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A Method for Estimating Operability and Location of the Timber Resource

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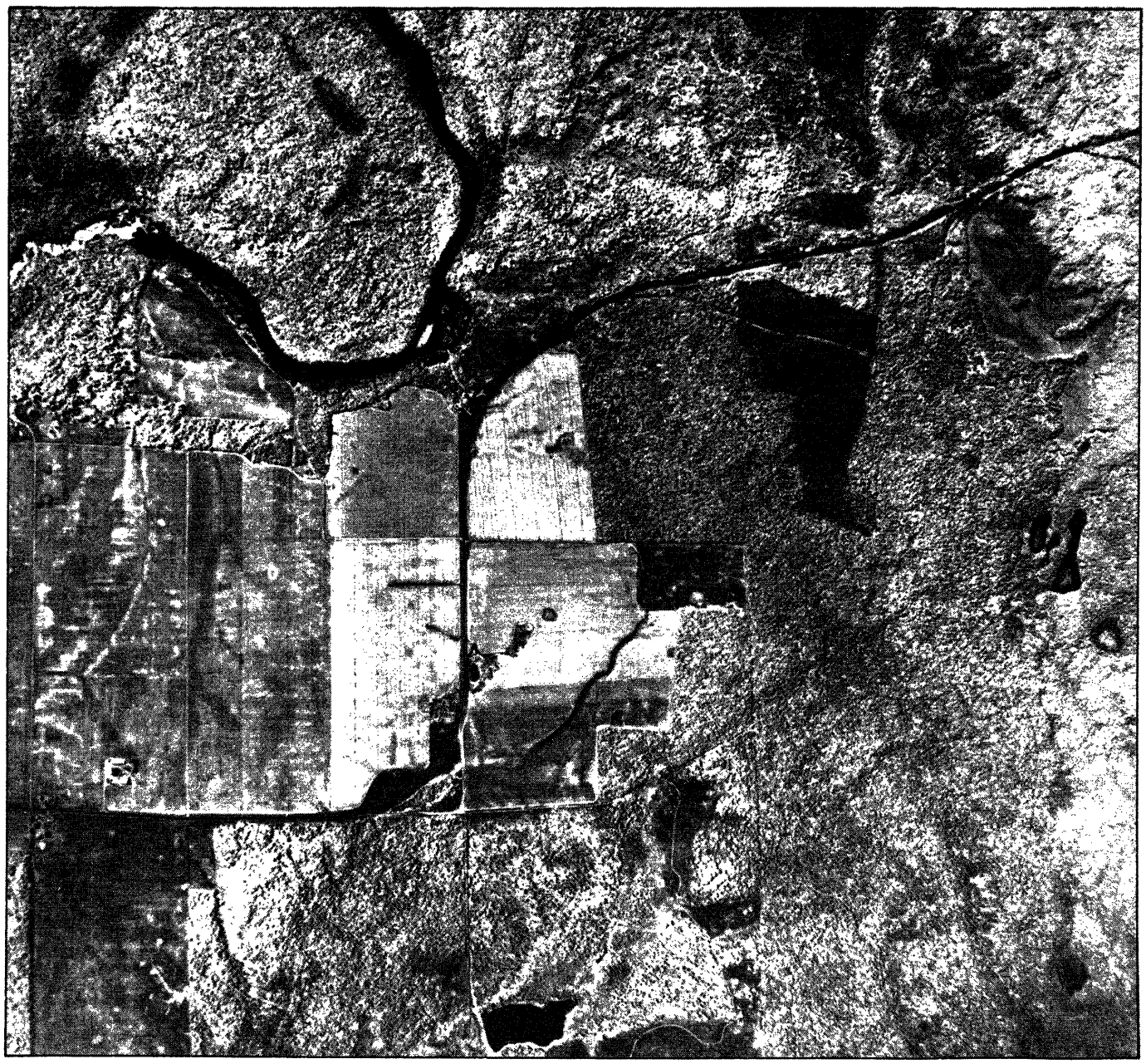

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A METHOD FOR ESTIMATING OPERABILITY AND LOCATION OF THE TIMBER RESOURCE

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Minnesota's 13.7 million acres of timberland in 1977[1] supported 11.5 billion cubic feet of growing stock[2]. Some of this material is unavailable to potential timber purchasers because landowners do not presently wish to sell their timber. Additional volume may be unavailable for harvesting or management due to operability. We define operability as the relative ease or difficulty of managing or harvesting timber because of physical conditions in the stand or on the site. Operability problems include small average tree size, fragile soils, poor drainage, inaccessibility, and small tract size, among others.

The primary purpose of this paper is to describe a method for evaluating the operability of timberland in a large geographic area, such as a State, using information collected during Statewide forest inventories. A secondary objective is to discuss the operability information generated for Minnesota.

Statewide inventory information was provided by Forest Inventory and Analysis (FIA) permanent sample plots. Although some subjectivity was involved in assigning values to operability components, the use of FIA data guarantees objectivity in the calculation of areas and volumes by operability classes. Users of this information can also mitigate some of this subjectivity by employing a method we've devised for tailoring the results to more closely fit his or her requirements. Up to three of the seven operability characteristics used to stratify areas into operability classes can be eliminated, and the remaining characteristics—those deemed important to the user—can be used alone to estimate operability class.

