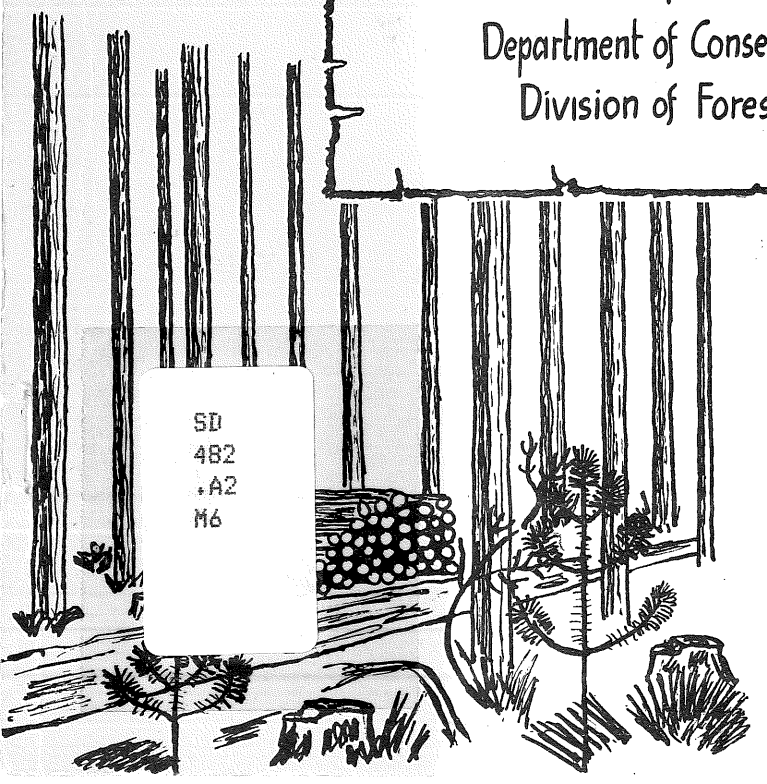
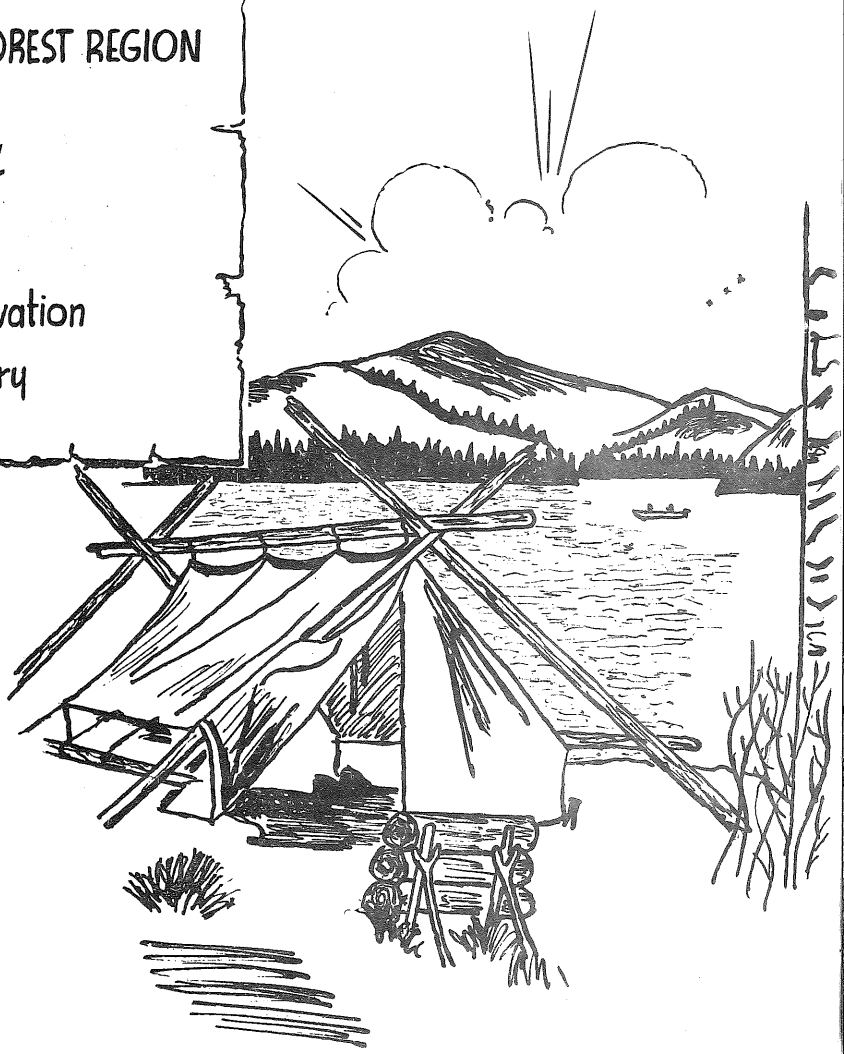
A Forest Inventory Report

FOR STATE LANDS in the FOREST REGION OF Minnesota

July 1955

Department of Conservation
Division of Forestry





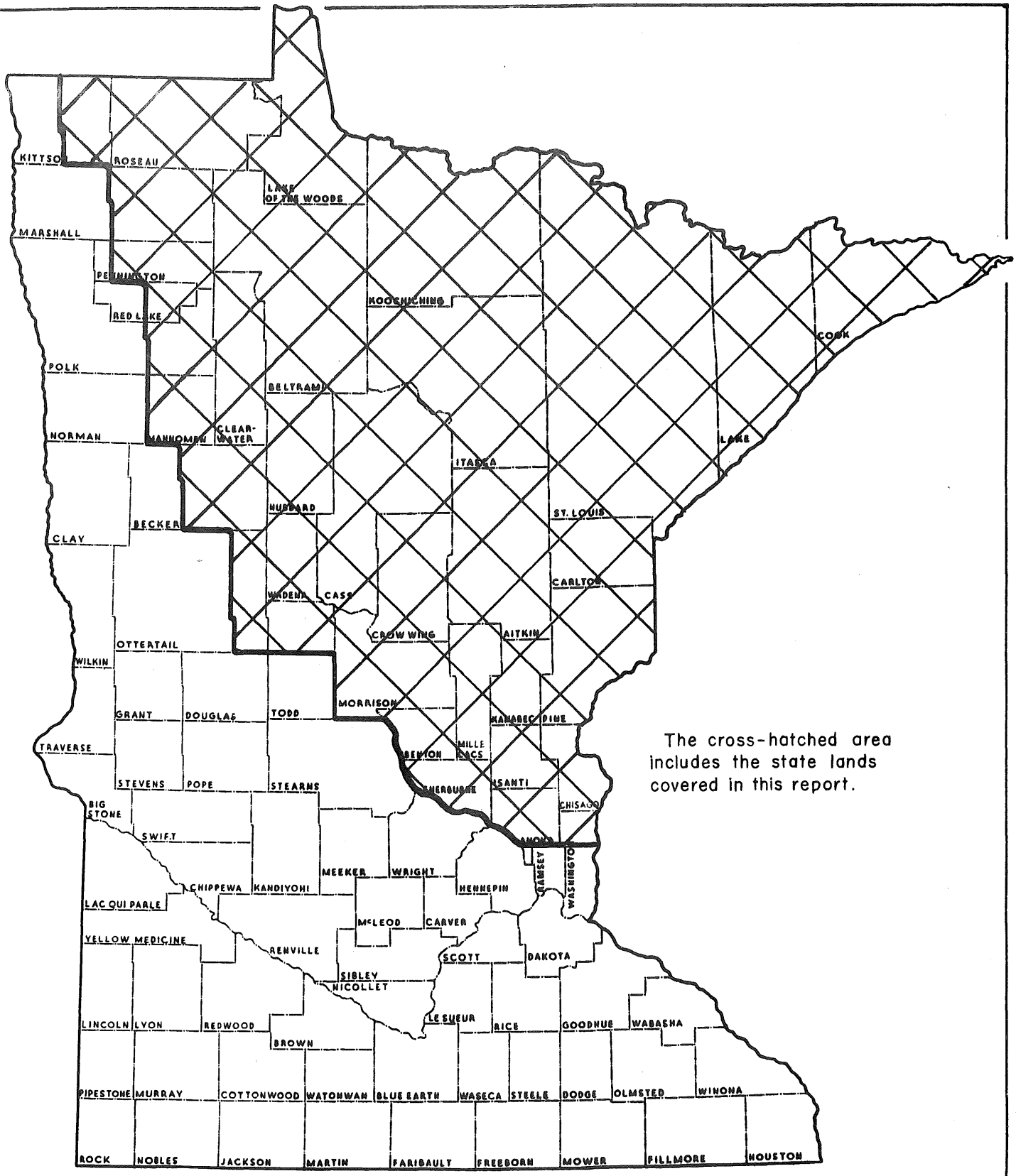
A FOREST INVENTORY REPORT FOR STATE LANDS IN THE FOREST REGION OF MINNESOTA

July 1, 1955

FOREST MANAGEMENT SECTION

DIVISION OF FORESTRY

MINNESOTA DEPARTMENT OF CONSERVATION



The cross-hatched area includes the state lands covered in this report.

STATE - WIDE FOREST INVENTORY

JULY 1955

DIVISION OF FORESTRY

DEPARTMENT OF CONSERVATION — STATE OF MINNESOTA

W-14 9-2-52

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INTRODUCTION

There are 4,750,484 acres of state land owned or administered by the Department of Conservation, in the forested area of Minnesota (See map). The Division of Forestry is responsible for management of the forests on this land. In order to accomplish this task, two types of inventory are being utilized.

Intensive management requires a stand by stand analysis of relatively small areas to establish cutting budgets and catalog individual stands by cover type, age vigor, site and cutting priority. The type of survey required to obtain all of this information is necessarily detailed and time-consuming. Some 2,400,000 acres of state land have been covered by this method in ten years.

There is also need for a survey which will give a complete picture of all of the timber holdings of the state at a given date. Such a survey was devised and put into effect in the fall of 1954. This survey, through use of aerial photographs, block sampling and IBM for computation was completed within six months.

The state-wide inventory supplies data on general timber condition, volume by species, type acreage and a recommended cutting budget for all state lands. Subsequent remeasurements of the permanent sample areas will give some excellent and long needed information on acreage and volume trends, mortality by cause, sustained yield and current forest development needs. The first remeasurement is planned for 1960.

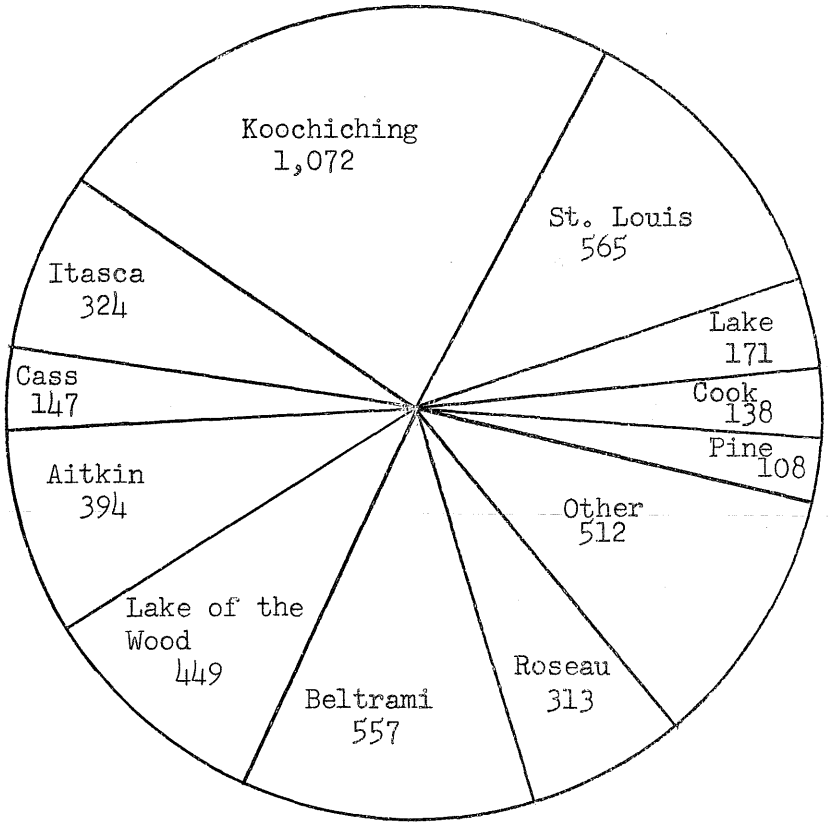
The text of this report will deal for the most part with round numbers to promote clarity.

