft. B.A., 11.9 trees, and 1518 ft. B.M. The total B.A. of 11.88 sq. ft for the 12 in and 14 in. class is subtracted from the basal area of 15.18 sq. ft. which represents age group II to leave 3.30 sq. ft. B.A. to come from the 16 in. class. The 16 in. class contains 11.90 sq. ft. B.A., so the percentage to be included in age group II is 3.30 sq. ft. divided by

11.90 sq. ft. or 27.6% of the 16 in. class. The number of trees to be included from the 16 in. class in age group II is 27.6% of 8.5 trees or 2.4 trees, and the volume to be included is 27.6% of 1705 ft. B.M. or 473 ft. B.M. These figures are recorded in the table.

All other calculations for completing the classified stand table are made in this manner. Hemlock and other species are considered to be in the same proportions as for the basal area for the entire stand, which simplifies the calculations considerably.

Such a stand table automatically indicates the harvest cut in the figures for the oldest age group, in this case age group VII. Thinning cuts from the younger age groups must be calculated separately.

#### Calculation of the Cut for the First Cutting Cycle.

Since it was previously determined that 100.0 sq. ft. B.A. represents a adequate stocking on a good site for ~~the~~ northern hardwood type, the basal areas for each age group are represented directly by the percentages as determined for Table 2. The summarization of the cut is given in Table 4. In compiling this table an attempt has been made to designate for removal as much of the hemlock in the thinnings as possible and to favor other species in the residual stand. The classified stand table at the end of the first cutting cycle (Table 5) is made up as the calculations progress.

The calculation of the thinning cut from Age group I is determined as follows:

1. The basal area desired at the end of the 1st cutting cycle from trees presently in age group I is 12.30 sq. ft.

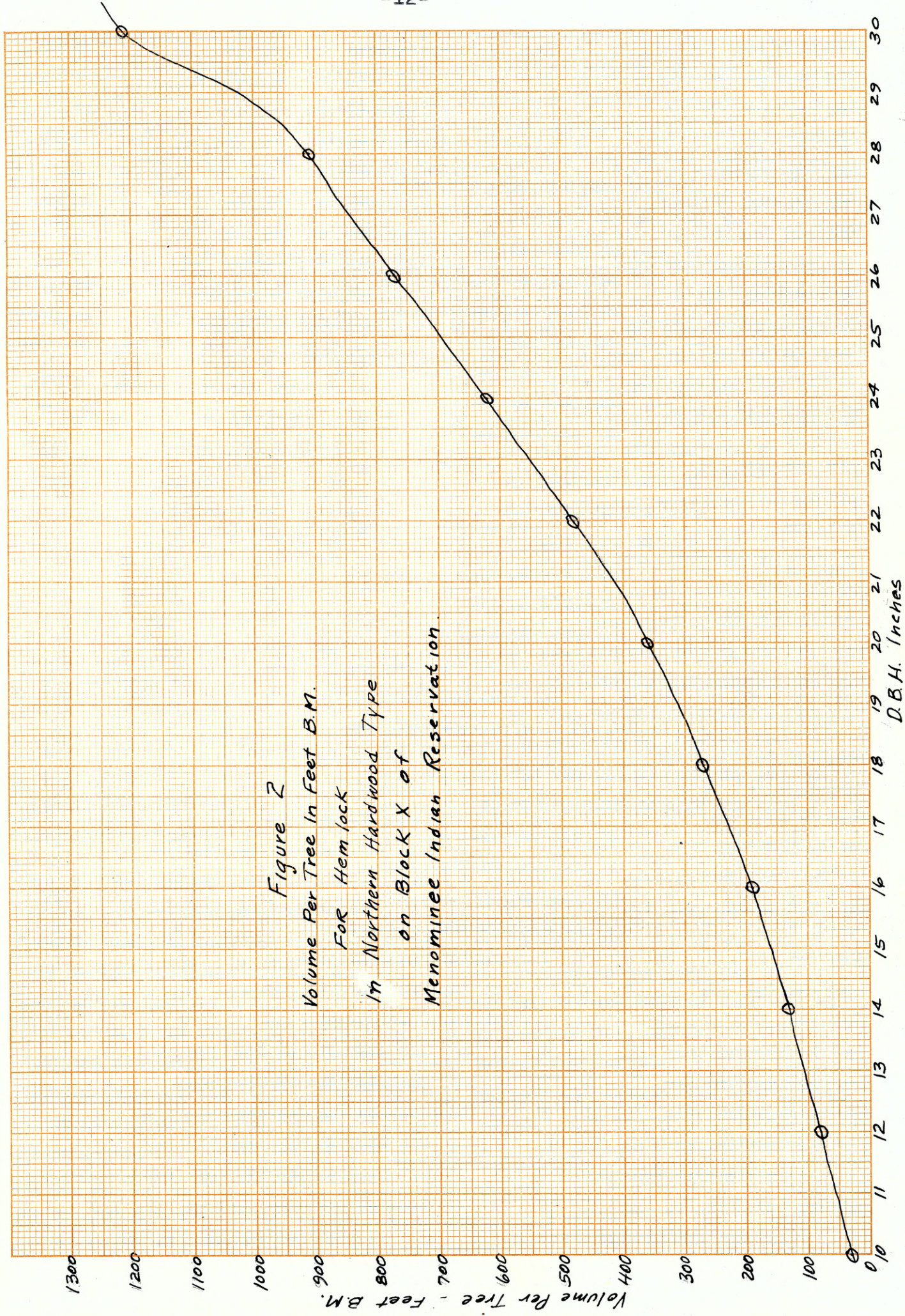
TABLE 4.