[1]*Jakes, Pamela J. The fourth Minnesota forest inventory: area. Resour. Bull. NC-54. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1980. 37 p.*

[2]*Spencer, John S., Jr. The fourth Minnesota forest inventory: timber volumes and projections of timber supply. Resour. Bull. NC-57. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1982. 72 p.*

METHODS

The method used to develop operability classes for Minnesota's timberland consisted of seven basic steps (fig. 1).

1. *Select Operability Class Components*

Information collected during Statewide forest inventories falls into two categories—tree data and stand data. Tree data include species, diameter at breast height (d.b.h.), merchantable height, log grade, and other items. Tree measurements are used to compute basic inventory statistics such as timber volume, growth, and quality. Stand data collected include site index, stand age, forest type, stand area, owner, distance to water and roads, and other items. Stand information complements tree data and allows for a more complete analysis of basic inventory data.

Information used to define operability classes in Minnesota was selected from tree and stand data collected during the 1977 State inventory. We asked representatives from the public and private sectors of forestry to identify tree and stand data they deemed important in determining operability. Although they identified numerous factors, we narrowed the list to those most frequently identified and those for which information was available from FIA plots. Our final list consisted of seven major operability components: stand area, growing-stock volume per acre, sawtimber volume per acre, percent of cull trees in the stand, average diameter at breast height (d.b.h.) of growing-stock trees, merchantable

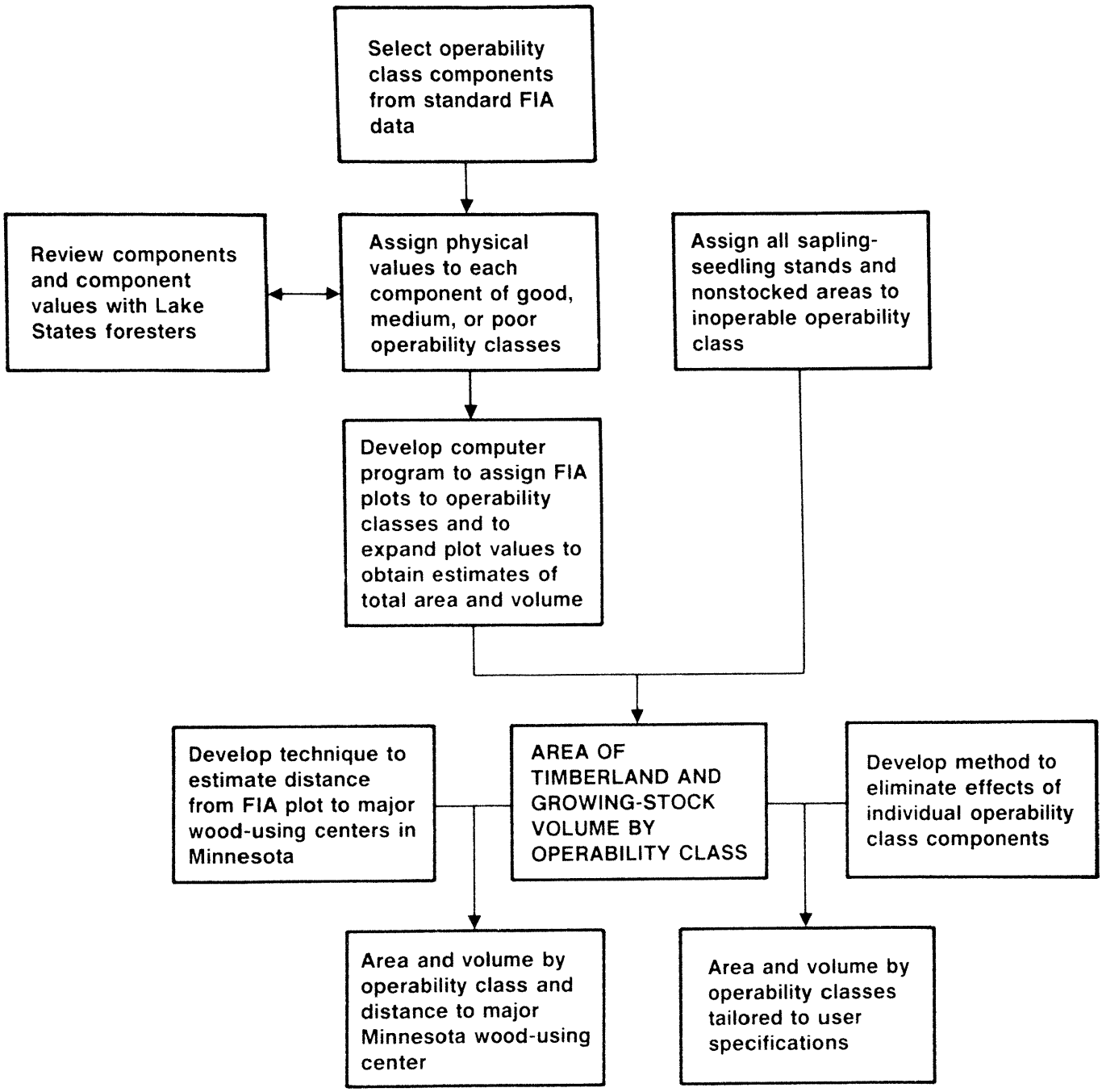

Figure 1.—*Method for determining Minnesota's timberland operability.*

height of growing-stock trees, and distance to a maintained[3] road from the stand.