STATE OWNERSHIP

The forest region boundaries as selected for this inventory encompass some 25,920,000 acres. State land administered by the Department of Conservation in this area amounts to 4,750,484 acres or 18.3% of the total. Eight classes of state ownership were recognized for survey purposes. A breakdown of acreage by class of state land is shown in Table 1.

Almost one-fourth of the state land in the region is in Koochiching County. Figure 1 illustrates the proportion of state ownership by county.

Figure 1 - State Ownership by County
Thousands of Acres



Basis: 4,750,000 Acres

LAND CLASSIFICATION

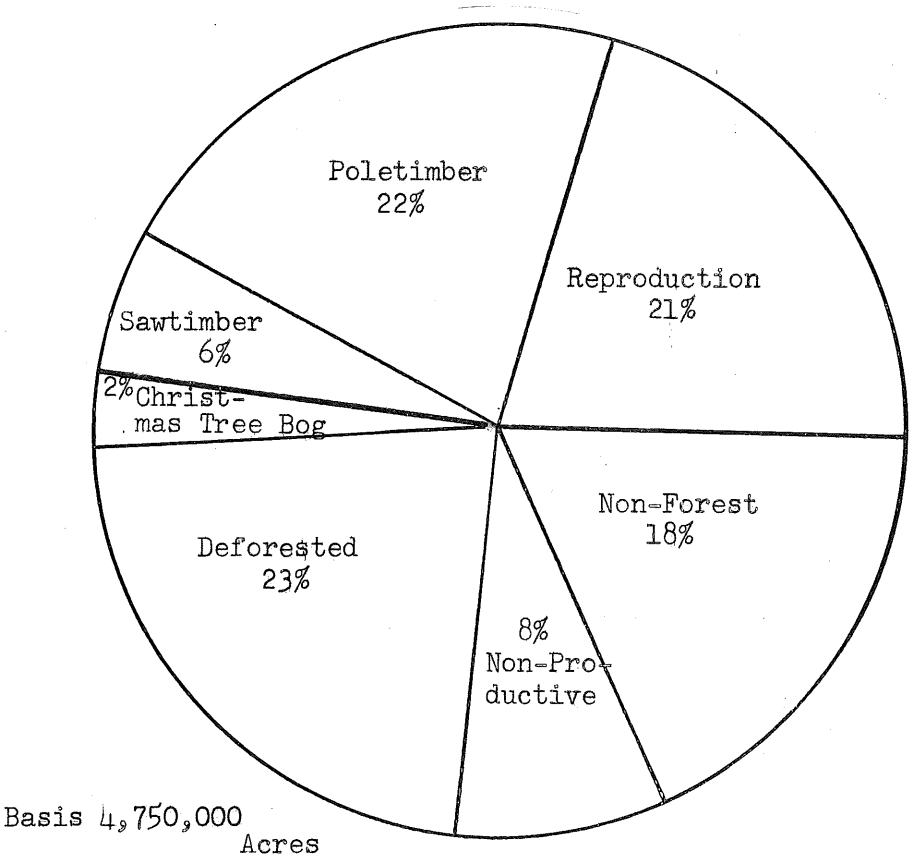
Each sample area on the state-wide inventory was classified as to land use. Four categories of land use were selected, namely:

Conservation - Land best adapted to the purpose of protecting, preserving and managing the forest, wildlife and water resources.
Agricultural - All accessible lands best suited to agricultural use.
Industrial - Lands in use for roads, railroads, cross-country power lines, gravel pits, etc.
Recreational - All lands in state parks, the Quetico-Superior no-cut area and all lake shore suitable for summer homesite platting.

Survey results (see Table 2) shows that 4,360,000 acres or 92% of the state land is most suitable for conservation purposes. Some 240,000 acres or 5% is agricultural, 90,000 acres or 3% is recreational and 60,000 acres or 2% is in industrial use. Approximately 67% of the state-owned lands are swamp.

Of the 4,750,000 acres of state land, 2,400,000 acres* or 51% is timber producing and 1,119,000 acres or 23% is deforested. A portion of the area classified as marsh and muskeg may eventually produce timber products through improved forest development techniques. Figure 2 shows the proportion of the various forest classifications. (See Table 3)

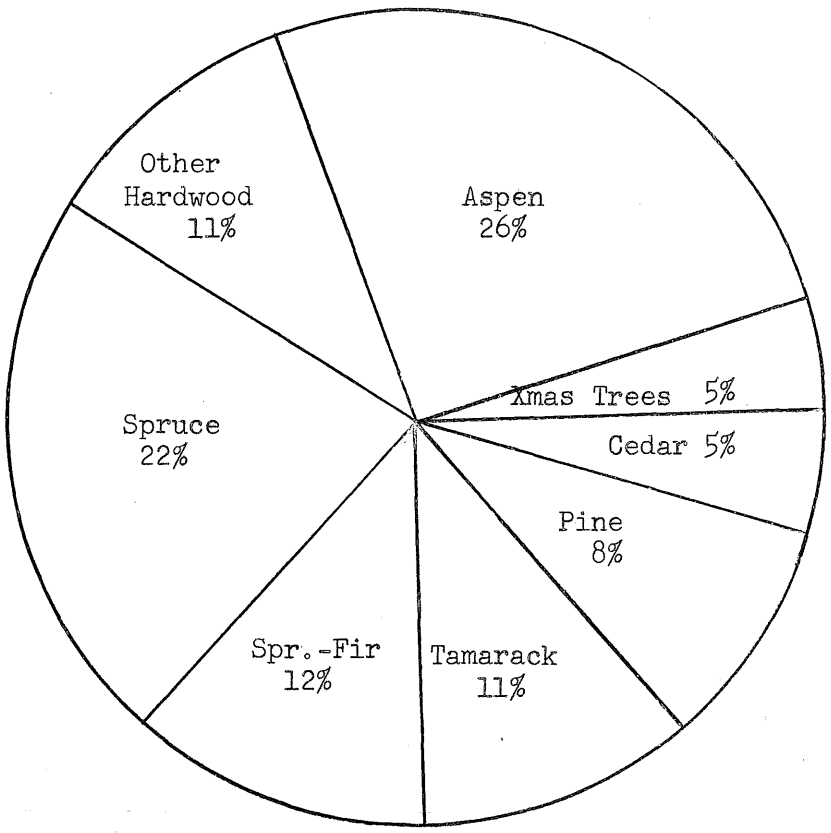
Figure 2 - Percentage of State Land in Various Classifications



* Includes 112,000 acres of Christmas tree bogs.

Of the 2,400,000 acres of timber producing land, 1,500,000 acres or 63% is in coniferous stands and 900,000 acres or 37% in hardwoods. Aspen and spruce cover types are the major timber types on state land. Table 4 gives a complete analysis of timber producing cover types by size class, age class, and site. Figure 3 shows the proportion of the various timber producing cover types.

Figure 3 - Percentage of Timber Producing Area by Cover Type



Basis: 2,400,000 Acres

Size class distribution (Table 4a) is generally good except in white and Norway pine types. However, a study of age class distribution (Table 4b) gives a better picture. It will be noted that there is a deficiency of acreage in the 0-20 year age class. This is possibly a reflection of better fire prevention and protection measures in the past 20 years. It points up the need for an expanded program of regeneration and planting.

A study of site distribution (Table 4c) shows a need for stand conversion of poor site hardwoods to more adaptable coniferous species. The answer to improvement of the poorer swamp sites may be found in a study of water levels and drainage.

Table 5 gives a breakdown of merchantable cover types by density class. More intensive management practices are definitely needed to increase the percentage of well-stocked stands.

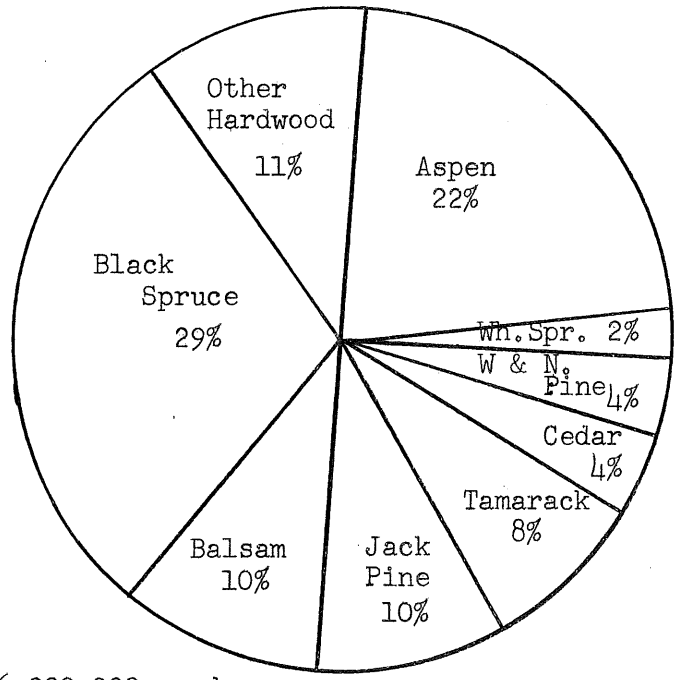
TOTAL TIMBER SUPPLY

There is an estimated merchantable volume on state lands of 12 million cords and 1,300 million board feet of all species in stands containing more than 3 cords or 1,300 board feet per acre. This volume includes all state lands classified as conservation and agricultural and all state lands in state parks. It does not include volume on lands classified as industrial or those recreational lands in the Quetico-Superior no-cut area and lakeshore suitable for summer home-sites. (See Appendix C for standards of measurement)

Black spruce, aspen, balsam fir and jack pine comprise almost 75% of the total volume in the following amounts:

Black Spruce	4,400,000 cords	
Aspen	2,500,000 cords	360 million board feet
Balsam Fir	1,500,000 cords	
Jack Pine	1,300,000 cords	130 million board feet

Figure 4 - Percentage of Volume by Species*



Basis: 16,000,000 cords

There are approximately 360 million board feet of white spruce and white and Norway pine and 270 million board feet of hardwoods other than aspen. Table 6 contains complete volume figures by species and product. Table 6 (b) gives total volume by operability. It was from this table that the recommended cut (Tables 8 & 9) was derived.

* Converted to cords on the basis of the following factors:

500 board feet - 1 cord	15 poles - 1 cord
150 posts - 1 cord	20 ties - 1 cord

RECOMMENDED CUT

Past annual drain by cutting on state lands, based on the years 1951 to 1955 inclusive, has averaged 192,000 cords and 28,000,000 board feet. While board foot drain has remained relatively stable since 1945 the average use of cordwood has increased from 135,000 to 200,000 cords annually as shown in Figure 5. (See Table 7)

The increase in use of cordwood is due to better utilization of aspen and balsam fir. Since 1945 the harvest of aspen for pulpwood has tripled and of balsam fir has doubled on state-owned lands.

Recommended annual cut on all state lands for the next ten years (1955-65) is 460,000 cords and 85,000,000 board feet of all species. This amounts to two and one-half times the past annual drain. The recommended cut in stands of good operability is 30% greater than past drain from cutting (Table 9a). Recommended annual cut is based on the estimator's recommendation of cutting priority for each stand. The recommended cut for each type was checked by a formula based on total type acreage and rotation age. Where the cut was excessively high it was modified wherever possible by an examination of stand vigor classes. Stands classed as "storage - good" and recommended for cut were thrown into the reserve category. Unfortunately the condition of most stands slated for cut was such that very little modification was possible.