SUMMARIZATION OF THINNING AND HARVEST CUTS DURING FIRST CYCLE

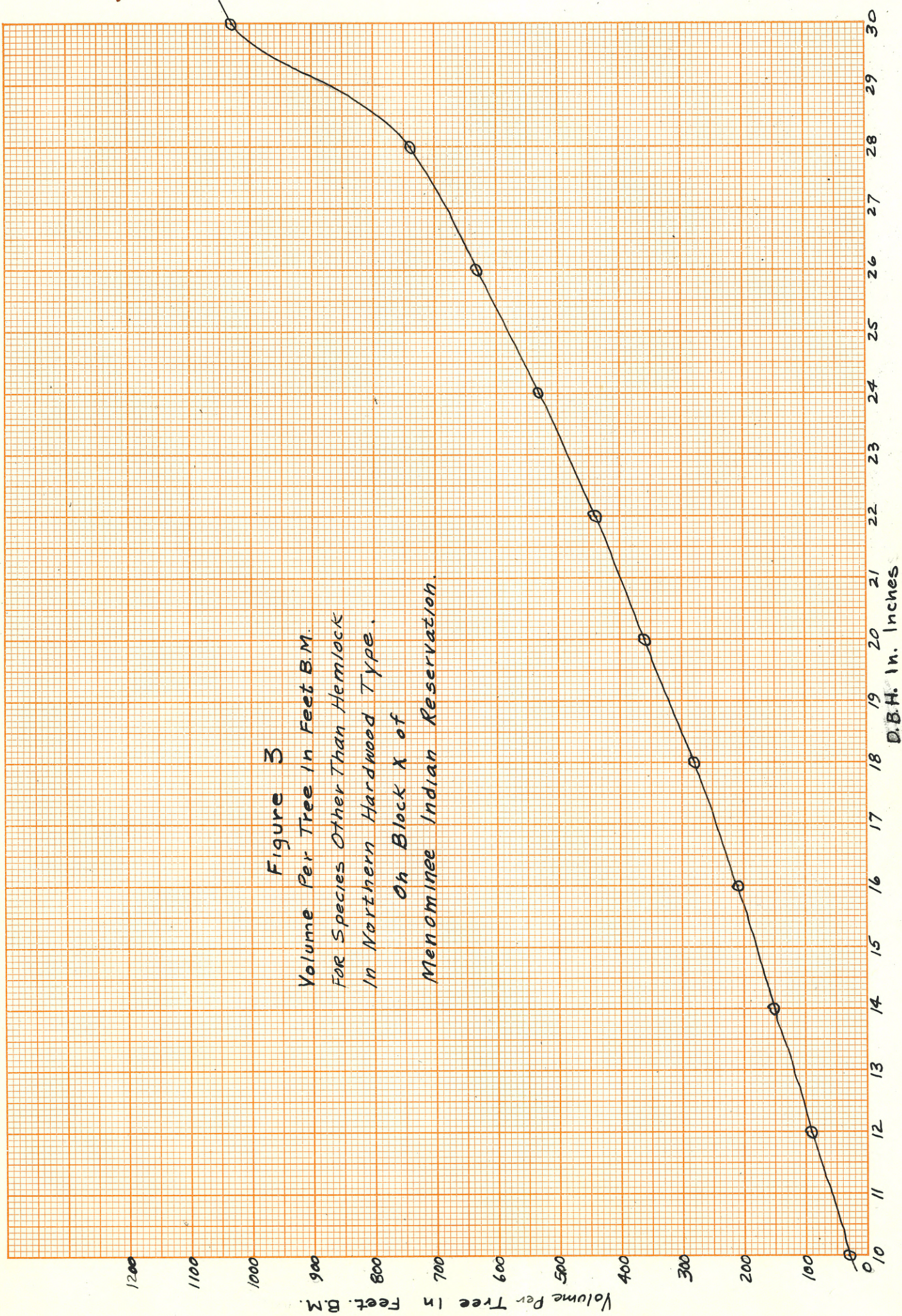
AGE GROUP	AVG. DIAM.	TOTAL			HEMLOCK		OTHER SPECIES	
		NO. TREES	B. A. SQ. FT.	VOLUME FT. B.M.	NO. TREES	VOLUME FT. B.M.	NO. TREES	VOLUME FT. B.M.
I	10.7	8.6	5.38	430	8.3	415	0.3	15
II	14.0	5.6	5.98	730	5.6	730	0	0
III	16.9	3.9	6.08	860	3.9	860	0	0
IV	19.3	3.1	6.30	990	3.1	990	0	0
V	22.2	2.6	6.99	1270	2.6	1270	0	0
VI	25.1	2.0	6.87	1400	2.0	1400	0	0
TOTAL FOR THINNINGS		25.8	37.60	5680	25.5	5665	0.3	15
VII	26	0.2	0.62	120	0.1	65	0.1	55
	28	2.0	8.56	1650	1.0	910	1.0	740
	30	2.0	11.18	2240	1.0	1210	1.0	1030
TOTAL HARVEST CUT		4.2	20.36	4010	2.1	2185	2.1	1825
TOTAL FOR THINNINGS AND HARVEST CUT		30.0	57.96	9690	27.6	7850	2.4	1840
PERCENTAGE CUT				100.0%		81.0%		19.0%