2. *Assign Physical Values to Components*

Based on information collected during interviews and through a literature search, we assigned physical values to each of the seven operability components separating the values of each component into three operability classes (good, medium, and poor).

[3]*See Definitions of Terms in Appendix.*

3. *Segregate Sapling-Seedling Stands and Nonstocked Areas*

We set aside the areas of all sapling-seedling stands and nonstocked areas in a separate operability class (IV), inoperable. It is our opinion that little of this land would be harvested in the short term (although it might be managed for regeneration or release) and that including this land in operability estimates would dilute or negate the usefulness of operability data. Tables found in the Appendix show

class IV areas and volumes in order that totals would add to the State totals published after the 1977 inventory[4].

4. *Review of Process by Lake States Foresters*

We asked a sample of foresters from forest industry, State Departments of Natural Resources, universities, and public forest research agencies in the Lake States to review our operability class components and their values. Suggested changes were incorporated into the final components and factors used in this paper. The final operability class components and the three subclasses of each are shown in table 1.

5. *Develop Computer Program to Scan Inventory Records and Expand Plot Data*

We devised a computer program to search the FIA data base and (1) retrieve the values for each of the seven operability class components on every sample plot (except those in sapling-seedling stands or on nonstocked areas), and (2) assign an overall operability class rating (I, II, or III) to the plot. In order for a plot to receive an overall operability class I (Good) rating, *all* of the values for the seven components on the plot had to be class I. A plot was rated operability class II (Medium) if values for the seven components on the plot were either class I or II. A plot was rated operability class III (Poor) if *any* of the component values were class III. (E.g. if the values for six components on a plot were class I and the value for the remaining component was class III, the plot was considered operability class III.)

We used expansion factors developed during the 1977 State inventory to convert plot data to estimates of timberland area by operability class for Minnesota. We computed the volume by species for each plot and then expanded the data to an estimate of volume by operability class for the State.

[4]*Appendix tables do not add exactly to 1977 published totals because of slight procedural changes in data processing used in computing operability information from the method used in 1977.*

Table 1.--Operability component values for each operability class

Operability component	Operability class		
	I (Good)	II (Medium)	III (Poor)
1. Stand area (in acres)	More than 60	10-60	Less than 10
2. Growing-stock volume per acre (in cubic feet)	More than 800	300-800	Less than 300
3. Sawtimber volume per acre (in board feet 1/)	More than 3,000	1,100-3,000	Less than 1,100
4. Percent of all live trees that are cull (in percent)	Less than 20	20-50	More than 50
5. Average diameter at breast height (d.b.h.) of growing-stock trees (in inches)	More than 10	6-10	Less than 6
6. Average merchantable height of growing-stock trees (in feet)	More than 28	16-28	Less than 16
7. Distance to a maintained road (in miles)	Less than 1/4	1/4 - 3/4	More than 3/4

1/ International 1/4-inch rule.

6. *Method for Eliminating Limiting Operability Class Components Not Considered Relevant by the User*

Some operability class components might not be considered important by some users. To permit these users to develop operability classes containing only components of concern to them, we developed tables showing area of timberland in operability classes II and III by limiting factor (tables 8 and 9 in Appendix). Similar tables for growing-stock volume were also developed (tables 16 and 17).

A limiting factor represents the operability class component or components that prevent the indicated area or volume from being classed in a higher operability class. As mentioned earlier, a plot was rated operability class II if all values for the seven operability class components on the plot were either class I or II. The limiting factor tables for class II show the individual components that were rated class II and, therefore, caused the indicated area or volume to be rated class II rather than class I. Limiting factor tables for class III show the same information. The limiting factor tables, then, can be used to find the area or volume on plots called operability class II or III because of a component(s) considered unimportant by the reader, and this can be added to the area or volume listed as operability class I or II to produce a revised estimate.

For example, table 8 shows that limiting factor 1 (stand area—first of the seven operability class components) is responsible for 52,700 acres of timberland being placed in operability class II rather than class I. All other components in the plots represented by the 52,700 acres were rated operability class I. If you feel that stand area is not relevant to your needs, you can add the 52,700 acres to the 52,100 acres classed as operability class I in table 7 (fig. 2a). The resulting 104,800 acres is the adjusted area in operability class I if the constraint of stand area as an operability class component is removed. To estimate the growing-stock volume on the above 52,700 acres, table 16 shows that limiting factor 1 represents 90,453,000 cubic feet. Adding this to the 71,893,000 cubic feet of growing stock in table 15 estimated to be operability class I results in an adjusted class I volume of 162,346,000 cubic feet (fig. 2b). The limiting factor tables provide the information necessary to adjust areas and volumes for any combination of up to three operability class components.