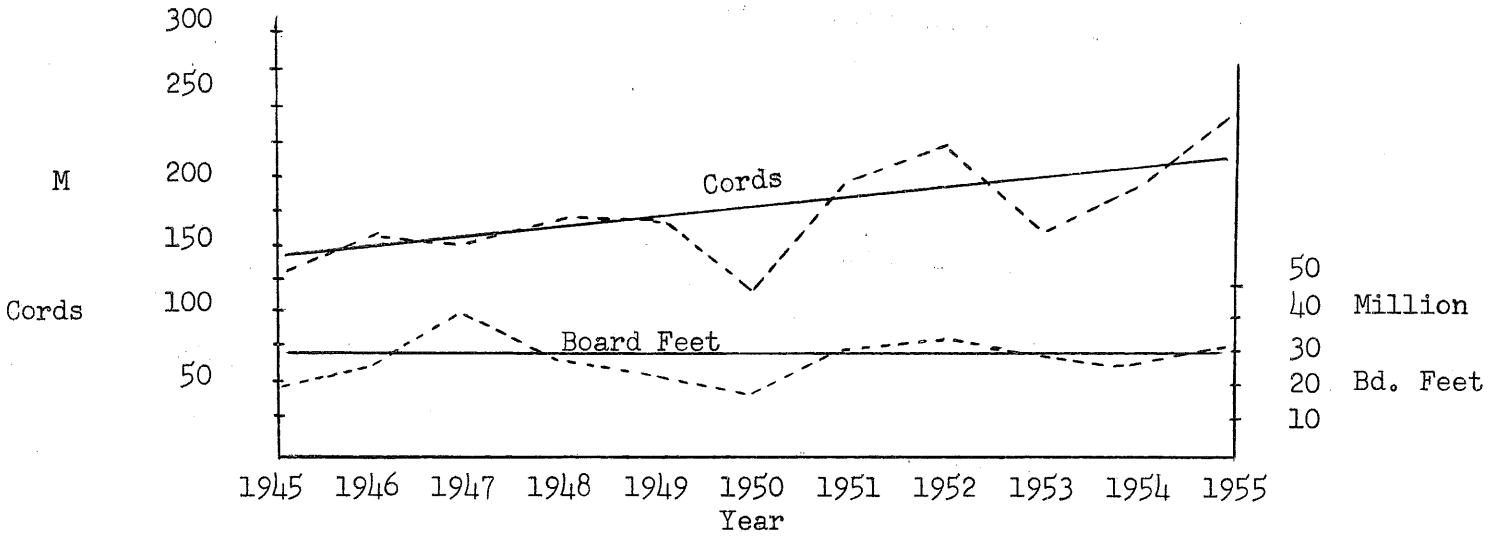
The recommended cut includes timber on lands classed as conservation, agriculture and in state parks. The cut recommended in state parks is very small and includes only salvage for the most part. Timber in the Quetico-Superior no-cut area and along lakeshore suitable for homesite development was reserved intact. The cut recommended on Division of Game and Fish lands is compatible with sound game management practices.

The rotation ages selected for general application are based on many factors including site, general stand vigor at various stand ages, reproductive habits, incidence of insect and disease where they occur in older stands, etc. An example is the spruce-fir type where an analysis of site alone indicates a rotation age of 60 years. However, incidence of butt rot and an impending epidemic of the spruce budworm dictate cutting of these stands at a lesser age. A rotation of 50 years was deemed most satisfactory for good management.

Reference to Tables 4 (b) and 10 will give a clear picture of the need for an initial cutting budget which is greater than the anticipated sustained yield. Table 4 (b) is self-explanatory. Table 10 is an analysis of field cutting recommendations. The acreages in the cut 0-10 columns represent the harvest or deteriorating stands. Acreages in the cut 10-20 column represent storage or non-growing stands and in the reserve column growing stands. These classifications are based on the best judgment of the foresters who participated in the field work for this survey.

At this time, drain from other causes such as insects, disease, blowdown, fire, etc., is not obtainable. At the next remeasurement these data

Figure 5 - Annual Drain by Cutting
1945 - 1955



will be included in the inventory report.

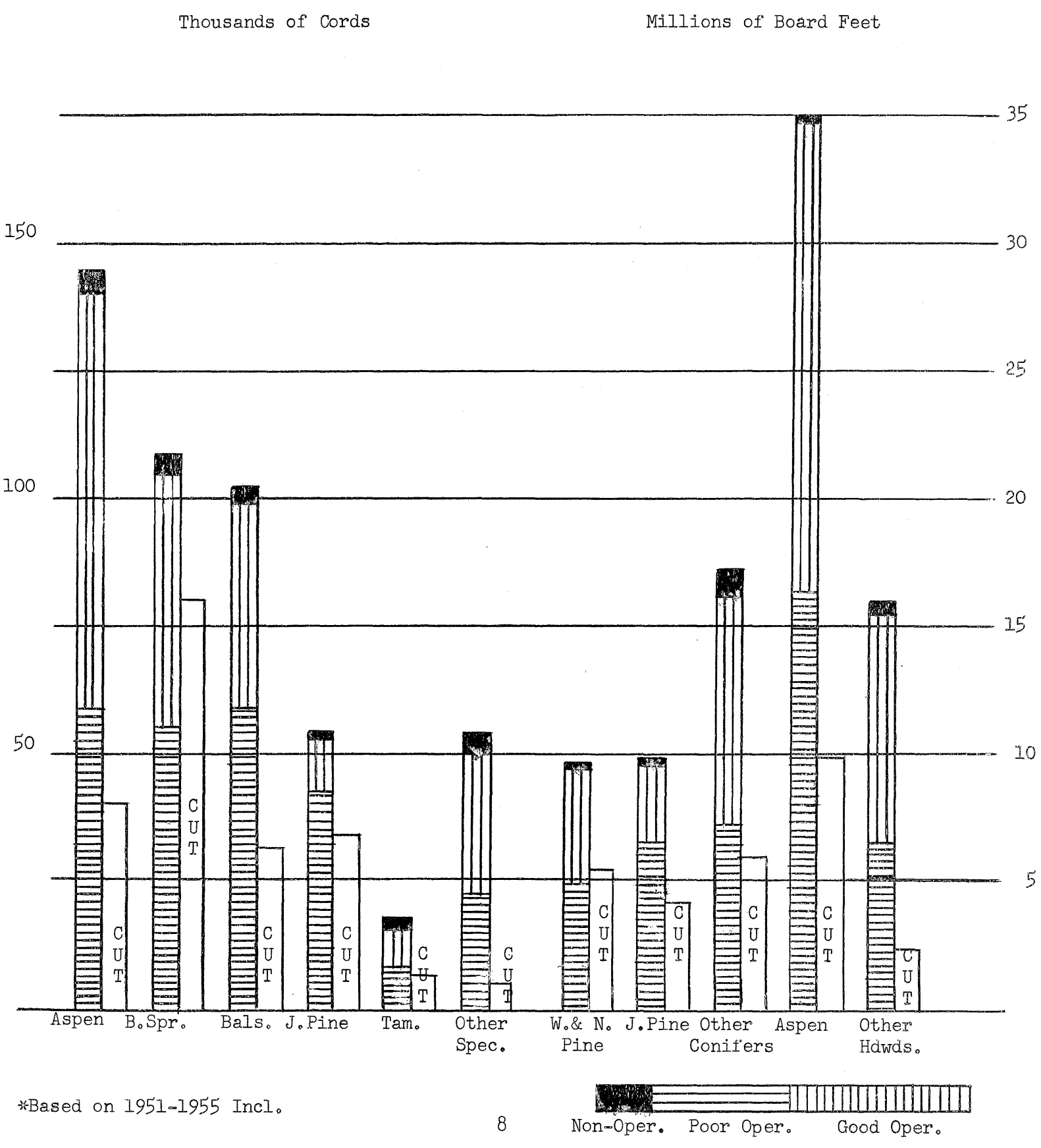
The volume in write-off stands gives some indication of loss to the state. The estimated volume in such stands is one million cords which would amount to some 100,000 cords of annual loss.

Figure 6 illustrates a comparison of annual drain by cutting based on the past ten years and recommended annual cut for the next ten years.

Figure 6 - Comparison of Past Annual

Drain by Cutting and Recommended Annual Cut

For the Years 1955 - 1965



*Based on 1951-1955 Incl.

FOREST DEVELOPMENT

The major forest development problem in Minnesota is reforestation. Deforested state lands amount to over one million acres of which some 420,000 acres can be economically reforested using techniques and equipment now available. (See Table 11). Reforestation may be accomplished as follows:

	Acres
Machine Planting	133,000
Hand Planting	197,000
Natural regeneration through use of herbicides, discing, burning, etc.	90,000
Total	420,000

Planting of the 330,000 acres will require 500 million trees. Of this amount at least 300 million trees should be transplant stock of swamp species for planting of swamp-lands. Development of a machine for swamp planting should be a vital part of the reforestation program. Such a machine would make it economically possible to plant a much larger portion of the total deforested area.

Approximately 225,000 acres of timber producing lands are presently supporting stands of aspen, paper birch and mixed upland hardwoods of poor stocking on poor site. This area is in need of stand conversion to more suitable species for the site. Much of this conversion might be accomplished through machine planting with a heavy bulldozer and planting machine guards.

Selective herbicides are becoming an established tool in forest development work. The use of herbicides on state lands for reforestion, plantation release, stand conversion and elimination of undesirable hardwoods from coniferous stands may increase tremendously in the next few years. Inventory figures recommend aerial spraying of some 250,000 acres of state land. This is a conservative estimate of the ultimate needs if the program proves successful.

Natural regeneration is the cheapest method of growing trees. Much progress has been made in regeneration of jack pine through discing before cutting and scattering cone bearing slash on the area. Direct seeding of disced areas has also been quite successful in some instances. The use of herbicides on low vegetation following seedling establishment shows good possibilities. Development of coated seed with rodent repellants such as tetramine shows promise. More work in this field will reduce need of expensive planting programs.

The whole forest development problem requires careful consideration of all land uses. It is not the forester's aim to plant every opening in the woods nor to reforest all of the deforested land in Minnesota. Much of the deforested land and many of the openings are needed for propagation and perpetuation of the many species of wildlife in the state. This subject is taken up at greater length in the following section of this report.

Table 12 (Understory Summary) gives an interesting analysis of the understory of merchantable stands. Understory in this instance is defined as "the cover remaining if the main stand were clearcut." Approximately 50% of the merchantable stands are presently understoried with timber producing types. The other 50% contain an understory of brush or low vegetation.

Almost 25% of the merchantable stands are understoried with timber producing types differing from the main stand cover type. Spruce-fir makes up one-half and cedar almost one-fourth of this conversion understory. Where conversion is not desirable this problem must be taken into consideration at the time of logging. Problems of conversion are dealt with at more length under the Section "Management by Cover Type".

Brush presents a real problem to regeneration of timber types. This analysis shows the extent of the problem. Major types are understoried with brush in the following proportions:

Jack Pine	33%
Spruce	19%
Tamarack	47%
Spruce-fir	19%
Aspen	48%

INTEGRATED LAND MANAGEMENT

Wild land management involves many considerations other than the trees or game populations. It involves diligent attention to the myriad of complex relationships which make the balance of nature.

Aerial spraying to eliminate certain insect pests or to kill undesirable plant species can have a profound effect on the entire animal and plant communities in the affected area. Spraying of DDT for mosquito control in villages has resulted in evacuation of the bird populations for as long as two years after spraying. Spraying of herbicides on brush areas may cause profound ecological changes.

Spraying projects should always be studied in their relationship to factors other than the immediate goal. Answers to related problems will be found as the program of spraying increases.

Animal populations are drastically affected by changing conditions in the forest. The harvest of Minnesota's timber at the turn of the century resulted in the disappearance of almost all of the original moose herd and extension of the deer range. Subsequent fires brought about conditions favorable to sharp-tailed grouse in areas that had not previously supported this species.

The Division of Forestry's land management policy is to integrate management of all natural resources on state land. All of the recent management plans for the various management units take game, recreation and watershed problems into consideration. Cuttings in important game areas are adapted insofar as practicable to favor proven game management practices. Whenever the primary use is recreation the timber is left untouched or is given an occasional light partial cut to maintain aesthetic values. In most other areas the very nature of state cutting practices produces small openings, creates edges and leaves patches or solid edges of cover which are ideal game management practices. These cutting practices encourage the establishment of available game foods.

There is a large acreage of state land in the northwestern portion of the forest region which has been deforested by recurrent fires. This area supports the major portion of the sharp-tailed grouse population in Minnesota. Rather than attempting to expensively reforest all of this area a portion of it should be managed for sharp-tails. A program of herbicide spraying, discing and planting for food would increase the potential for sharp-tailed grouse many fold.

Many of the old fields in the state have been solidly planted to tree species. A policy of leaving a one chain open strip around the entire plantation would favor game in creating additional edges and would serve to protect the plantation to some extent from winter rabbit damage. On large fields or openings a pattern of planting in blocks with open strips round the entire edge and between blocks will be adopted.