2. The average diameter at the end of the 1st cutting cycle will be 3.0 inches of growth added to the average diameter of 10.7 inches at the present time or 13.7 inches.
3. The basal area of a 13.7 inch tree is 1.024 sq. ft.
4. The number of trees forward to age group II is 12.30 sq. ft. B.A. divided by 1.024 sq. ft. (the B.A. of a 13.7 in. tree) or 12.0 trees.
5. The cut in trees from the present age group I is the 20.6 trees at present in age group I less 12.0 trees needed at the end of the 1st cycle to go forward to age group II or 8.6 trees of an average diameter 10.7 inches.
6. Of the 8.6 trees to be removed, 8.3 can be chosen from the hemlock and the remainder 0.3 trees can be chosen from other species, leaving zero trees of hemlock and 12.0 trees of other species.
7. The cut in basal area for the 8.6 trees to be removed is determined by multiplying 8.6 trees by 0.625 sq. ft., the basal area of a 10.7 inch tree, which amounts to 5.38 sq. ft.  
B. A.
8. The stand table (Table 1) gives the volumes for trees for different diameters for hemlock and other species. These figures were plotted so that volume determinations could be made for any diameter. Figure 2 is the graph for hemlock and Figure 3 is the graph for other species. The cut for hemlock is 8.3 trees multiplied by 50 ft. B.M., the volume for a 10.7 inch hemlock tree as read from the graph, or 415 ft. B.M. The cut for other species is 0.3 trees multiplied by 50 ft. B.M., the volume for a 10.7 inch other species tree, or 15 ft. B.M. The total cut for all species from age group I is the total of the two or 430 ft. B.M.









**Figure 3**  
 Volume Per Tree in Feet B.M.  
 For Species Other Than Hemlock  
 In Northern Hardwood Type.  
 Oh Block X of  
 Menominee Indian Reservation.



The thinning cut from age group II is determined in a similar manner as follows:

1. The basal area desired at the end of the 1st cutting cycle from trees presently in age group II is 13.70 sq. ft.
2. The average diameter at the end of the 1st cycle will be 3.0 inches of growth added to the present average diameter of 14.0 inches or 17.0 inches.
3. The basal area of a 17.0 inch tree is 1.576 sq. ft.
4. The number of trees to go forward to age group III is 13.70 sq. ft. B.A. divided by 1.576 sq. ft. B.A. for a 17.0 inch tree or 8.7 trees.
5. The cut in trees with an average diameter of 14.0 inches from the present age group II is the 14.3 trees in the group at the present time less 8.7 trees needed at the end of the 1st cycle to go forward to age group III, or 5.6 trees.
6. All 5.6 trees can be removed from the hemlock which will leave 0.7 trees in hemlock and 8.0 trees in other species.
7. The cut in basal area for the 5.6 trees removed is determined by multiplying 5.6 trees by 1.069 sq. ft., the B.A. of a 14.0 inch tree, which amounts to 5.98 sq. ft. B.A.
8. The cut in volume in ft. B.M. for hemlock and for total species is found in one operation in this case by multiplying the number of trees cut by the volume for a tree with a 14.0 in. D.B.H. as read from Fig. 2, or 5.6 trees multiplied by 130 ft. B.M. to give 730 ft. B.M.
9. The thinning cuts for the other age groups are determined in a similar manner, and the harvest cut will automatically contain all the trees contained in age group VII.

DETERMINATION OF THE CUT FOR THE SECOND AND SUBSEQUENT CUTTING CYCLES.

Classified Stand Table at the End of the First Cutting Cycle.

The classified stand table at the end of the 1st cutting cycle was constructed at the time that the cut for the 1st cutting cycle was determined. The figures for basal area, average diameter, and number of trees were found for age groups II through VII in making that calculation. An assumption for age group I was made that the average diameter would remain the same at 10.7 inches which has a basal area of 0.625 sq. ft. Since the basal area desired for this group is 10.50 sq. ft., the number of trees which would come into this class would be 10.50 sq. ft. divided by 0.625 sq. ft. or 16.8 trees. The chances are that a greater number of trees would come into age group I than the number calculated from reproduction. This would give more opportunity to favor other species in the residual stand.

Volume determinations were made by reading the volumes for hemlock and other species for the average diameters from Figures 2 & 3, and multiplying the readings by the trees for each species in that class.

The completed classified stand table at the end of the 1st cutting cycle is given in Table 5.

Calculation of the Cut for the Second and Subsequent Cutting Cycles.

The cut for the second cutting cycle was also made on the assumption that 100.0 sq. ft. B.A. represents the desired stocking. Table 6 gives the tabulation of the results. The basis for this cut is the classified stand table at the end of the first cutting cycle (Table 5). The cut from age group I is determined as follows:



TABLE 5

CLASSIFIED STAND TABLE AT THE END OF THE FIRST CYCLE

AGE GROUP	AVG. DIAM. IN.	BASAL AREA SQ. FT.	TOTAL			HEMLOCK			OTHER SPECIES		
			NUMBER TREES	BASAL AREA SQ. FT.	VOLUME FT. B. M.	NUMBER TREES	BASAL AREA SQ. FT.	VOLUME FT. B. M.	NUMBER TREES	BASAL AREA SQ. FT.	VOLUME FT. B. M.
I	10.7	0.625	16.8	10.50	890	6.8	4.25	390	10.0	6.25	500
II	13.7	1.024	12.0	12.30	1680	0	0	0	12.0	12.30	1680
III	17.0	1.576	8.7	13.70	2080	0.7	1.10	160	8.0	12.60	1920
IV	19.9	2.160	6.9	14.90	2470	1.3	2.80	450	5.6	12.10	2020
V	22.3	2.712	5.9	15.90	2730	1.4	3.80	700	4.5	12.10	2030
VI	25.2	3.46	4.7	16.20	2890	1.0	3.45	710	3.7	12.75	2180
VII	28.1	4.31	3.8	16.50	3000	0.9	3.90	830	2.9	12.60	2170
TOTAL			58.8	100.00	15740	12.1	19.30	3240	46.7	80.70	12500