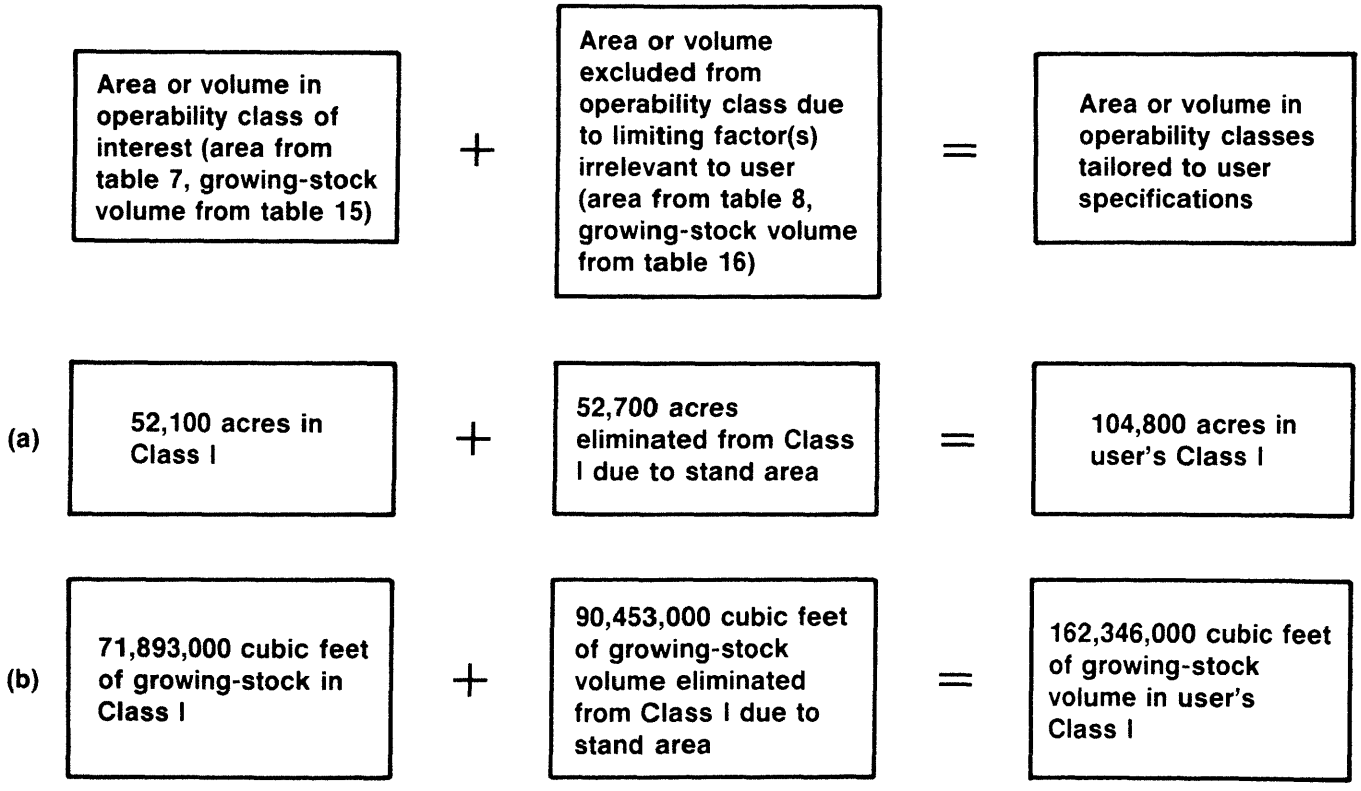

Figure 2.—*Eliminating limiting operability class components not considered relevant by the user.*

7. *Estimate the Area of Timberland and the Volume of Growing Stock by Operability Class and by its Distance from the Major Wood-using Centers in the State*

During the aerial photo interpretation phase of the Minnesota forest inventory, the legal description of each plot (township, range, section, and quarter-quarter section) was recorded. Each plot legal description was then converted to Universal Transverse Mercator (UTM) coordinates, accurate to within 300 meters. (See Appendix for further discussion of Universal Transverse Mercator Grid System.)

We identified nine current major wood-using centers in Minnesota: Bemidji, Brainerd, Cloquet, Cook, Grand Rapids, International Falls, Sartell, the Twin Cities (Minneapolis-St. Paul), and Winona. The UTM coordinates for each of these cities were referenced and compared with the coordinates for each plot to get the straight-line distance between points. The area and volume associated with each plot could then be estimated in relation to its straight-line distance from each city. These plot areas and volumes were summed and stratified by operability class to produce an estimate of the area of timberland (table 13) and volume of growing stock (table 21) by distance from each of the nine wood-using centers and by operability class. Distances were grouped in three classes: (1) less than 20 miles, (2) from 20 to 50 miles, and (3) more than 50 miles.

DISCUSSION

The method described here is one of many possible avenues to evaluate operability. We acknowledge that factors other than the seven we selected to determine operability are important. However, our intent in this paper is to present a method based only on measurable, physical stand data that can be used by foresters and others without experience in forest economics. The necessary data are routinely collected in the North Central Region on FIA permanent sample plots used to inventory a State's timber resource and are readily available to the public through a data base management system[5]. Thus, users with programming ability can access the appropriate data base and write their own programs to assess operability.

[5]*Hahn, Jerold T.; Hansen, Mark H. Data bases for forest inventory in the North-Central Region. Gen. Tech. Rep. NC-101. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1985. 57 p.*

The method of assigning plot operability class used in this study may be considered too restrictive by some users. Analysts may wish to consider less stringent requirements in future studies. For example, a plot could be assigned operability class I if all values for the components were rated as I or II, but there were no more than 2 II's. A plot might be rated class II if component values were rated I, II, or III, but there were no more than 2 I's and 2 III's. Similarly, a plot might be rated class III if component values were rated II or III, but there were no more than 2 II's.