Drainage, especially in swamp areas, is frequently a major problem. Beaver dams can cause tremendous damage to timber producing swamps. Improper drainage from clogged waterways is another detrimental factor in many swamps. On the other hand, the ditching program has caused a lot of damage through drying up some of the productive swamp areas. Lakes like Kettle and Rice Portage in Carlton County and Little Rice and Mud in Aitkin County were drained by ditches. These should be restored as was Thief Lake in Marshall County to provide habitat for aquatic wildlife. There are some large non-forest swamp areas in the forest region that should be flooded for the same purpose. Beaver ponds in areas of this type are beneficial. The possibilities in management of our water resources are extensive. The relation of water resources to the forests of Minnesota is inseparable.

MANAGEMENT BY COVER TYPE

SPRUCE - The spruce type is the most important and contains more volume than any other timber type on state land. It includes some 521,000 acres of which 305,000 acres is in the merchantable size classes. The total volume of all species in the spruce type is 4,254,000 cords apportioned as follows:

Black Spruce	3,822,000 cords	90%
Tamarack	215,000 cords	5%
Other Species	217,000 cords	5%

Average volume per acre in merchantable stands is 14.0 cords. Almost 60% of the type is in Koochiching County.

The recommended cut for the period 1955-65 is 88,400 cords annually of which 80,400 cords is black spruce, 4,800 cords tamarack and the balance of other species. This cut can probably be sustained for 30 to 40 years. Examination of Table 4 (b) shows a poor balance of age classes. In order to attain a balance some 52,000 acres must be clearcut and regenerated in each 10 year period on a 100 year rotation. On the present acreage this would sustain an annual cut of some 80,000 cords of all species. The harvest range for this type is 80 to 150 years depending on site.

Thrifty well-stocked stands will be commercially thinned to prevent loss through mortality and to promote growth. In general thinnings will be confined to suppressed, poorly-crowned and defective trees. Thinnings must be light enough to avoid loss from excessive blowdown. In heavily stocked stands of poor site it may be advisable to thin from above in order to produce more merchantable trees per acre over the life of the stand and to avoid over thinning.

Mature stands of spruce should be harvested according to the best silvicultural methods of obtaining natural reproduction. On deep peat sites this may include progressive rim cuts plus thinning of suppressed and defective trees in that portion of the stand slated for the succeeding rim cut. Another method includes rim cuts plus the removal of small patches or narrow strips from the remainder of the stand.

On shallow peat or upland sites where the danger of blowdown is very high, stands should be clearcut or reserved in large blocks (if presently wind firm).

In some areas mistletoe infection is widespread. As planned cutting progresses all trees including culls and reproduction should be cut down in a one chain strip extending outward from observed broomed trees.

About 19% of the spruce acreage is understoried with a medium to heavy stocking of brush. It may be necessary to aerial spray such areas with herbicides in the growing season following cutting. Since this brush condition exists on the better sites, some measures must be taken toward re-establishment of the stand. Some 15% of the spruce acreage has a cedar understory. This condition is undesirable since this cedar is

generally on poor site or off-site for the species and by its location would be of little value as browse. To prevent conversion, research with herbicides or controlled burning is recommended.

The distribution of merchantable spruce stands by density class is:

Poor (3-7 Cords/A)	77,000 acres	25%
Medium (7-13 Cords/A)	115,000 acres	38%
Good (13-20 Cords/A)	68,000 acres	22%
Very Good (20+ Cords/A)	45,000 acres	15%
Total	305,000 acres	

The distribution of spruce acreage by site class is:

Very Poor	19,000 acres	4%
Poor	144,000 acres	27%
Medium	266,000 acres	51%
Good	92,000 acres	18%
Total	521,000 acres	

ASPEN - The aspen type contains the largest acreage of all timber producing types on state land and is second only to the spruce type in total volume. It includes 621,000 acres of which 374,000 acres is in merchantable size classes. The total volume of all species in the aspen type is 3,625,000 cords. Composition by major species is as follows:

Aspen	2,826,000 cords	78%
Balsam Fir	217,000 cords	6%
Other Conifers	236,000 cords	7%
Other Hardwoods	346,000 cords	9%

The average volume per acre in merchantable stands is 9.7 cords. The aspen type is well represented throughout the forest region.

The recommended annual cut for the period 1955-1965 is 168,500 cords and 38,000,000 board feet. The cut by species is as follows:

Aspen	127,900 cords	32,070,000 board feet
Spruce-Balsam	20,800 cords	1,130,000 board feet
Other Conifers	4,200 cords	2,250,000 board feet
Other Hardwoods	15,600 cords	2,550,000 board feet

The recommended rotation age for the aspen type is 50 years with a harvest range, depending on site, of 40 to 65 years. The recommended cut cannot be sustained at the initial level. An analysis of Table 4 (b) indicates an improper balance of age classes. Table 10 shows the poor condition of the merchantable aspen stands on state lands. Of the 374,000 acres in merchantable stands, 45,000 acres or 12% are in the write-off category and 200,000 acres or 54% are in a harvest or deteriorating condition. There are 89,000 acres or 23% in the storage class and only 40,000 acres or 11% in the growing class. This indicates that two-thirds of the merchantable aspen must be liquidated or written off as inoperable within the next ten years. These estimates represent the careful judgment of the foresters engaged in the field work. This could be rectified through one rotation and a sustained cut of 125,000 cords is possible at the present average level of stocking.

Aspen should be clearcut. Cutting during the summer months should be avoided if reproduction by suckering is desired. Aspen on the best sites may be commercially thinned to promote better sawtimber for the final cut, but this is not recommended as a general practice at this time except in areas tributary to industry dependent upon aspen bolts or sawlogs.

It is a general belief that aspen needs no encouragement to maintain its present abundance. This is generally untrue since many of our aspen stands are reverting to brush and other more tolerant species. At present 48% of the aspen acreage is understoried with brush, 24% with spruce-fir and 8% with other hardwoods. If good aspen sites which will produce sound bolts and sawtimber are to be maintained in aspen, techniques such as discing, selective herbicide spraying and the like must be employed.

Distribution of merchantable aspen stands by density class is as follows:

Poor (3-7 Cords/A)	143,000 acres	38%
Medium (7-13 Cords/A)	166,000 acres	45%
Good (13-20 Cords/A)	56,000 acres	15%
Very Good (20+ Cords/A)	9,000 acres	2%
	374,000 acres	

Distribution of total aspen acreage by site class is as follows:

Very Poor	18,000 acres	3%
Poor	160,000 acres	26%
Medium	293,000 acres	47%
Good	150,000 acres	24%
	621,000 acres	

Aspen is subject to attack by many types of insects. The only attacks of any consequence, however, are the periodic defoliations by the forest tent caterpillar (Malacosoma disstria). While this defoliation is seldom fatal it has been proven that it definitely retards growth during the period of defoliation. The most serious disease of aspen is hypoxylon canker. Research on this disease has found no correlation with site. It is hoped that continuing research will provide control measures which may be employed in aspen management.

SPRUCE-FIR - The spruce-fir type is third in both acreage and volume on state lands. It contains 229,000 acres of which 165,000 acres is in merchantable size classes. Total volume of all species is 1,988,000 cords. Composition by major species is as follows:

Balsam fir	1,031,000 cords	52%
Black spruce	184,000 cords	9%
White spruce	152,000 cords	8%
Other conifers	206,000 cords	10%
Aspen	164,000 cords	8%
Other hardwoods	251,000 cords	13%

Average volume per acre in merchantable stands is 12.0 cords. The spruce-fir type is most common on state lands in the north central and northeastern portions of Minnesota.

The recommended annual cut for the period 1955-1965 is 137,000 cords and 11,000,000 board feet of all species. The cut for the major species is:

Balsam fir	75,500 cords	
Spruce	16,800 cords	2,900,000 board feet
Aspen	8,600 cords	1,660,000 board feet

The rotation age for the spruce-fir type is 50 years (100 years on long-lived species such as white spruce, white and Norway pine, etc.). The harvest range is 40 to 60 years (90-130 years on long-lived species). The recommended cut for the spruce-fir type cannot possibly be sustained. At present levels of stocking the sustained yield cut would amount to some 55,000 cords annually of all species. There is presently too much acreage of this type in the older age classes (Table 4 b). Table 10 gives a picture of the spruce-fir type which is very discouraging towards attaining sustained yield in the near future. Over 53% or 88,000 acres of the merchantable area is in the harvest or deteriorating classification. An additional 14,000 acres or 9% is in need of a partial cut to prevent undue loss. More than 13% or 22,000 acres is in the write-off category. This analysis indicates that almost three-fourths of the present merchantable spruce-fir type must be liquidated within ten years. This is the only realistic approach since an attempt to hold these stands for a better balanced cutting budget will result in losses incommensurate with any advantage to be gained.

Conversion of other types, mainly aspen, to spruce-fir will result in an eventual sustained yield cut of more than 80,000 cords annually of all species.

At present the best information indicates a clearcut of balsam fir, black spruce and aspen and a selective-cut of white spruce, white pine, and Norway pine in spruce-fir mixtures. Experiments in pure stands of balsam fir may produce answers on the advisability of selectively cutting such stands. A stick-limit cutting is acceptable in uneven-aged balsam fir stands but should not be used in even-aged stands.

The spruce-fir type, represented primarily by balsam fir, occurs as an understory on 153,000 acres presently classed as cover types other than spruce-fir (see table 12). Only 14,000 acres of the spruce-fir type is understoried by other timber types and 31,000 acres by medium to heavy brush cover. This would seem to indicate that the spruce-fir type will increase by some 110,000 acres over the next 25 years. Conversion of aspen stands to spruce-fir is a possibility on 90,000 acres. This could be regulated to some extent by method of cutting or, in case of aspen suckering, by season of cut. Conversion of pine to spruce-fir is likely on some 30,000 acres unless measures are taken to retain the better pine areas. The brush understory occurs mainly

in poorly-stocked and patchy spruce-fir stands. Discing, herbicides or other measures may be necessary to regenerate these areas at the time of harvest.

Distribution of merchantable spruce-fir stands by density class is as follows:

Poor (3-7 Cords/A)	49,000 acres	30%
Medium (7-13 Cords/A)	76,000 acres	46%
Good (13-20 Cords/A)	32,000 acres	19%
Very Good(20+ Cords/A)	8,000 acres	5%
Total	165,000 acres	

Distribution of total spruce-fir acreage by site class is as follows:

Very poor	2,000 acres	1%
Poor	37,000 acres	12%
Medium	156,000 acres	52%
Good	104,000 acres	35%
Total	299,000 acres	

The spruce-fir type is presently menaced by the spruce budworm which appears to be building up to the epidemic stage. The best measures of protection, other than aerial spraying, are lowering of the rotation age, selective cutting of all balsam fir which produces large quantities of staminate flowers and clearcutting overmature stands especially in proximity to large areas of younger stands. Butt rot in balsam fir is primarily found in overmature trees. Lowering of the rotation age will also alleviate the incidence of rot. No other insects or diseases are presently important in spruce-fir management.

JACK PINE - The jack pine type is most prevalent on state lands in the northeastern and northwestern counties of the forest region. There are 139,000 acres of which 105,000 acres are in merchantable size classes. Total volume of all species is 1,523,000 cords of which 1,342,000 cords is jack pine. Average volume per acre in merchantable stands is 14.5 cords.

The recommended annual cut for the period 1955-1965 is 68,000 cords of which 61,000 cords is jack pine. The rotation age for the jack pine type is 65 years and the harvest range 50-80 years. The recommended cut is more than twice as great as the cut that can be sustained on the present type acreage. If this cut is removed in the ten year period it will bring age classes into a better balance and the type can then be managed on a sustained yield basis.

Young well-stocked stands of jack pine should be selectively cut to remove trees of poor vigor and poor form and to provide growing space for crop trees. In some stands, it may be commercially possible to make two or more selection cuts. Mature stands should be disced prior to cutting or clearcut during the summer or early fall to provide for soil scarification. Slash should be lopped and scattered. Under certain conditions

of terrain or in the event of poor seed crops it may be advisable to plant or seed the area following clearcutting. The better sites should be managed for sawlog, pole and piling production.

Jack Pine has many enemies. The seedlings are a favorite browse for deer and rabbits in most localities. Various species of sawfly may reach epidemic proportions on some plantations or reproduction areas. Over-mature trees are susceptible to heart rot and ants. At present an epidemic of the jack pine budworm is building up. Removal of trees which bear large amounts of staminate flowers is the best control measure where such measures are feasible. Aerial spraying may be employed in high value areas. Reduction of the rotation age is of questionable value since jack pine bears flowers and cones at a very young age.