TABLE 6

SUMMARIZATION OF THINNING AND HARVEST CUTS DURING SECOND CYCLE

AGE GROUP	AVG. DIAM.	TOTAL			HEMLOCK		OTHER SPECIES	
		NO. TREES	B.A. SQ. FT.	VOLUME FT.B.M.	NO. TREES	VOLUME FT. B.M.	NO. TREES	VOLUME FT.B.M.
I	10.7	4.8	3.00	240	4.8	240	0	0
II	13.7	3.0	3.07	420	0	0	3.0	420
III	17.0	1.9	2.99	450	0.7	160	1.2	290
IV	19.9	1.3	2.81	455	1.3	455	0	0
V	22.3	1.3	3.52	650	1.3	650	0	0
VI	25.2	0.9	3.03	640	0.9	640	0	0
TOTAL THINNING CUT		13.2	18.42	2855	9.0	2145	4.2	710
VII 28.1 (HARVEST CUT)		3.8	16.50	3005	0.9	830	2.9	2175
GRAND TOTAL CUT( THINNINGS AND HARVEST)		17.0	34.92	5860	9.9	2975	7.1	2885
PERCENTAGE CUT				100.0		50.8		49.2

1. The basal area desired for age group I at the end of the 2nd cutting cycle is 12.30 sq. ft.
2. The average diameter at the end of the 2nd cycle is 3.0 inches of growth during the 15 year cutting cycle added to the average diameter of 10.7 inches or 13.7 inches.
3. The basal area of a 13.7 inch tree is 1.024 sq. ft.
4. The number of trees forward to age group II at the end of the 2nd cycle is 12.30 sq. ft. B.A. divided by 1.024 sq. ft. B.A. or 12.0 trees.
5. The cut in trees with an average diameter of 10.7 inches is 12.0 trees subtracted from 16.8 trees or 4.8 trees.
6. All 4.8 trees can be removed from hemlock as there are 6.8 trees of hemlock represented in this group. This leaves 2.0 hemlock trees and 10.0 trees of other species in the residual stand.
7. The cut in basal area from age group I is 0.625 sq. ft., the basal area of a 10.7 inch tree, multiplied by 4.8, the number of trees to be removed, or 3.00 sq. ft. B.A.
8. The cut in volume from the 10.7 inch trees designated for removal is 4.8 trees multiplied by 250 ft. B.M. for that size hemlock from Figure 2 or 240 ft. B.M. Since hemlock composes the entire cut, there is no calculation for other species.

The cut from age group II is determined similarly as follows:

1. The basal area desired at the end of the 2nd cycle for age group II is 13.70 sq. ft.
2. The average diameter at the end of the 2nd cycle is the 3.0 inches of growth anticipated during the 2nd cutting cycle added to 13.7 inches, the average diameter at the end of the

1st cycle, or 16.7 inches.

3. The basal area for a tree 16.7 inches D.B.H. is 1.521 sq.ft.

4. The number of trees forward to age group III at the end of the 2nd cycle is 13.70 sq. ft. B.A. divided by 1.521 sq. ft. B.A. or 9.0 trees.

5. The cut in trees of an average diameter of 13.7 inches D.B.H. is 12.0 trees, the present number in age group II, less 9.0 trees, the number of trees desired at the end of the 2nd cycle, or 3.0 trees.

6. Since the stand per acre at the end of the 1st cycle shows no hemlock trees in age group II, the entire cut will come from other species. This leaves zero hemlock trees and 9.0 other species in the residual stand.

7. The cut in basal area is 1.024 sq. ft. B.A., the basal area of a 13.7 inch tree, multiplied by 3.0 trees, the number of trees designated for removal, or 3.07 sq. ft.

8. The cut in ft. B.M. is 140 ft. B.M., the volume of a 13.7 inch other species tree as read from Figure 3, multiplied by 3.0 trees to be removed or 420 ft. B.M.

The calculations for the cut from the other age groups are made in the same manner. The harvest cut will automatically contain all the trees from Age group VII.

The cut for cycles subsequent to the second cutting cycle will not be materially different from the cut for the second cutting cycle. It is not considered necessary to make these calculations since at the time of the third cut conditions may have changed considerably. Any determination now is likely to be in error, and a better estimate can be obtained in the light of actual conditions at that time.

CUTTING AREA AND THE TOTAL VOLUME SUPPLIED BY IT.

Menominee Mills requires a cut of at least 14,000,000 ft. B.M. per year net scale for full operation. Since 20% cull is anticipated during the first cutting cycle, this net figure is 80% of the gross cut needed. The gross cut is then 14,000,000 ft. B.M. divided by 0.80 or 17,500,000 ft. B.M. The cutting area for the first few years is then 17,500,000 ft. B.M. divided by 9,690 ft. B.M., the cut per acre during the 1st cycle, or approximately 1806 acres. Since Block X contains 5,500 acres, it will require three years to cut the area over. In view of using exactly three years to cut the area over, recalculations are in order.