This method may serve users' needs as well as the original method, because it is not usually true that one low rating for a component should determine plot operability. In some cases, however, one component may decide operability class for a plot. For example, Minnesota Department of Natural Resources (DNR) foresters find that timber operators will usually bid on DNR saw log timber sales containing less than 1,000 board feet per acre if the stand contains large-diameter trees and/or high quality species. However, they may not bid on sales with the same volume per acre in small-diameter trees and/or low values species. Aspen pulpwood timber sales on DNR land are usually considered inoperable (economically infeasible) if they contain less than 5 cords per acre. In these cases, the volume per acre components could automatically trigger the plot to be assigned to the lowest operability class.

The described method weights the better operability classes toward stands with large trees and attendant large volumes per acre, such as many of those found in the oak-hickory and maple-basswood forest types. This is largely the result of the operability components selected by foresters to describe operability. Such stands are most likely to be harvested, particularly for saw logs. Forest types with typically small trees such as aspen-birch, black spruce, and jack pine are at a disadvantage in the method described.

We recognize that straight-line distance from the resource to a major wood-using center is not as useful a measure of economic feasibility as hauling (road) distance. Methods are available to calculate the hauling distance between two points; however, it was beyond the scope of this study to make these calculations. Future analysts of operability in other States may want to consider substituting hauling distance for straight-line distance.

The component values used here are appropriate for the Lake States in general and Minnesota in particular. When determining operability for other

States, the use of the same component values would facilitate comparisons across regions; however, values would undoubtedly be altered in other States to reflect local conditions and practices.

RESULTS FOR MINNESOTA

Area

Using the method outlined above, 7.1 million acres (52 percent of the total) of timberland in Minnesota are rated operability class III—Poor (table 7). Another 2.9 million acres (21 percent) are rated class II—Medium, and only 52,100 acres (less than 1 percent) are rated class I—Good. Class IV forest, sapling-seedling stands and nonstocked areas, total 3.6 million acres (27 percent).

Of the 15 forest types identified in Minnesota, only 5 have any area in operability class I (table 7). Of the 5, the oak-hickory type contains the greatest portion of its total area in class I—3 percent.

Adjustment by Limiting Factors

Using the method of limiting factors described earlier, forest areas can be shifted towards the good operability class (class I). For example, the 52,100 acres originally rated operability class I can be increased to 131,600 acres (52,100 + 79,500 acres from tables 7 and 8), if the single operability component of average d.b.h. of growing-stock trees is waived. Or, the total area in class I can be increased to 127,000 acres (52,100 + 74,900 acres) if the constraint on distance to road is removed. If both components are waived the new class I area becomes 406,700 acres (52,100 + 79,500 + 74,900 + 200,200 acres). Although the resulting 406,700 acres is 8 times larger than the original class I area, it still represents only 4 percent of the total of classes I-III in the State. This suggests, too, that the physical standards for some operability components may be too confining or that the definitions of operability classes could be modified. Those investigating operability in subsequent studies may wish to relax the standards somewhat to provide a different distribution of area among the three operability classes. However, new standards should reflect actual conditions and should not be developed only to achieve a more equal distribution of the resource among operability classes.

Likewise, the areas of class II and III forest can be adjusted. If the above two components (average d.b.h. of growing-stock trees and distance to road) are waived, the area of class II forest land changes from 2,935,000 to 3,265,900 acres. The adjusted area represents 32 percent of the class I-III total, an increase of 3 percent over the unadjusted area. This change causes the class III area to be adjusted from 7,073,800 to 6,388,300 acres. The new class III area is 64 percent of the three-class total instead of the original 70 percent.

Areas for individual forest types can likewise be adjusted. The 24,500 acres in the oak-hickory type rated operability class I (table 7) swells to 124,200 acres if limiting factors five and seven are applied (table 8). And the area of the aspen type in class I jumps from 1,400 to 108,100 acres after the same adjustment.

Volume Per Acre

As expected, higher volumes per acre are associated with the better operability classes (table 2). Although all the areas in class I have more than 800 cubic feet per acre, only 54 percent of class III land has the same volumes.

Table 2.--Timberland (excluding sapling-seedling stands and nonstocked areas) by growing-stock volume per acre class and operability class, Minnesota, 1977

(In percent)

Growing-stock volume per acre (cu.ft./acre)	Operability class		
	I	II	III
More than 800	100	82	54
300-800	--	18	41
Less than 300	--	--	5
Total	100	100	100

Ownership

The portion of timberland in each operability class differs substantially among ownership classes. Farmer-owned timberland, the owner class with the largest area in Minnesota, contains the highest portion of operability classes I and II and the smallest portion of operability class III. Generally, farmer-owned timberland is accessible by road in Minnesota and receives less forest management than timberland owned by some other parties. The latter may result in stands with greater volume per acre than stands owned by other groups, thus predisposing them to higher operability ratings.

National Forests, miscellaneous private parties, and Indian owners follow with the next highest portions in operability classes I and II (table 3).

Distance from Wood-using Center

Ignoring operability and sapling-seedling stands and nonstocked areas (operability class IV), a larger area of timberland (385,000 acres) is less than 20 miles (straight-line distance) from Bemidji, Minnesota, than from any of the other eight major wood-using centers in the State. Cook, Minnesota (377,000), and Grand Rapids, Minnesota (374,000), follow. If the timbershed is extended to a radius of from 20 to 50 miles, Grand Rapids is first (1,842,000 acres), followed by Bemidji (1,630,000) and Cook (1,626,000).