The distribution of merchantable jack pine stands by density class is as follows:

Poor (3-7 Cords/A)	18,000 acres	17%
Medium (7-13 Cords/A)	39,000 acres	37%
Good (13-20 Cords/A)	38,000 acres	36%
Very Good (20+ Cords/A)	10,000 acres	10%
	105,000 acres	

Distribution of total jack pine acreage by site class is as follows:

Very Poor	2,000 acres	1½%
Poor	16,000 acres	11½%
Medium	67,000 acres	48 %
Good	54,000 acres	39 %
	139,000 acres	

The understory problem with jack pine is most acute on good sites. Some 35,000 acres or 33% of the merchantable acreage is understoried with brush. An additional 19,000 acres is understoried with the spruce-fir type. Discing, herbicides or controlled burning will be necessary on much of this acreage to maintain the present jack pine type.

WHITE AND NORWAY PINE - The white and Norway pine types are grouped in this report for statistical reasons. Furthermore, management of these types does not differ appreciably. There are 50,000 acres of white and Norway pine stands of which 39,000 acres is in merchantable size classes. Total volume of all species is 171,000 cords and 256 million board feet. Composition by major species is as follows:

White and Norway Pine	52,000 cords	214,000,000 bd. ft.
Jack Pine	12,000 cords	18,000,000 bd. ft.
Aspen	30,000 cords	7,000,000 bd. ft.
Spruce	31,000 cords	10,000,000 bd. ft.
Other	46,000 cords	7,000,000 bd. ft.

Average volume per acre in merchantable stands is 4.4 cords and 6,500 board feet. White and Norway pine stands are most common on state lands in the northern portions of Hubbard, Cass, Itasca and St. Louis counties.

The recommended annual cut for the period 1955-1965 is 7,600 cords and 9,280,000 board feet of all species. The cut by species is as follows:

White & Norway Pine	500 cords	6,520,000 board feet
Jack Pine	1,100 cords	1,380,000 board feet
Aspen	2,400 cords	510,000 board feet
Spruce	600 cords	260,000 board feet
Other	3,000 cords	610,000 board feet

The rotation age for white and Norway pine is 120 years with a harvest range of 100-180 years. The proposed annual cut for the next ten years is far in excess of the cut that can be sustained. Under careful management these types should eventually sustain a cut of 4 to 5 million board feet per year. The proposed cut is high because of the advanced age and deterioration of many of the old age stands. Second growth stands are generally in excellent condition but some of these stands have reached an age where selection cuts or the first shelterwood cut should be made.

Both white and Norway pine stands should be managed under a modified shelterwood method. Well stocked pole-sized stands should be commercially thinned for posts and pulpwood to optimum stocking levels at periodic intervals. Sawtimber stands should be selectively cut whenever necessary to remove poor vigor trees. At an age of 100 to 120 years of age a summer shelterwood cutting of 25 to 30 percent of the total volume should be made. If reproduction is not established at a stand age of 120 to 150 years a second cut removing up to 65 to 70 percent of the original volume should be made during or immediately following a good seed year. If logging is to be done in the winter the area should be scarified during the preceding autumn. The final cut is made following establishment of advance reproduction. Most stands of white and Norway pine may be held to an age of 150 to 180 years. On good sites the rate of growth in older stands may warrant holding the residual stand for especially large timber. Where conditions are favorable Norway pine stands should be managed for the production of piling as well as sawtimber.

Norway pine should be planted wherever possible at a spacing not greater than 4 x 4 feet. Subsequent thinnings for Christmas trees will produce a sizeable net income after deducting costs of planting. White pine should be interspersed with other species on desirable sites up to ten percent of the total planting stock. Pure white pine plantations have not been very successful in the past due to blister rust, white pine weevil and deer browsing.

Norway pine is one of the most insect - and disease - resistant trees in Minnesota. Potential enemies of plantations and natural reproduction are the red-headed sawfly and saratoga spittle bug. They have not been of much importance in Minnesota to date, but there is evidence of a build up of saratoga spittlebug in some areas.

White pine is subject to many diseases and insects. Blister rust is the major problem and precludes planting of pure white pine stands

in most of the state. There is evidence, however, that some trees are resistant to the disease so planting of white pine in mixture with other species is present state policy. There are a number of insects which feed on white pine reproduction. Most of these are endemic at the present time, but the introduced pine sawfly (Diprion Simile) is approaching epidemic proportions in the east central part of Minnesota. Deer browse on white pine reproduction is a serious problem over most of the state. The policy of mixed planting of white pine helps to alleviate browse damage. Heart rot is fairly common in overmature stands of white pine.

Distribution of merchantable white and Norway pine stands by density class is as follows:

Poor(3-7 Cords/A)	17,000 acres	44%
Medium (7-13 Cords/A)	9,000 acres	23%
Good (13-20 Cords/A)	11,000 acres	28%
Very Good (20+ Cords/A)	2,000 acres	5%
	39,000 acres	

The distribution of total white and Norway pine acreage by site class is as follows:

Very Poor	-	
Poor	-	
Medium	34,000 acres	68%
Good	16,000 acres	32%
	50,000 acres	

About one-third of the present merchantable acreage of white and Norway pine stands is understoried with balsam fir in varying degrees of stocking. This understory must be removed when the harvest cuts are being made to prevent stand conversion. About 20 percent of the stands are understoried with brush. This area must be treated by discing prior to cutting or by herbicides before or after cutting to eliminate the brush competition to seedlings.

TAMARACK - The tamarack type is important on state lands because of its extent. The only good market at the present time is for mining timbers, ties, poles and piling. The tamarack type contains 256,000 acres of which 128,000 acres or 50% is in merchantable size classes. Total volume of all species is 1,050,000 cords and 30 million board feet of which 840,000 cords and 23 million board feet is tamarack and 181,000 cords is black spruce. The average volume per acre in merchantable stands is 8.7 cords.

The recommended annual cut for the type is 19,000 cords and 2 million board feet of which 1,670,000 board feet is tamarack and 4,900 cords is black spruce. This cut can be sustained over the rotation. The rotation age for the tamarack type is 110 years with a harvest range of 90-160 years. Stands on good sites should be held to maximum sizes.

Not very much is known about the silviculture of the tamarack type. There are experimental cuttings being made at present in Aitkin, Carlton and Koochiching counties to determine the feasibility of strip cutting for regeneration. Preliminary observations indicate that it may be successful where heavy brush is not a factor. Using the techniques of black spruce silviculture including rim, patch and strip cuts is probably a sound measure in the tamarack type. Clear cutting seems to be satisfactory in some areas when sufficient seed is present. Selective cutting is almost out of the question except in stands of high value products.

The marketing problems in the tamarack type will undoubtedly be resolved as more and more pulpwood volume becomes available. Tamarack produces a fiber of high tearing resistance which is satisfactory for the production of Kraft paper, by the sulfate process. Considerable quantities of tamarack are also being pulped by the semi-chemical process.

Distribution of merchantable acreage in the tamarack type by density class is as follows:

Poor (3-7 Cords/A)	68,000 acres	53%
Medium (7-13 Cords/A)	38,000 acres	30%
Good (13-20 Cords/A)	22,000 acres	17%
Very good (20+ Cords/A)	-	
	128,000 acres	

Distribution of total acreage by site class is as follows:

Very Poor	24,000 acres	10%
Poor	100,000 acres	39%
Medium	111,000 acres	43%
Good	21,000 acres	8%
	256,000 acres	

The major enemy of tamarack is the larch sawfly. In the period 1910-1930 this insect in combination with the eastern larch beetle, which attacked the weakened defoliated trees, wiped out thousands of acres of the tamarack type. Much of the dead standing wood was sold for fuelwood, but most of the volume killed was a total loss. Another epidemic now covers the northern half of the forest region. It may soon be necessary to spray the better stands if they are to be saved.

Another major problem in maintaining the present tamarack acreage is brush. Almost half of the present pole and sawtimber stands are understoried by a medium to heavy brush cover. This is a problem which has not been taken up as yet due to the small acreage of annual cut in past years. As tamarack assumes more importance and as the cut increases this problem must be met.

CEDAR - The northern white cedar type has lost a great deal of the importance that it once held in the economy of the region. Cedar stands were generally picked over for sound poles and ties which has resulted in many acres of large culls overtopping suppressed, deformed smaller trees.

There is a total acreage of 128,000 acres of cedar type of which 62,000 acres is in merchantable size classes. Total volume in the cedar type in terms of cords is 487,000 cords or 7.9 cords per acre average in merchantable stands. There are approximately two million cedar poles, one million cedar ties and 13½ million cedar posts in merchantable stands and an additional 83,000 cords of black spruce and 76,000 cords of balsam fir.

Recommended annual cut in the cedar type is 124,000 cedar poles, 72,000 cedar ties, 726,000 cedar posts, 6,100 cords of black spruce and 5,600 cords of balsam fir. This cut cannot be sustained, but is necessary to liquidate overmature stands and bring age class distribution into better balance. Rotation age for the cedar type should be 100 years with a harvest range of 75-125 years.

Cedar is very susceptible to heart rot and for this reason should not be held beyond an age sufficient to produce cedar products in accordance with the site. A fairly common defect in cedar is spiral grain which renders it unfit for poles. Cedar is a hardy species relatively immune to most insects and diseases. Reproduction is severely browsed by deer in deer yards or overpopulated areas. However, cedar management should always consider the possibilities for creating available browse for deer.

Being tolerant species cedar occurs as an understory on 63,000 acres of other timber producing types, chiefly black spruce. Balsam fir is the only species found to any extent as an understory in cedar stands. Over 20% of cedar stands are understoried with balsam fir and 20% with brush.

Distribution of merchantable acreage by density class is as follows:

Poor (3-7 Cords/A)	32,000 acres	52%
Medium (7-13 Cords/A)	20,000 acres	32%
Good (13-20 Cords/A)	9,000 acres	14%
Very Good (20+ Cords/A)	1,000 acres	2%
	62,000 acres	

Distribution of total acreage by site is as follows:

Very Poor	4,000 acres	3%
Poor	52,000 acres	41%
Medium	56,000 acres	44%
Good	16,000 acres	12%
	128,000 acres	

OTHER HARDWOOD TYPES - For purpose of brevity the birch, northern and bottomland hardwood types will be dealt with together. Total and merchantable acreages is as follows:

	Total Acreage	Merchantable Acreage
Birch	59,000	23,000
Northern Hardwoods	97,000	53,000
Bottomland Hardwoods	116,000	60,000

Total volume by types and per acre averages in merchantable stands is

as follows:

Birch	180,000	24,000,000	7.8 cds.-1040 Bd.Ft.
Northern Hdwds.	155,000	100,000,000	2.9 cds.-1890 Bd.Ft.
Bottomld. Hdwds.	244,000	83,000,000	4.0 cds.-1380 Bd.Ft.

The total cords is composed of 59,000 cords of aspen, 66,000 cords of balsam fir, 36,000 cords of balm of gilead and 391,000 cords of mixed hardwoods. The total board foot volume contains the following major species and amounts:

Birch	35,000,000 Bd. Ft.	17%
Ash	39,000,000 Bd. Ft.	19%
Elm	30,000,000 Bd. Ft.	14%
Oak	29,000,000 Bd. Ft.	14%
Basswood	21,000,000 Bd. Ft.	10%
Maple	16,000,000 Bd. Ft.	8%
Pine	17,000,000 Bd. Ft.	8%
Other	20,000,000 Bd. Ft.	10%
	207,000,000 Bd. Ft.	100%

The recommended annual cut in hardwood types is 11,000 cords and 11,440,000 board feet. This may be higher than the types will sustain in the near future, but under careful management these types could produce much greater volumes per acre than now exist.

Many of the hardwood species, especially maple, are at the extreme limits of their range in northern Minnesota and do not produce the size and quality of trees that are found elsewhere. Maple is very slow growing and generally frostcracked. Oak is subject to many diseases and insects such as oak wilt, walking stick, and other leaf feeders and galls. Basswood, yellow birch, elm and ash grow slowly and do not attain great size without being subject to many defects. Much of the paper birch on state lands has followed pine on sandy sites which will not produce good birch.

On some sites, on the other hand, it is possible to produce excellent basswood, paper birch, yellow birch, elm and ash. It is on these sites that hardwood management should be intensively practices. Some of the poorer sites should be converted to more adaptable species.