One third of the 5,500 acre area will be cut over during each year which amounts to 1,833 acres. The entire block will be cut over in three years, and each cutting area will be returned to for subsequent cuts at 15 year intervals. The volume cut per acre is larger for the first cycle than it will be for the second and subsequent cycles.

The cut per year during the first cycle is 9,690 ft. B.M. per acre multiplied by 1,833 acres which equals 17,765,000 ft. B.M. gross scale. This reduces to 14,212,000 ft. B.M. net scale which is slightly above the required figure.

The cut per year during the second and subsequent cycles is 5,860 ft. B.M. multiplied by 1,833 acres or 10,743,000 ft. B.M. gross scale. It is estimated that cull will be negligible during the second and subsequent cycles, so the gross scale is the same as net scale in this case. This total cut does not meet the full yearly requirements, so the deficit must be made up from areas outside Block X.

DERIVATION OF THE COSTS FOR THE FIRST CUTTING CYCLE FOR THE LOGGING PLAN TO BE USED.

Felling and Bucking (gross scale)

Two man crews are to be used for felling and bucking.

The cost is estimated as follows:

Cost per 8-hour day

A. Direct labor

2 men at 80 cents per hour	\$12.80
Plus 10% allowance for portal to portal pay	1.28
Plus 20% for industrial comp., ins, etc.	2.82

B. Indirect costs

Supplies and maintenance	1.00
Depreciation tools	0.25
Direct supervision and overhead	3.00

Total \$21.15

Cost per man hour--- \$21.15 / 16 man hours \$1.32

Estimated production per man hour:

Hemlock-----	0.4 M ft.B.M.
Other Species-----	0.3 M ft.B.M.

Estimated cost per M for felling and bucking:

Hemlock-----	\$1.32 / 0.4 M.ft.	\$3.30
Other Species-----	\$1.32 / 0.3 M.ft.	\$4.40

Skidding (gross scale)

Both teams and tractors are to be used for skidding. The machine rate for each is given below:

A. Machine rate for teams:

Per Hour

Teamster and 1/2 time swamper @ \$0.80	\$1.20
Social security and industrial comp. etc @ 20%	0.24
10% allowance for portal to portal pay	0.14
Depreciation on team and harness	0.20
Feed and care of team	0.32

Total----- \$2.10

Rate per minute-- \$2.10 / 60	\$0.035
Average fixed time per turn-----	3.6 minutes
Average round trip time per station--	1.0 minutes
Average load -----	140 ft. B.M.

B. Machine rate for tractor:	<u>Per Hour</u>
Driver @ \$1.25	\$1.25
Hooker @ \$0.90	0.90
Social security etc. @ 20%	0.43
10% allowance for portal to portal pay	0.26
Depreciation and supplies and tractor maintenance	3.76
Total	\$6.60
Rate per minute      \$6.60 / 60	\$0.11
Average fixed time per turn	7.0 minutes
Average round trip speed per station	0.8 minutes
Average load	700 ft. B.M.

There is a skidding distance at which the cost with the teams and tractors will be equal. Matthews (1942) developed a break even skidding distance formula for finding this distance. The formula is as follows:

$$D = \frac{F' - F}{C - C'}$$

where: D is the skidding distance at which the cost with the two types of machines will be equal.  
 F' is the fixed cost of the high fixed cost machine.  
 C' is the variable skidding cost of the high fixed cost machine.  
 F is the fixed cost of the low fixed cost machine.  
 C is the variable cost of the low fixed cost machine.

The values for substituting in the above formula are derived below from the machine rates for tractors and teams.

F' or the fixed per turn cost per M. ft. B.M. for tractor. =  $\frac{7.0 \text{ min.} \times \$0.11 \text{ per min}}{0.7 \text{ M ft. B.M.}} = \$1.10$

C' or the variable cost per M Ft. B.M. per 100 ft. of skidding distance for tractor. =  $\frac{0.8 \text{ min.} \times \$0.11 \text{ per min}}{0.7 \text{ M.ft. B.M.}} = \$0.126$

F or the fixed per turn cost per M. ft. B.M. for team. =  $\frac{3.6 \text{ min} \times \$0.035 \text{ per min}}{0.14 \text{ M.ft. B.M.}} = \$0.90$

C or the variable cost per M ft. B.M. per 100 ft. of skidding distance for team. =  $\frac{1.0 \text{ min} \times \$0.035 \text{ per min.}}{0.14 \text{ M.ft. B.M.}} = \$0.25$

By substituting in the formula the above values, the following is obtained:

D or the skidding distance at which the cost with tractor and team will be equal =  $\frac{1.10 - 0.90}{0.25 - 0.126} = \frac{0.20}{0.124} = 1.61$  hundred feet.

Matthews (1942) also developed a road spacing formula for roads on level ground served by two types of skidding machines. It is as follows:

$$S = \sqrt{\frac{0.33 R}{V C'} - \frac{4 C D^2}{C'} + 4 D^2}$$

Where: S is the spacing of roads in units of 100 feet.  
R is the cost of road construction per mile.  
V is the volume to be removed per acre.  
D is the break even distance as between the two types of machines, or the economical skidding distance for the low fixed cost machine.  
C is the variable cost of the low fixed cost machine.  
C' is the variable skidding cost of the high fixed cost machine.