If, however, operability is factored into the consideration of distance of timberland from wood-using center, a clearer picture emerges. Winona, Minnesota, leads other cities in area of operability class I timberland less than 20 miles from town with 6,000 acres. However, because this is such a small area, as is the entire class I area, it makes more sense to discuss operability classes I and II combined here.

Bemidji leads all other centers less than 20 miles from operability class I and II timberland (154,000 acres), followed by Brainerd (125,000) and Grand Rapids (114,000). Therefore, although Cook is second in area of all operability classes of timberland within 20 miles of town (above), Brainerd is second in area of class I and II timberland located within this distance from town. Bemidji and Grand Rapids remain first and third, respectively, in the same comparison. Analysts, then, can use table 13 to estimate the difficulty of managing or harvesting timber from three different radii from nine different wood-using centers in the State.

Volume

Growing-stock volume on timberland in Minnesota was stratified into operability classes, just as was the area of timberland. Because the same kind of tables were generated for volume that were discussed for area above, only the highlights are discussed.

Table 3.--Timberland (excluding sapling-seedling stands and nonstocked areas) by ownership class and operability class, Minnesota, 1977

(In percent)

Ownership class	Operability class		
	I	II	III
Farmer	1	39	60
National Forest	1	35	64
Miscellaneous private	1	30	69
Indian	1	26	73
Other federal	--	23	77
County and municipal	--	22	78
Forest industry	--	22	78
State	--	19	81
All owners	1	29	70

Minnesota's 1977 operability class I-III growing-stock inventory of 10.5 billion cubic feet is broken down into operability classes as follows:

Operability class	Growing-stock inventory	
	(Million cubic feet)	(Percent)
I	72	1
II	3,743	35
III	6,723	64
All classes	10,538	100

The aspen type, which represents 41 percent of the combined volumes in classes I-III, represents only 4 percent of the operability class I volume (table 15). This again reflects the bias of the operability components selected towards larger, older trees.

Adjustment by Limiting Factors

Volumes can be adjusted to suit the needs of the user the same way area can be adjusted, as discussed earlier. If the same two operability components are waived as were used earlier in the area discussion (average d.b.h. of growing-stock trees and distance to road), the volume in operability class I changes from 72 to 672 million cubic feet (tables 15 and 16). Likewise, the volume in operability class II shifts from 3,743 to 4,057 million cubic feet and that in class III declines from 6,723 to 5,809 million cubic feet (tables 15 and 17). Percents in each class then become:

Operability class	Percent
I	6
II	39
III	55
All classes	100

Volume Per Acre

Average volume per acre differed somewhat by operability class and volume per acre class, but it generally is highest in the best operability classes (table 4). The extremely small volume in operability class I probably prevented the average volume per acre in that class from being greater than it is.

Ownership

The largest portion of growing-stock volume—like area, discussed earlier—in operability classes I and II is on farmer-owned timberland (table 5).

Distance from Wood-using Center

Bemidji is within 20 miles of 216 million cubic feet of operability class I and II growing stock—more than any other wood-using center in the State. Grand Rapids and Brainerd follow with 171 and 151 million cubic feet, respectively (table 21). The same cities are in the same order if the radius is extended to 50 miles.

Table 4.--Average growing-stock volume[1/] per acre on timberland by volume per acre class and operability class, Minnesota, 1977

(In cubic feet)

Cubic foot volume per acre class	Average all classes	Operability class I	II	III
More than 800	1,343	1,380	1,416	1,297
300-800	591	--	646	581
Less than 300	215	--	--	215

1/ Excludes growing-stock volume in sapling-seedling stands and on nonstocked areas.

Summary

The tables discussed above permit a user to separate timberland and the growing-stock volume on the land into operability classes and to do so by forest type, volume per acre class, stand-age class, ownership class, and distance from wood-using center. In addition, tables are provided that permit a user to discount up to three operability components and then determine operability class based on the remaining relevant components.

Table 5.--Growing-stock volume[1/] by ownership class and operability class, Minnesota, 1977

(In percent)

Ownership class	Operability class		
	I	II	III
Farmer	2	46	52
National Forest	1	43	56
Miscellaneous private	1	37	62
Indian	2/	34	66
Forest industry	--	28	72
County and municipal	--	27	73
Other federal	--	27	73
State	2/	24	76
All owners	1	35	64

1/ Excludes growing-stock volume in sapling-seedling stands and on nonstocked areas.
2/ Less than 0.5 percent.