Distribution of hardwood types by site is as follows:

Very poor	22,000	8%
Poor	103,000	38%
Medium	115,000	42%
Good	32,000	12%
	272,000	

The future possibilities for use of the poor quality hardwoods lies in pulp, paper and wood conversion. Some balm of gilead and paper birch is being used for this purpose now. Fuelwood is presently the major use for hardwood species other than aspen. The better quality hardwoods are being utilized for sawlogs, ties and veneer bolts and the market is generally good.

APPENDICES

APPENDIX A

TABLES

TABLE 1

CLASS OF STATE LAND OWNERSHIP

January 1955

Class of State Land	Acres	Percent
Trust Fund	2,635,983	55.5
Conservation	1,573,966	33.1
Salt Springs	5,757	.1
Acquired - Forestry	271,534	5.7
Acquired - Game & Fish	116,762	2.5
Acquired - Parks	65,360	1.4
Acquired - Other[1]	474	-
Beltrami Island Lease[2]	80,648	1.7
	4,750,484	100.0

1 - Includes lands acquired by the Division of Waters and Division of Lands and Minerals.

2 - U. S. Lands leased to the Division of Game and Fish by the U. S. Fish and Wildlife Service.

TABLE 2

LAND USE

	Timber Prod.	Deforested	Non-Productive	Non-Forest	TOTAL	%
		ACRES				
Conservation[1]	2,294,706	1,021,688	347,122	695,561	4,359,077	92
Agriculture[2]	60,424	84,704	27,295	66,363	238,786	5
Industrial[3]	7,401	4,528	-	48,578	60,507	1
Recreational[4]	34,993	7,925	932	48,264	92,114	2
TOTAL	2,397,524	1,118,845	375,349	858,766	4,750,484	100

1 - Forest, game and watershed management.

2 - Lands classified as best suited to agricultural development.

3 - Roads, railroads, rights-of-way, gravel pits, etc.

4 - Quetico - Superior no-cut area, all recreational and state parks.

TABLE 3

STATE LAND CLASSIFICATION

January 1955

	Thousands of Acres	Percent
Sawtimber	290	
Poletimber	1,024	
Reproduction	972	
Christmas Tree Bog	112	
Total Timber Producing	2,398	51
Low Vegetation*	72	
Upland Brush	136	
Lowland Brush	868	
Offsite Aspen and Oak	43	
Total Deforested	1,119	23
Stagnant Swamp Conifers	367	
Non-permanent Flowage	8	
Total Non-Productive	375	8
TOTAL FOREST	3,892	82
Marsh and Muskeg	684	
Other Non-forest	174	
Total Non-Forest	858	18
TOTAL STATE LAND IN FOREST REGION	4,750	100

* Includes upland grass, ferns, labrador tea, moss, etc.

TABLE 4 (a)

TIMBER PRODUCING STATE LANDS BY COVER TYPE AND SIZE CLASS

January 1955

Cover Type	Reproduction	Poletimber	Sawtimber	Total	Percent
	ACRES - Thousands				
White and Norway Pine	11	3	36	50	2
Jack Pine	34	83	22	139	6
Spruce	216	305	-	521	22
Tamarack	128	119	9	256	11
Spruce-Fir	134	130	35	299	12
Cedar	66	48	14	128	5
TOTAL CONIFER	589	688	116	1,393	58
Aspen	247	280	94	621	26
Birch	36	17	6	59	2
Upland Hardwoods	44	13	40	97	4
Bottomland Hardwoods	38	19	32	89	4
Balm of Gilead	18	7	2	27	1
TOTAL HARDWOOD	383	336	174	893	37
TOTAL ALL TYPES	972	1,024	290	2,286	95
		Christmas Tree Bog		112	5
		Total Timber Producing		2,398	100

TABLE 4 (b)

TIMBER PRODUCING STATE LAND BY COVER TYPE AND AGE CLASS

January 1955

Cover Type	Age Class - Years							
	0-20	20-40	40-60	60-80	80-100	100-150	150+	TOTAL
	ACRES - Thousands							
White & Nor. Pine	2	9	6	7	5	5	16	50
Jack Pine	10	35	47	35	12	-	-	139
Spruce	46	90	59	115	100	102	9	521
Tamarack	9	30	66	60	39	46	6	256
Spruce-Fir	19	99	80	64	31	6	-	299
Cedar	3	26	9	34	27	25	4	128
Aspen	47	303	170	63	37	1	-	621
Birch	-	41	8	4	6	-	-	59
Upland Hdwds.	2	41	12	7	10	25	-	97
Bottomland Hdwds.	-	27	15	13	10	22	2	89
Balm of Gilead	5	14	5	3	-	-	-	27
TOTAL OF ALL TYPES	143	715	477	405	277	232	37	2,286

TABLE 4 (c)

TIMBER PRODUCING STATE LANDS BY COVER TYPE AND SITE

January 1955

Cover Type	Site*				
	Very Poor	Poor	Medium	Good	TOTAL
		ACRES - Thousands			
White Pine	-	-	34	16	50
Jack Pine	2	16	67	54	139
Spruce	19	144	266	92	521
Tamarack	24	100	111	21	256
Spruce-Fir	2	37	156	104	299
Cedar	4	52	56	16	128
Aspen	18	160	293	150	621
Birch	2	16	27	14	59
Northern Hardwoods	20	52	25	-	97
Bottomland Hardwoods	-	27	48	14	89
Balm of Gilead	-	8	15	4	27
TOTAL ALL TYPES	91	612	1,098	485	2,286
Percent	4	27	48	21	100

*Site was based on the estimator's judgment of relative growth and condition of the individual stands.

TABLE 5

MERCHANTABLE TIMBER PRODUCING STATE LANDS BY
COVER TYPE, SIZE CLASS AND DENSITY CLASS

January 1955

Poletimber	Poor	Medium	Good	Very Good	Total
		ACRES - Thousands			
Jack Pine	13	31	30	9	83
Spruce	77	115	68	45	305
Tamarack	63	34	22	-	119
Spruce-Fir	36	61	26	7	130
Cedar	24	16	8	-	48
Aspen	110	125	40	5	280
Other	27	30	2	-	59
TOTAL	350	412	196	66	1,024
Sawtimber		ACRES - Thousands			
White & Norway Pine	15	9	10	2	36
Jack Pine	5	8	8	1	22
Tamarack	5	4	-	-	9
Spruce-Fir	13	15	6	1	35
Cedar	8	4	1	1	14
Aspen	33	41	16	4	94
Birch	2	4	-	-	6
Upland Hardwood	24	14	2	-	40
Bottomland Hardwood	18	13	3	-	34
TOTAL	123	112	46	9	290
GRAND TOTAL	473	524	242	75	1,314
PERCENT	36	40	18	6	100

TABLE 6 (a)

TOTAL VOLUME IN MERCHANTABLE STANDS BY STAND CONDITION

January 1955

Species	Mature Stands[1]	Growing Stands[2]	TOTAL	Write-off Stands[3]
		CORDS - Thousands		
Black Spruce	2,393	2,000	4,393	173
Aspen	1,468	1,001	2,469	237
Balsam Fir	1,052	423	1,475	159
Jack Pine	628	647	1,275	17
Tamarack	416	644	1,060	105
Balm of Gilead	87	89	176	45
White Spruce	93	54	147	10
White & Norway Pine	15	57	72	2
Misc. Hardwoods	442	368	810	179
TOTAL	6,594	5,283	11,877	927
		BOARD FEET - Millions		
Aspen	342	21	363	40
White & Norway Pine	166	118	284	4
Jack Pine	92	40	132	6
White Spruce	56	16	72	5
Birch	54	17	71	13
Ash	30	15	45	19
Oak	32	4	36	7
Elm	30	4	34	15
Tamarack	24	4	28	3
Basswood	19	4	23	5
Balm of Gilead	17	4	21	9
Maple	14	2	16	14
TOTAL	876	249	1,125	140
		CEDAR PRODUCTS - Thousands of Pieces		
Poles	2,201	988	3,189	815
Ties	1,358	497	1,855	486
Posts	18,015	11,296	29,311	7,200

1 - Mature stands are stands in which net annual growth is declining, negligent or negative.

2 - Growing stands are stands in which net annual growth is increasing or at a maximum level.

3 - Write-off stands are definitely non-operable and in such condition that it is unlikely they will exist for ten years (until 1965).

TABLE 6 (b)

TOTAL VOLUME IN MERCHANTABLE STANDS BY OPERABILITY

January 1955

Species	Good Operability	Poor Operability	Total Operable*	Non-Operable
	CORDS - Thousands			
Black Spruce	2,746	1,392	4,138	255
Aspen	943	1,165	2,108	361
Balsam Fir	800	572	1,372	103
Jack Pine	880	335	1,215	60
Tamarack	401	414	815	245
Balm of Gilead	48	95	143	33
White Spruce	86	51	137	10
White & Norway Pine	44	20	64	8
Misc. Hardwoods	240	313	553	257
TOTAL	6,188	4,357	10,545	1,332
	BOARD FEET - Millions			
Aspen	171	190	361	2
White & Norway Pine	188	85	273	11
Jack Pine	90	38	128	4
White Spruce	43	24	67	5
Birch	34	30	64	7
Ash	8	19	27	18
Elm	9	23	32	2
Oak	17	17	34	2
Tamarack	3	15	18	10
Balm of Gilead	6	14	20	1
Maple	9	5	14	2
Basswood	13	7	20	3
TOTAL	591	467	1,058	67
	CEDAR PRODUCTS - Thousands of Pieces			
Poles	1,047	1,813	2,860	329
Ties	642	1,048	1,690	165
Posts	9,900	15,203	25,103	4,208

* Operability is based on the estimator's judgment using factors such as: area market conditions, accessibility, stand composition, stand density size of timber, condition of timber, etc. Most of the Non-operable volume is in young growing stands.

TABLE 6 (c)
TOTAL VOLUME IN MERCHANTABLE STANDS BY COVER TYPE*
January 1955

Species	White and Nor. Pine	Jack Pine	Spruce	Tamarack	Cedar	Spruce-Fir	Aspen	Birch	Upland Hdwds.	Bottomland Hdwds.	TOTAL
					CORDS - Thousands						
Black Spruce	17	64	3,822	181	83	184	33	6	-	3	4,393
Aspen	30	55	15	-	2	126	2,172	30	18	21	2,469
Balsam Fir	23	6	53	3	76	1,031	217	28	14	24	1,475
Jack Pine	12	1,146	37	0	0	20	59	0	1	0	1,275
Tamarack	-	-	215	840	-	5	-	-	-	-	1,060
Balm of Gilead	-	-	-	-	-	19	118	2	1	36	176
White Spruce	14	5	11	-	-	72	41	3	1	-	147
White & Nor. Pine	52	10	-	4	-	6	-	-	-	-	72
Misc. Hdwds.	23	11	24	5	20	164	172	111	120	160	810
TOTAL	171	1,297	4,177	1,033	181	1,627	2,812	180	155	244	11,877
					BOARD FEET - Millions						
Aspen	7	2	-	-	-	19	327	2	4	2	363
White & Nor.Pine	214	11	-	3	2	23	18	-	13	-	284
Jack Pine	18	98	1	-	-	1	10	4	-	-	132
White Spruce	10	2	-	-	-	40	15	1	-	4	72
Birch	5	-	-	-	-	20	11	17	15	3	71
Ash	-	-	-	-	-	3	3	-	1	38	45
Elm	-	-	-	-	-	2	2	-	6	24	34
Oak	2	-	-	-	-	1	4	-	28	1	36
Tamarack	-	-	3	23	2	-	-	-	-	-	28
Balm of Gilead	-	-	-	-	-	7	7	-	-	7	21
Maple	-	-	-	-	-	-	-	-	14	2	16
Basswood	-	-	-	-	-	1	1	-	19	2	23
TOTAL	256	113	4	26	4	117	398	24	100	83	1,125
					CEDAR PRODUCTS - Thousands of Pieces						
Poles	-	-	339	73	1,929	665	117	-	35	31	3,189
Ties	-	-	128	48	1,047	625	4	-	1	2	1,855
Posts	4	-	5,426	2,511	13,415	6,539	1,218	15	33	150	29,311
TOTAL IN M CORDS	683	1,523	4,254	1,110	487	1,988	3,625	228	358	414	14,670
AVE. CORDS PER AC.	17.5	14.5	14.0	8.7	7.9	12.0	9.7	9.9	6.8	6.9	11.2

* On merchantable timber producing lands

TABLE 6 (d)

TOTAL VOLUME IN MERCHANTABLE STANDS BY REGION*

January 1955

Species	Region I	Region II	TOTAL**
		CORDS - Thousands	
Black Spruce	4,000	566	4,566
Aspen	1,649	1,057	2,706
Balsam Fir	1,259	375	1,634
Jack Pine	922	370	1,292
Tamarack	782	382	1,164
Balm of Gilead	135	86	221
White Spruce	121	36	157
White & Norway Pine	54	20	74
Misc. Hardwoods	574	415	989
TOTAL	9,496	3,307	12,803
		BOARD FEET - Millions	
Aspen	293	110	403
White & Norway Pine	189	99	288
Jack Pine	102	36	138
White Spruce	61	16	77
Paper Birch	50	25	75
Ash	39	25	64
Elm	28	21	49
Oak	13	30	43
Tamarack	27	4	31
Balm of Gilead	21	9	30
Maple	10	20	30
Basswood	8	20	28
Yellow Birch	4	5	9
TOTAL	845	420	1,265
		CEDAR PRODUCTS - Thousands of Pieces	
Poles	3,337	667	4,004
Ties	2,027	314	2,341
Posts	29,885	6,626	36,511

* Region I comprises Cook, Lake, St. Louis, Itasca, Koochiching and Lake of the Woods Counties (57% of total State Land). Region II includes the balance of the forested region (see map in the introduction).