The values for substituting in the above formula are as follows:

- R \$1000.00 per mile, since the spur and branch roads are to be semi permanent in character and are estimated to cost \$1000.00 per mile.
- V 9.69 M Ft. B.M., the estimated cut per acre during the 1st cutting cycle.
- D 1.61 hundred feet, or the skidding distance at which the cost with tractor and team will be equal.
- C \$0.25 or the variable cost per M. ft. B.M. per 100 feet of skidding distance for teams.
- C' \$0.126 or the variable cost per M. ft. B.M. per 100 feet of skidding distance for tractors.

Substituting in the formula,

$$\begin{aligned}
 S &= \sqrt{\frac{0.33 \times \$1000.00}{9.69 \times \$0.126} - \frac{4 \times \$0.25 \times (1.61)^2}{\$0.126} + 4 \times (1.61)^2} \\
 &= \sqrt{\frac{330.00}{1.22} - \frac{2.5921}{0.126} + 4 \times 2.59} \\
 &= \sqrt{270.0 - 20.6 + 11.6} \\
 &= \sqrt{261.0}
 \end{aligned}$$

S = 16.15 stations (spacing in units of 100 feet)

When tractors and teams are used in combination for skidding, the teams will be used to move all the timber within its economical reach of about 160 feet, while the tractors will be used to handle the more distant interior timber between the roads which will be spaced about 1615 feet apart.

Very little savings can be anticipated by using the teams



for skidding such a short distance. However, their limited use is justified since they must be on the job anyway for loading the trucks for haul to the mill in Neopit.

The variable and fixed costs are different for team and tractor skidding, so their values must be weighted in order to arrive at a correct per M figure. Matthews (1942) developed formulas for this procedure.

Fixed costs are weighted according to the proportion of the areacovered by each. For team skidding this area will be  $2D/S$  and for tractor skidding it will be  $(S-2D) / S$ , where D is the skidding distance at which the cost with the teams and tractors will be equal and S is the spacing of roads in units of 100 feet. It is seen that the combination of the two is unity, when added together, so each represents the proportion of the area allotted to that machine.

The variable costs are weighted according to the proportion of the area covered by each as given above, and also to the average skidding distance. The skidding distance for teams can be expressed as  $D/2$  and for tractors as  $(\frac{1}{2}S + D) / 2$ .

The calculations are as follows:

Weighted cost for team skidding:

$$\begin{aligned} \text{Weighted fixed cost} &= F \times \frac{2D}{S} \\ &= \$0.90 \times \frac{2 \times 1.61}{16.15} = \$0.179 \end{aligned}$$

$$\begin{aligned} \text{Weighted variable cost} &= C \times \frac{D}{2} \times \frac{2D}{S} \\ &= \$0.25 \times \frac{1.61}{2} \times \frac{2 \times 1.61}{16.15} = \$0.040 \end{aligned}$$

$$\text{Total weighted cost for skidding by teams} = \$0.219$$

Weighted cost for tractor skidding:

$$\text{Weighted fixed cost} = F' \times \frac{S - 2D}{S}$$

$$= \$1.10 \times \frac{(16.15 - 2 \times 1.61)}{16.15} = \$0.882$$

$$\text{Weighted variable cost} = C' \times \frac{(\frac{1}{2}S + D)}{2} \times \frac{(S - 2D)}{S}$$

$$12.6 \times \left( \frac{\frac{1}{2} \times 16.15 + 1.61}{2} \right) \times \frac{(16.15 - 2 \times 1.61)}{16.15} = \$0.488$$

$$\text{Total weighted cost for skidding by tractor} = \$1.370$$

$$\begin{aligned} \text{Total skidding costs per M for all species} &= \$1.589 \\ \text{(Team cost of \$0.219 plus tractor cost of \$1.370)} & \end{aligned}$$

Branch Road Construction (Gross Scale)

The branch roads are to be semi-permanent in nature and will probably cost \$1000.00 per mile. Generally Block X will be divided into three cutting areas on the basis of the road construction. It will be necessary to construct 10 roads across the area in a general east-west direction so as to conform with the computed spacing of slightly over 1600 feet. This will involve construction of about 10 miles of roads for each of the three years of the first cut, or a total of about 30 miles. Their actual location can best be determined on the ground.

Matthews (1942) developed a formula for estimating the cost of these branch roads per M ft. B.M. The formula and the calculation is as follows:

$$\text{Cost of road construction} = \frac{R/12.1}{V \times S}$$

Where: R is the estimated cost per mile.  
V is the per M volume removed per acre.  
S is the spacing of the roads in hundreds of feet

$$\text{Cost} = \frac{1000/12.1}{9.69 \times 16.15} = \frac{8270}{156.4} = \$0.529 \text{ per M.ft.B.M.}$$

Loading (gross scale)

When the trucks arrive at the loading points, the skidding teams will power the jammers. The skidding machine rate of \$0.035 per minute applies to the cost of loading. The estimated loading rate is 15 minutes per M. ft. B.M.. The calculation is as follows:

$$\text{Loading cost} = \$0.035 \text{ per minute} \times 15 \text{ minutes} = \$0.525 \text{ per M ft. B.M.}$$

Hauling (gross scale)

Trucks are to be used for hauling the logs to the mill, and the machine rate for a comparable operation is given in the attached schedule. Matthews (1942) developed a formula for determining the hauling cost per M. ft. B.M. It is given below:

$$\text{Hauling cost} = \frac{2 \times \text{hourly cost} \times \text{distance}}{\text{miles per hour} \times \text{load}}$$

The values for substituting in this formula are determined as follows:

The hourly cost was determined at \$3.25 for the trucks to be used.