APPENDIX

PRINCIPAL TREE SPECIES GROUPS IN MINNESOTA[6]

Softwoods
- Eastern white pine ..... *Pinus strobus*
- Red pine ..... *Pinus resinosa*
- Jack pine ..... *Pinus banksiana*
- Black spruce ..... *Picea mariana*
- White spruce ..... *Picea glauca*
- Balsam fir ..... *Abies balsamea*
- Tamarack ..... *Larix laricina*
- Northern white-cedar ..... *Thuja occidentalis*
- Other softwoods
  - Eastern redcedar ..... *Juniperus virginiana*
  - Scotch pine ..... *Pinus sylvestris*

Hardwoods
- White oaks
  - White oak ..... *Quercus alba*
  - Bur oak ..... *Quercus macrocarpa*
  - Swamp white oak ..... *Quercus bicolor*
- Select red oak
  - Northern red oak ..... *Quercus rubra*
- Other red oaks
  - Black oak ..... *Quercus velutina*
  - Northern pin oak ..... *Quercus ellipsoidalis*
- Hickories
  - Shagbark hickory ..... *Carya ovata*
  - Bitternut hickory ..... *Carya cordiformis*
- Yellow birch ..... *Betula alleghaniensis*
- Hard maples
  - Sugar maple ..... *Acer saccharum*
  - Black maple ..... *Acer nigrum*
- Soft maples
  - Red maple ..... *Acer rubrum*
  - Silver maple ..... *Acer saccharinum*
- Ashes
  - White ash ..... *Fraxinus americana*
  - Black ash ..... *Fraxinus nigra*
  - Green ash ..... *Fraxinus pennsylvanica*
- Balsam poplar ..... *Populus balsamifera*
- Paper birch ..... *Betula papyrifera*
- Aspens
  - Bigtooth aspen ..... *Populus grandidentata*
  - Quaking aspen ..... *Populus tremuloides*
- Basswood ..... *Tilia americana*
- Elms
  - American elm ..... *Ulmus americana*
  - Slippery elm ..... *Ulmus rubra*
  - Rock elm ..... *Ulmus thomasii*
- Select hardwoods
  - Butternut ..... *Juglans cinerea*
  - Black walnut ..... *Juglans nigra*
  - Black cherry ..... *Prunus serotina*
- Other hardwoods
  - Boxelder ..... *Acer negundo*
  - River birch ..... *Betula nigra*
  - Hackberry ..... *Celtis occidentalis*
  - Eastern cottonwood ..... *Populus deltoides*
  - Black willow ..... *Salix nigra*
  - Kentucky coffeetree ... *Gymnocladus dioicus*

[6]*The common and scientific names are based on: Little, Elbert D. Checklist of native and naturalized trees of the United States. Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service; 1979. 375 p.*

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.

UNIVERSAL TRANSVERSE MERCATOR (UTM) GRID SYSTEM

The UTM Grid system is designed for world use between 80° south latitude and 84° north latitude. The globe is divided into narrow zones of 6° of longitude in width, numbered 1 through 60. Each zone is bounded on the east and west by a meridian of longitude and with a central meridian passing through the center of the grid zone. In the northern hemisphere the intersection of the central meridian and the equator is given a value of 0 meters for north-south coordinates, and the numbers increase towards the north pole. Because values increase from west to east, this same point of intersection is given a value of 500,000 meters for east-west coordinates to avoid negative numbers at the west edge of the zone. A grid system of two sets of parallel lines intersecting at right angles and forming a series of squares is established within each grid zone. On the U.S. Geological Survey maps used, the grid interval or length of each side of these squares is 1,000 meters. Each grid square can be referenced by two nu-

merical coordinates intersecting in the lower left corner of the square. The first of these coordinates represents the distance in meters east or west of the central meridian of the grid zone and the second coordinate represents the distance in meters north of the equator. Any point within a grid square can be referenced by using these coordinates and by dividing the sides of the grid square into 10 or multiples of 10 parts. The point coordinates, then, are read to a greater number of digits than the grid coordinates. Such a system permits location of a point to the nearest 10 meters.

DEFINITION OF TERMS

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam and hawthorn.)

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Diameter classes.—A classification of trees based on diameter outside bark, measured at breast height (4½ feet above the ground). (Note: d.b.h. is the common abbreviation for diameter at breast height. Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.)

Farm.—Any place from which $1,000 or more of agricultural products were produced and sold during the year.

Farmer-owned land.—Land owned by farm operators. (Note: Excludes land leased by farm operators from nonfarm owners, such as railroad companies and States.)

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas are classed as forest if less than 120 feet wide. Also see definitions for land area, timberland, unproductive forest land, and water.

Forest industry land.—Land owned by companies or individuals operating primary wood-using plants.

Forest trees.—Woody plants having a well-developed stem and usually more than 12 feet tall at maturity.

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. Major forest types in the State are:

Jack pine.—Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple.)

Red pine.—Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)

White pine.—Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, aspen, birch, and maple.)

Balsam fir.—Forests in which balsam fir and white spruce comprise a plurality of the stocking with balsam fir the most common. (Common associates include white spruce, aspen, maple, birch, northern white-cedar, and tamarack.)

White spruce.—Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include balsam fir, aspen, maple, birch, and northern white-cedar.)

Black spruce.—Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)

Northern white-cedar.—Forests in which swamp conifers comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)

Tamarack.—Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)

Oak-hickory.—Forests in which northern red oak, white oak, or bur oak, singly or in combination, comprise a plurality of the stocking. (Common associates include aspen, elm, and maple.)

Elm-ash-cottonwood.—Forests in which lowland elm, ash, cottonwood, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include basswood and balsam poplar.)

Maple-basswood.—Forests in which sugar maple, basswood, yellow birch, elm, and red

maple, singly or in combination, comprise a plurality of the stocking. (Common associates include white pine and elm.)

Aspen.—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)

Paper birch.—Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)

Balsam poplar.—Forests in which balsam poplar comprises a plurality of the stocking. (Common associates include aspen, elm, and ash.)