**Includes write-off volume

TABLE 7

DRAIN SUMMARY

July 1955

Annual Timber Drain From State Lands

Fiscal Year[1]	M Cords[2]	Million Board Feet[3]	Total in M Cords
1945	129	21	171
1946	160	27	213
1947	152	40	232
1948	164	27	218
1949	163	24	211
1950	103	20	143
1951	182	29	240
1952	206	30	267
1953	164	28	220
1954	182	24	230
1955	225	30	285
Eleven Year Total	1,830	300	2,430
Ave. Annual Drain	166	27	220

Average Annual Drain By Products

Sawtimber	16,400,000	board feet (includes piling)
Bolts	11,700	cords
Pulpwood	150,000	cords
Fuelwood	7,700	cords
Ties	60,000	
Poles	84,000	
Posts	260,000	
Mining Poles	528,000	lineal feet
Christmas trees	1,030,000	

1 - July 1 through June 30

2 - Cords include pulpwood, fuelwood, posts and mining poles

3 - Board feet include sawlogs, bolts, ties, poles and piling.

TABLE 8

PAST ANNUAL CUT AND RECOMMENDED ANNUAL CUT BY SPECIES

Species	Past Annual Cut 1951-1955 M Cords	Past Annual Cut 1951-1955 M Bd. Ft.	Recommended Annual Cut 1955-1965 M Cords	Recommended Annual Cut 1955-1965 M Bd. Ft.
White & Nor. Pine	-	5,220	-	9,370
Jack Pine	33	3,620	54	9,680
Black Spruce	80	-	105	-
White Spruce	2	1,660	8	4,520
Balsam Fir	30	240	99	-
Tamarack	6	620	16	1,300
Maple	-	130	-	930
Oak	-	100	-	2,080
Birch	-	1,200	-	5,310
Aspen	38	9,980	138	34,800
Basswood	-	710	-	1,360
Elm	-	360	-	2,190
Ash	-	300	-	1,930
Balm of Gilead	1	300	8	1,790
TOTAL	190	24,440	428	75,260
	M Pieces		M Pieces	
Cedar Poles	71		185	
Ties	20		122	
Posts	205		1,400	
Christmas Trees	1,320		1,000	

TABLE 9 (a)

RECOMMENDED ANNUAL CUT BY SPECIES AND OPERABILITY
FOR PERIOD 1955-1965

July 1955

Species	GOOD OPERABILITY	POOR OPERABILITY	TOTAL	Non-Oper. Stands
	CORDS			
Black Spruce	55,000	49,800	104,800	4,300
Aspen	55,500	82,900	138,400	5,600
Balsam Fir	58,200	41,100	99,300	2,200
Jack Pine	42,100	11,000	53,100	200
Tamarack	7,600	8,100	15,700	1,200
Balm of Gilead	2,800	5,300	8,100	400
White Spruce	4,700	3,200	7,900	200
Wh. & Nor. Pine	1,000	400	1,400	-
Misc. Hdwds.	9,400	15,200	24,600	2,100
TOTAL CORDS	236,300	217,000	453,300	16,200
	BOARD FEET - Thousands			
Aspen	16,230	18,570	34,800	140
Wh. & Nor. Pine	4,780	4,590	9,370	100
Jack Pine	6,480	3,200	9,680	150
Wh. Spruce	2,970	1,550	4,520	60
Paper Birch	2,640	2,300	4,940	150
Ash	390	1,540	1,930	100
Elm	450	1,740	2,190	30
Oak	830	1,320	2,150	-
Tamarack	130	1,170	1,300	800
Balm of Gilead	590	1,200	1,790	-
Maple	600	330	930	-
Basswood	830	530	1,360	-
Yellow Birch	170	200	370	-
TOTAL MBF	37,090	38,240	75,330	1,530
	CEDAR PRODUCTS - Pieces			
Poles	69,900	115,300	185,200	1,400
Ties	50,200	71,500	121,700	900
Posts	589,100	810,800	1,399,900	39,400

TABLE 9 (b)
RECOMMENDED ANNUAL CUT BY COVER TYPE
July 1955

Species	White & Nor. Pine	Jack Pine	Spruce	Tamarack	Spr.-Fir	Cedar	Aspen	Birch	Upland Hdwds.	Btmland Hdwds.	TOTAL
					CORDS						
Black Spruce	500	2,100	80,400	4,900	12,600	6,100	2,300	-	-	200	109,100
Aspen	2,400	2,200	300	-	8,600	-	127,900	1,500	300	800	144,000
Balsam Fir	1,600	400	1,300	-	75,500	5,600	15,300	300	500	1,000	101,500
Jack Pine	1,100	46,400	800	-	1,400	-	3,600	-	-	-	53,300
Tamarack	-	-	4,800	11,800	300	-	-	-	-	-	16,900
Balm of Gil.	-	-	-	-	1,400	-	6,200	-	-	900	8,500
White Spruce	100	200	300	-	4,200	-	3,200	100	-	-	8,100
Wh. & Nor. Pine	500	500	-	100	300	-	-	-	-	-	1,400
Misc. Hdwds.	1,400	800	500	300	7,800	1,100	9,400	2,100	1,000	2,300	26,700
TOTAL CORDS	7,600	52,600	88,400	17,100	112,100	12,800	167,900	4,000	1,800	5,200	469,500
					BOARD FEET - Thousands						
Aspen	510	170	20	-	1,660	10	32,070	100	200	200	34,940
Wh. & Nor. Pine	6,520	140	-	300	1,050	190	870	-	400	-	9,470
Jack Pine	1,380	7,170	20	-	50	-	980	230	-	-	9,830
W. Spruce	260	100	10	-	2,900	-	1,130	40	-	140	4,580
Paper Birch	430	40	-	60	1,540	80	1,020	1,170	1,020	100	5,460
Ash	-	-	-	-	150	30	300	-	90	1,460	2,030
Elm	-	-	-	-	120	-	180	-	320	1,600	2,220
Oak	180	-	-	-	80	-	370	-	1,450	70	2,150
Tamarack	-	-	100	1,670	80	200	-	-	-	50	2,100
Balm of Gilead	-	-	-	-	560	-	560	90	-	580	1,790
Maple	-	-	-	-	-	-	10	-	790	130	930
Basswood	-	-	-	-	40	-	110	-	1,060	150	1,360
TOTAL MBF	9,280	7,620	150	2,030	8,230	510	37,600	1,630	5,330	4,480	76,860
					CEDAR PRODUCTS - Pieces						
Poles	-	-	7,100	900	44,600	124,100	8,900	-	1,000	-	186,600
Ties	-	-	2,800	600	46,700	72,100	300	-	100	-	122,600
Posts	400	-	119,300	63,100	441,300	726,600	86,400	200	1,800	200	1,439,300
TOTAL IN CORDS	26,163	67,840	90,203	21,683	137,405	32,197	244,403	7,261	12,557	14,161	653,873

TABLE 10

MERCHANTABLE TIMBER PRODUCING STATE LANDS
BY CUTTING PRIORITY

January 1955

Cover Type	Clearcut 0-10	Partial Cut 0-10	Cut 10-20	Reserve	Write-off	TOTAL
			ACRES			
Wh. & Nor. Pine	10,292	6,279	3,190	19,040	-	38,801
Jack Pine	39,110	7,718	35,714	22,025	926	105,493
Spruce	56,195	16,672	70,912	142,030	18,937	304,746
Tamarack	18,423	5,043	12,968	73,896	16,879	127,209
Spruce-Fir	87,482	14,409	23,157	18,114	21,951	165,113
Cedar	20,893	3,910	412	15,335	21,820	62,370
TOTAL CONIFER	232,395	54,031	146,353	290,440	80,513	803,732
Aspen	200,179	-	88,306	39,830	45,079	373,394
Birch	6,587	-	-	16,467	206	23,260
Upland Hdwds.	7,307	13,688	4,118	16,570	11,424	53,107
Bottomld. Hdwds.	13,483	5,557	5,455	15,541	20,481	60,517
TOTAL HDWDS.	227,556	19,245	97,879	88,408	77,190	510,278
TOTAL ALL TYPES	459,951	73,276	244,232	378,848	157,703	1,314,010

TABLE 11

FOREST DEVELOPMENT ACREAGE SUMMARY

Type of Forest Development	Trust Fund State For.	Conservation Area State For.	Conservation Area Not St. For.	Game & Fish Lands	Other State Lands St. For.	Other State Lands Not. St. For.	TOTAL
				ACRES			
Machine Planting:							
No preparation	8,600	6,400	15,000	8,200	3,600	12,800	54,600
Herbicides	1,800	6,900	3,100	5,200	9,600	9,100	35,700
Discing or bulldozing	10,100	1,300	8,500	-	4,700	18,200	42,800
TOTAL	20,500	14,600	26,600	13,400	17,900	40,100	133,100
Hand Planting:							
No preparation	24,900	3,900	5,100	-	5,700	10,800	50,400
Herbicides	75,500	2,400	9,500	-	11,800	48,000	147,200
TOTAL	100,400	6,300	14,600	-	17,500	58,800	197,600
Natural Regeneration with aid of herbicides, discing and controlled burning	49,800	2,000	5,100	2,600	10,300	19,800	89,600
Non-Comm. Thinning, Pruning, etc.	4,600	3,100	-	-	1,900	2,800	12,400
TOTAL - ALL DEVELOPMENT	175,300	26,000	46,300	16,000	47,600	121,500	432,700
					TOTAL DEFORESTED ACREAGE		1,118,845

TABLE 12

UNDERSTORY SUMMARY

January 1955

Main Stand Cover Type	UNDERSTORY COVER TYPE: White & Nor. Pine	Jack Pine	Spruce	Tamarack	Spruce-Fir	Cedar	Aspen	Birch	Upland Hdwds.	Bottomld. Hdwds.	Brush	Low* Veg.	TOTAL
	ACRES - Thousands												
W. & N. Pine	3	1	1	-	13	-	5	4	-	-	8	4	39
Jack Pine	2	17	1	-	19	-	1	1	1	-	35	28	105
Spruce	-	-	108	4	6	45	-	-	-	-	58	84	305
Tamarack	-	-	17	34	1	11	-	3	-	-	60	2	128
Spruce-Fir	-	-	-	-	99	5	4	2	-	3	31	21	165
Cedar	-	-	-	-	14	22	-	-	-	2	13	11	62
Aspen	3	-	-	-	90	2	64	12	11	5	178	9	374
Birch	-	-	-	-	6	-	2	-	3	-	12	-	23
Upland Hdwds.	-	-	-	-	-	-	-	1	44	-	6	2	53
Btmld. Hdwds.	-	-	-	-	4	-	1	-	-	33	16	6	60
TOTAL	8	18	127	38	252	85	77	23	59	43	417	167	1,314
Total of Differing Understories	5	1	19	4	153	63	13	23	15	10	-	-	306

* Ferns, herbs, grasses, labrador tea, mosses, etc.