The average distance of haul on the main road is 8.5 miles, since the SW corner of Block X is 7 miles from the mill on the main road and the NW corner of Block X will be 10 miles, the average is 8.5 miles.

The average distance of haul on the branch roads is 1.5 miles, since the distance will vary from zero miles at the main road along the west of the block to the maximum 3 miles from the main road to the E of the block, which is across three sections.

The average round trip speed on the main roads is 20 M.P.H.

The average round trip speed on branch roads is 12 M.P.H.

The load for hemlock is 2.5 M. ft. B.M.

The load for other species is 2.0 M. ft. B.M.

The total hauling cost will be the main road hauling cost plus the branch road hauling cost, and it must be determined for each species separately.

MACHINE RATE FOR LOGGING TRUCK - LAKE STATES REGION  
(Based on 2000 Hour Year and 3 Year Life)

Fixed Cost Per Hour:

License and Insurance:

Registration	\$55.00	
Public liability \$50,000/100,000 plus Property Damage \$25,000.	\$52.20	
Collision (\$50 Deductible)	\$40.00	
Fire and Theft	32.00	
	<u>\$179.20</u>	
\$179.20	2000 hours	\$0.09

Depreciation

Original cost	\$3000.00	
Less tires	400.00	
	<u>\$2600.00</u>	
Less wrecking value	200.00	
	<u>\$2400.00</u>	
\$2400.00	6000 hours	\$0.40

Labor (Michigan Data)

Driver's wages	\$1.25
Social security, workmen's compensation, etc. at 20%	<u>\$0.25</u>

Total fixed cost per hour-----\$1.99

Operating Cost per Hour:

Oil @ \$0.30 per qt. -10 qts. every 50 hours	\$0.06
Repairs - average of \$500.00 per year	0.25
Greasing and general maintenance	0.05
Fuel (average)	0.50
Tires - \$400.00 - 1,000 hours	<u>0.40</u>

Total operating cost per hour-----\$1.26

Hauling Cost Per Hour-----\$3.25

Average load:

Hemlock----- 2.5 M. ft. B.M.

Other Species----- 2.0 M. ft. B.M.

$$\begin{aligned} \text{Hauling cost for hemlock} &= \frac{2 \times 3.25 \times 8.5}{20 \times 2.5} + \frac{2 \times 3.25 \times 1.5}{12 \times 2.5} \\ &= \$1.105 + \$0.325 = \$1.430 \text{ per M ft. BM} \end{aligned}$$

$$\begin{aligned} \text{Hauling cost for other species} &= \frac{2 \times 3.25 \times 8.5}{20 \times 2.0} + \frac{2 \times 3.25 \times 1.5}{12 \times 2.0} \\ &= \$1.381 + \$0.406 = \$1.787 \text{ per M ft. BM} \end{aligned}$$

Loading and Unloading Delay (gross scale)

When the trucks are being loaded and unloaded, the total fixed cost per hour will be in effect. This is \$1.99 per hour.

The estimated loading rate is 15 minutes or 0.25 hours per M. ft. B.M. Unloading at the mill takes about 15 minutes or 0.25 hours per trip on the average.

The average load for hemlock is 2.5 M ft. B.M. and for other species 2.0 M. ft. B.M.

In view of this data the loading and unloading delay cost can be determined as follows:

For Hemlock:

$$\begin{aligned} \text{Loading delay} &= 0.25 \text{ hours} \times \$1.99 = \$0.498 \\ \text{Unloading delay} &= \frac{0.25 \times \$1.99}{2.5} = \underline{\underline{\$0.199}} \quad \underline{\underline{\$0.697}} \end{aligned}$$

For Other Species:

$$\begin{aligned} \text{Loading delay} &= 0.25 \times \$1.99 = \$0.498 \\ \text{Unloading delay} &= \frac{0.25 \times \$1.99}{2.0} = \underline{\underline{\$0.249}} \quad \underline{\underline{\$0.747}} \end{aligned}$$

Main Road Costs (Net scale)

The main logging road was constructed at a cost of \$10,000 per mile. The additional logging road is to be built to the same standard with similar costs prevailing. This will amount to an additional 3 miles, for a total of 10 miles since 7 miles was built previously. Since the logging operation is on a sustained yield basis, the road investment will not be amortized.

A yearly maintenance cost of \$200 per mile plus 6% on the capital cost of \$10,000 per mile are to be charged against the annual cut. The calculation based on the net cut is as follows:

$$\begin{aligned} \text{Main road cost} &= \frac{10 \text{ miles} \times (\$200 + 0.06 \times 10,000)}{14,212 \text{ M. ft. B.M.}} \\ &= \$0.563 \text{ per M. ft. B.M.} \end{aligned}$$

Overhead (net scale)

It is estimated that overhead and general supervision costs chargeable to the woods operations will amount to \$30,000 per year. The cost per M. ft. B.M. based on net scale is as follows:

$$\text{Overhead costs} = \frac{\$30,000}{14,212 \text{ M.}} = \$2.111 \text{ per M.ft.B.M.}$$

Total costs for First Cutting Cycle.

The costs involved during the first cutting cycle may be summarized as follows:

Costs calculated on gross scale:

	<u>Hemlock</u>	<u>Other Species</u>
Felling and bucking	\$3.300	\$4.400
Skidding	1.589	1.589
Branch roads	0.529	0.529
Loading	0.525	0.525
Hauling	1.430	1.787
Loading and unloading delay	0.697	0.747
Total of above costs	<u>\$8.070</u>	<u>\$9.577</u>

Since the net log scale at the mill will only be 80% of the gross log scale, any costs calculated on the gross scale must be increased in proportion when converted to the net scale basis. This is done by dividing by 0.80.

Above costs converted to net scale:	\$10.087	\$11.971
Costs calculated on net scale:		
Main road	0.563	0.563
Overhead	<u>2.111</u>	<u>2.111</u>
Total costs on net scale basis	\$12.761	\$14.645
Per M. ft. B.M.		

DERIVATION OF THE COSTS FOR THE SECOND AND SUBSEQUENT CUTTING CYCLES.

The cut during the first cutting cycle will remove most of the overmature and defective timber, so that an allowance for defect during the second and subsequent cutting cycles is not necessary. Consequently all the following costs as calculated for the first cycle on gross scale apply to the second and subsequent cycles: felling and bucking, skidding, loading, hauling, and loading and unloading delay. The main road costs and overhead costs will remain the same, since they are figured over the total cut required by the mill (net scale) which has been determined to be 14,212,000 ft. B.M.

The only cost which must be recalculated is the cost of the branch roads. The entire cost of the branch roads is charged against the first cutting cycle. At the time of the second and subsequent cuts, these branch roads must be put into condition at an estimated cost of \$200 per mile. The calculation of this maintenance cost is as follows:

Where: R is \$200 reconditioning cost per mile.  
 V is 5.86 M. ft. B.M., the volume of cut per acre during the second and subsequent cutting cycles.  
 S is the spacing of roads at 16.15 hundred feet carried over from the first cycle.

$$\begin{aligned} \text{Cost of branch road maintenance} &= \frac{R/12.1}{V \times S} \\ &= \frac{\$200/12.1}{5.86 \times 16.15} \\ &= \$0.175 \text{ per M.ft.B.M.} \end{aligned}$$

Total costs for the second and subsequent cutting cycles:

	<u>Hemlock</u>	<u>Other Species</u>
Felling and bucking	\$3.300	\$4.400
Skidding	1.589	1.589
Branch roads	0.175	0.175
Loading	0.525	0.525
Hauling	1.430	1.787
Loading and unloading delay	0.697	0.747
Main road	0.563	0.563
Overhead	2.111	2.111
Totals	\$10.390	\$11.897

DEFINITIONS AND FORMULAS USED IN APPRAISAL.

Appraisal of Stumpage.

The appraisal of stumpage is the act of estimating or determining the conversion return and deciding how to split it between the stumpage owner and the operator. In this case it is the determination of the split between the tribal profit fund and the fund to take care of the risk involved in operating the woods and mill operations.

Conversion Return, or Stumpage Recovery.

The conversion return or the stumpage recovery per unit is defined as the difference between the total sales value per unit and the total cost, or the amount of money left over per unit after meeting all costs. It is composed of two factors: the margin for profit and risk and the stumpage value per unit, and must be split between them. Conversion return may be expressed as follows:

$$\text{Conversion return} = \text{Sales} - \text{Cost}$$

Operating Ratio.

The operating ratio is the relationship of unit cost to unit sale value. It is the proportion of the income dollar that is absorbed by cost, and may be expressed as follows:

$$\text{Operating Ratio} = \frac{\text{Cost} + \text{Stumpage}}{\text{Sale value}}$$

Profit Ratio.

The profit ratio is the relationship of margin to the total cost. It is complementary to the operating ratio, and may be expressed as follows:

$$\text{Profit Ratio} = \frac{\text{Margin}}{\text{Cost} + \text{Stumpage}}$$



Valuation Factor.

The valuation factor is the percent stumpage is of the conversion return and is expressed as follows:

$$\text{Valuation factor} = \frac{\text{Stumpage}}{\text{Conversion Return}}$$

Since:             $\text{Operating ratio} = \frac{\text{Stumpage} + \text{Cost}}{\text{Sales value}}$

Then:             $\text{Stumpage} = (\text{Sales value} \times \text{Operating ratio}) - \text{Cost}$

And:             $\text{Conversion return} = (\text{Sales} - \text{Cost})$

By substituting:

$$\text{Valuation factor} = \frac{(\text{Sales value} \times \text{Operating ratio}) - \text{Cost}}{(\text{Sales value} - \text{Cost})}$$

$$= \frac{\frac{\text{Sales value} \times \text{Operating Ratio}}{\text{Sales value}} - \frac{\text{Cost}}{\text{Sales value}}}{\frac{\text{Sales value} - \text{Cost}}{\text{Sales value}}}$$

$$= \frac{\text{Operating ratio} - \frac{\text{Cost}}{\text{Sales value}}}{1 - \frac{\text{Cost}}{\text{Sales value}}}$$

Formula For Determining Capital Value of the Property after Cutting.

Matthews (1935) presents formulas for determining the present values of a terminable series of annual incomes and the present value of an infinite series of periodic payments. Both of these apply to this case where payments for a number of years are interrupted until the beginning of the next cutting cycle. A combined formula has been developed as follows:

$$C_0 = \frac{a (1.0p^n - 1)}{0.0p \times 1.0p^n} \times \frac{1}{(1.0p^t - 1)}$$

- Where:
- $C_0$  = Present capital value.
  - $a$  = Annual income
  - $p$  = Interest rate in percent
  - $n$  = Period of years payment is made (in one C.C.)
  - $t$  = Interval, ie length of C.C.

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