APPENDIX B

THE SURVEY METHOD AND A STATISTICAL ANALYSIS OF THE SURVEY

SURVEY METHOD

This survey employs a mechanical sampling procedure with major emphasis on cover type acreage. The sample consisted of 1,162 "forties" or 46,157 acres. Plot interval was calculated at 2 1/2 miles. In order to facilitate location, section corners were used instead of exact miles and the interval selected was 2-3-2-3 etc. To avoid bias related to section line roads, ditches, etc., the $SE\frac{1}{4}$ of the $SE\frac{1}{4}$ was alternated with the $NW\frac{1}{4}$ of the $SE\frac{1}{4}$. The starting point for the grid was the easternmost tip of Minnesota. Pigeon Point on Lake Superior.

Each "forty" was type mapped from aerial photographs and subsequently thoroughly examined on the ground. Mapping of types was to a minimum of one acre. The area sample was 0.97 percent.

Field work was started in late August of 1954 and completed in early January of 1955. Each of the 12 foresters in the forest management section was allotted a quota of "forties". Volume plots were 1/5 acre in size and were permanently established in each merchantable stand in each sample "forty". There were 1,212 volume plots located by use of a standard grid to avoid bias. Each "forty" was permanently marked at one corner with penta-treated stakes and with paint.

Field data were punched into IBM cards and cross-checked with source data and with IBM check listings. Subsequent computation was through use of the Conservation Department's IBM equipment. Stock tables were prepared from the volume plots and total volume by species for each individual stand was punched into the proper card. Each card represented a single type in each "forty". There were some 7,000 cards or types and the average type was about 7 acres in size.

Each type was classified as to forty number, type number, condition class, class of state land, land use, acreage, and forest development needs. Merchantable types were further classified as to understory, stand vigor, operability, stand age, site, volume by species and cutting priority by species. Two cards were necessary for merchantable stands containing board foot measure. Examples of the key punch sheets used on this survey are in Appendix C.

SAMPLING ERROR

The following formula was employed for calculating sampling error for forest areas.

Formula for error variance:

$$E^2 = \frac{Q \ (1 + (n-1) \ R)}{P \ m \ n}$$

Where P = Percent subject area

Q = Percent non-subject area

m = Number of 40 acre samples (1162)

n = Number of elements (40 since each acre was mapped and field-checked)

R = Coefficient of intra-class correlation

Formula for coefficient of intra-class correlation:

$$R = \frac{Sd^2 - S^2/n}{(n-1) \ S^2/n}$$

TABLE 1

Sampling Error Variance By Land Types

	Acreage	Percent	Standard error Percent
Sawtimber	290,000	6.1	8.4
Poletimber	1,024,000	21.6	4.0
Reproduction	972,000	20.4	4.1
Christmas Tree Bog	112,000	2.4	14.0
Total Timber Prod.	2,398,000	50.5	1.9
Total Deforested	1,119,000	23.5	3.1
Total Non-Prod.	375,000	7.9	5.2
TOTAL FOREST	3,892,000	81.9	0.3
Total Non-Forest	858,000	18.1	4.5
TOTAL STATE LAND	4,750,000	100.0	--

TABLE 2

Sampling Error Variance by Timber Types

Cover Type	Acreage	Percent of Total Forest Land	Standard Error Percent
Aspen	621,000	16.0	5.6
Spruce	521,000	13.4	5.9
Spruce-Fir	299,000	7.7	8.0
Tamarack	256,000	6.6	8.8
Jack Pine	139,000	3.6	11.9
Cedar	128,000	3.3	12.2
Bottomland Hdwd.	116,000	3.0	12.8
Northern Hdwd.	97,000	2.5	12.9
Birch	59,000	1.5	16.2
White & Norway Pine	50,000	1.3	15.8

Breakdown of acreage by cover type or of volume by species are relatively reliable. However, many of the breakdowns in the tables in Appendix A are unreliable and only indicate relative magnitudes.

APPENDIX C

GLOSSARY

STANDARDS OF MEASUREMENT

Cords - standard 4 X 4 X 8 feet

Black spruce and balsam fir - 4 inches DBH and larger to 3 inch top DIB.
White spruce - 4 to 9 inches DBH to a 3 inch top DIB.
Other species exc. cedar - 5 to 9 inches DBH to a 4 inch top DIB.

Board Feet - Scribner rule (Minnesota Standard)

All species except black spruce, balsam fir and cedar - 9 inches DBH and larger to a 6 inch top DIB.

Cedar Products - poles, ties and posts

Cedar 5 inches and larger DBH was tallied in 16 to 35 foot poles, small and standard ties and standard 7 foot posts to a 3 inch top DIB.

Diameter Standards

Diameters were recorded in two inch classes as follows:
4 inch class - 3.0 to 4.9 inches DBH
6 inch class - 5.0 to 6.9 inches DBH
etc.
The 4 inch diameter class was only measured in stocked pole-size stands.

Height Standards

In cord measure, heights were measured in terms of 8 foot sticks. A tree with 37 feet of merchantable height was recorded as 5 sticks while a tree with 35 feet was recorded as 4 sticks. A tree with 36 feet of merchantable height was recorded as 4 sticks since the rule of rounding-off to <u>even</u> applied to all of this survey.

In board foot measure, heights were measured in terms of 16 foot logs and half-logs. The same rules of rounding-off applied.

Cull Standards

Any tree with more than 40 percent defect was culled. Defect includes rot, cracks, poor form, twisted grain, excessive branching, etc. Each species in each stand was assigned a cull percentage dependant on the average condition. All volumes in this report are net.

CLASS OF STATE LAND

Trust fund land - There are four permanent trust funds deriving revenue from four categories of trust fund land, namely school, swamp university, and internal improvement. Revenue from these funds is allotted to public schools, other educational and charitable institutions of the state, the state university, and the road and bridge fund. Twenty five percent of the total cost of administering the forests on these lands within state forests goes into a State Forest Development Fund which is used for planting trees and improving timber stands on these lands.

Conservation area lands - These are tax-forfeited lands in certain areas which have forfeited to the state in full title without any trust in favor of the local taxing districts, because the state financed the counties bonded indebtedness incurred in ditching. The revenue from these lands goes into the Consolidated Conservation Areas Fund. The state legislature appropriates monies from this fund for use in development work in the conservation areas.

Salt springs land - Land granted by the federal government for univeristy purposes. The University of Minnesota has full jurisdiction over such lands and receives all of the revenue directly.

Acquired land - This includes all lands to which title has been acquired by grant, gift or purchase for specific purposes such as forest production, building sites, game management, watershed, parks, etc. Among these lands is the Burntside Forest grant, the Itasca State Park grant, tax-forfeited county lands turned over to the state for forest management and others.

Beltrami Island lease lands - These are lands which were purchased by the federal government under the Resettlement Program and leased to the state Game and Fish Division. The Division of Forestry manages the timber on these lands in cooperation with the Division of Game and Fish.

DEFINITION OF TERMS

Clearcut - A method of harvest wherein all merchantable trees or all merchantable trees of a given species in a stand are removed.

Condition Class - A classification of timber-producing stands which includes cover type, size class and density.

Conifers - Cone bearing trees including pines, spruces, fir, cedar and tamarack.

Cover Type - A classification of lands according to forest or non-forest cover.

DBH - The diameter of a tree 4 1/2 feet above the ground (breast height).

Deforested - Productive forest land which is presently non-stocked through cutting, fire, wind or other causes.

Diameter limit cut - A regulated cut where all trees meeting or larger than a specified diameter are cut.

Density - An expression in percentages of the growing space occupied by commercial tree species (See stocking).

DIB - Diameter inside bark.

Drain - The periodic loss in a forest through removal of cut products, fire, insects, disease, windthrow, etc. Drain is expressed in units of volume as cords, board feet, cubic feet, etc.

Forest land - All lands including swamps, cut-over land and brush areas where timber grows and exists.

Growth - The change in volume of a tree or trees resulting from natural causes other than mortality or harvest.

Hardwoods - Non-cone bearing broad leaved trees such as aspen, oak, maple, birch, etc.

Harvest range - The age range in years during which the stand should be harvested.

Herbicides - Any of several chemical compounds used to kill or control trees, shrubs, grasses, etc.

Mature stand - Silviculturally a stand which has reached or just passed its maximum growth rate.

Merchantable stand - Any stand, operable or inoperable which contains more than 3 cords or 1,300 board feet per acre. Write-off stands not regarded as merchantable.

Mortality - The loss in volume in live trees due to death from natural causes or logging damage. Harvest is not considered as mortality.

Non-forest land - Land in the forest region which is not growing timber such as marsh, muskeg, water, roads, hayfields, etc.

Non-productive land - Forest land supporting trees which will not meet minimum standards of stocking in 100 years.

Operability - Three standards of operability, namely, good, poor and non-operable were employed. Operability was based on the estimator's judgment using factors such as area market conditions, accessibility, stand composition, stocking, size and condition of timber, etc.

Overmature - Stands well past their maximum growth rate. Applies to decadent stands as well.

Poletimber - Trees from 5.0 to 8.9 inches DBH. The term is also applied to stands where the stocking is chiefly in trees of this size class.

Productive land - Forest land which is capable of producing more than 3 cords or 1,300 board feet per acre in 100 years.

Recommended cut - Based on actual field observations of each stand, checked by a formula allowable cut, and adjusted if possible.

Regeneration - Establishment of a stocked stand of seedlings on forest land. Applies to planted or natural areas.

Reproduction - Trees from one foot high to 4.9 inches DBH. Also applies to stocked stands containing less than 3 cords or 1,300 board feet per acre.

Rim cut - The removal of a strip of varying width (usually not more than twice the tree height) from the edge of a stand.

Rotation age - The average stand age selected for harvest based on factors such as cover type, species, site, products requirements and general management considerations.

Saplings - Trees from 1.0 to 4.9 inches DBH.

Sawtimber - Trees 9.0 inches DBH and larger. Applies to stands where the stocking is chiefly in trees of this diameter range.

Seedlings - Trees from one foot high to 0.9 inches DBH.

Selective Cut - Usually applies where the trees to be cut or left have been marked. The term is sometimes applied to diameter and stick limit cuts.

Shelterwood Cut - A method of cutting to encourage regeneration. In the one-cut method about one-half of the volume is selectively cut. The harvest cut is made when advanced reproduction is well established.

Site - Based on the estimator's judgment in this survey. Four standards were set up, namely, good, medium, poor and very poor. The major factors employed were relative growth and general stand condition.

Size Class - The three major size classes were employed as follows: Reproduction, poletimber and sawtimber. For mapping purposes reproduction was separated into seedling and sapling stands and sawtimber into small (9.0 - 14.9 inches DBH) and large (15.0 DBH and larger) sawtimber.

Stand - A single type containing a stocking of forest trees. (See cover type).

Stand Condition - The general appearance of a stand relating primarily to the thrift or vigor of the trees of which it is composed.

Stick limit - A regulated cut wherein all trees meeting or exceeding a specified stick height are cut. A stick is either 8 feet or 100 inches long.

Stocking - Four classes of stocking or density were employed. Volumes are per acre.

	Poor	Medium	Good	Very Good
Seedlings	200-800 trees	800-1400 trees	1400+ trees	--
Saplings	100-400 "	400-700 "	700+ "	--
Poletimber	3-7 cords	7-13 cords	13-20 cords	20+ cords
Small Sawtimber	1300-2500 BF	2500-5000 BF	5000-8000 BF	8000+ BF
Large Sawtimber	1300-4500 BF	4500-8500 BF	8500-13000 BF	13000+ BF

Stocking Levels - The optimum number of trees per acre in a stand at varying stages of stand development.

Suckering - The ability of certain species of trees to grow shoots from the roots or root collar following cutting.

Sustained Yield - An ideal condition wherein an approximately equal volume of timber may be harvested periodically and indefinitely.

Timber Producing land - Forest land containing a stocking of forest trees.

Tolerance - Generally used to denote the relative sunlight requirements of the various species of forest trees, e.g.: Balsam fir is tolerant - aspen is intolerant.

Type - See "Cover Type".

Understory - The cover type which would exist if the main stand were clearcut.

Vigor - As applied to stands there are four vigor classes, namely, growing, storage, deteriorating and write-off.

Write-off - Refers to stands (or one or more minor species within a stand) which are definitely non-operable and deteriorated to the extent that they will not likely exist through the planning period.