Growing-stock trees.—Live trees of commercial species qualifying as desirable and acceptable trees. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5 inches d.b.h. and over, from a 1-foot stump to a minimum 4 inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs. Cubic feet can be converted to standard cords by dividing by 79. One standard cord is 128 cubic feet of stacked wood, including bark and air.

Hardwoods.—Dicotyledonous trees, usually broadleaved and deciduous.

Indian land.—All lands held in trust by the United States for individual Indians or tribes, or all lands, titles to which are held by indiviual Indians or tribes, subject to Federal restrictions against alienation.

Land area.—A. *Bureau of the Census*. The area of dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

B. *Forest Inventory and Analysis*. The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Live trees.—Growing-stock, rough, and rotten trees 1 inch d.b.h. and larger.

Maintained road.—Any road, hard-topped or other surface, that is plowed or graded at least once a year. Includes rights-of-way that are cut or treated to limit herbaceous growth.

Miscellaneous Federal land.—Federal land other than National Forest and land administered by the Bureau of Land Management.

Miscellaneous private land.—Privately owned land other than forest-industry and farmer-owned land.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land administered by the USDA Forest Service.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.)

a. *Nonforest land without trees*.—Nonforest land with no live trees present.

b. *Nonforest land with trees*.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Timberland less than 16.7 percent stocked with growing-stock trees.

Poletimber trees.—Growing-stock trees of commercial species at least 5 inches d.b.h. but smaller than sawtimber size.

Saplings.—Live trees 1 to 5 inches d.b.h.

Sapling-seedling stands.—(See stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) of 7 inches for softwoods (9 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw log portion.—That part of the bole of sawtimber trees between the stump and the saw log top.

Saw log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw log top is 7 inches d.o.b. for softwoods and 9 inches d.o.b. for hardwoods.

Sawtimber stands.—(See stand-size class.)

Sawtimber trees.—Growing-stock trees of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom

from defect. Softwoods must be at least 9 inches d.b.h. Hardwoods must be at least 11 inches d.b.h.

Sawtimber volume.—Net volume of the saw log portion of live sawtimber in board feet, International 1/4-inch rule, from stump to a minimum 7 inches top diameter outside bark (d.o.b.) for softwoods and a minimum 9 inches top d.o.b. for hardwoods.

Seedlings.—Live trees less than 1 inch d.b.h. that are expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A growth of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—Age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class.—A classification of forest land based on the size class of growing-stock trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

a. *Sawtimber stands*.—Stands at least 16.7 percent stocked with growing-stock trees, with half or more of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

b. *Poletimber stands*.—Stands at least 16.7 percent stocked with growing-stock trees of which half or more of this stocking is in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

c. *Sapling-seedling stands*.—Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the stocking is saplings and/or seedlings.

d. *Nonstocked areas*.—Timberland on which stocking of growing-stock trees is less than 16.7 percent.

State land.—Land either owned by States or leased to them for 50 years or more.

Timberland.—Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as timberland are capable of producing more than 20 cubic feet per acre per year of annual growth when managed. Currently inaccessible and inoperable areas are included except when the areas involved are small and unlikely to become suitable for producing industrial wood in the foreseeable future.)

Unproductive forest land.—Forest land incapable of producing 20 cubic feet per acre of annual growth or of yielding crops of industrial wood under natural conditions because of adverse site conditions. (Note: Adverse conditions include shallow soil, dry climate, poor drainage, high elevation, steepness, and rockiness.)

Upper stem portion.—That part of the bole of sawtimber trees above the saw log top to a minimum top diameter of 4 inches outside bark or to the point where the central stem breaks into limbs.

Urban and other areas.—Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; schoolyards; cemeteries; roads; railroads; airports; beaches; powerlines; other rights-of-way; or other nonforest land not included in any other specified land use class.

Water—(a) *Bureau of the Census*.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) *Noncensus*.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

TABLES

Text Tables

Appendix Tables

Table 6.--Area of timberland by operability class component and forest type, Minnesota, 1977

(In thousand acres)

Operability class component	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
Stand area (acres)									
More than 60	3,176.9	88.8	29.3	15.6	85.9	20.7	207.4	59.8	75.1
10-60	4,391.6	139.3	136.6	13.9	230.2	12.9	306.9	140.3	151.9
Less than 10	6,135.4	276.3	81.1	36.1	541.5	45.6	527.7	298.5	238.9
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Growing-stock volume per acre (cubic feet/acre)									
More than 800	6,370.3	294.8	183.4	59.5	384.0	20.7	221.4	212.6	81.1
300-800	4,581.7	170.3	35.5	4.2	335.8	26.4	352.2	189.7	181.0
Less than 300	2,751.9	39.3	28.1	1.9	137.8	32.1	468.4	96.3	203.8
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Sawtimber volume per acre (board feet/acre)									
More than 3000	2,719.1	140.6	156.5	57.0	125.4	15.3	20.2	115.0	13.9
1100-3000	3,875.5	160.5	31.8	6.7	296.6	15.5	118.4	164.8	77.0
Less than 1100	7,109.3	203.3	58.7	1.9	435.6	48.4	903.4	218.8	375.0
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Percent cull trees (percent)									
Less than 20	8,386.1	439.6	181.0	49.2	630.0	37.3	794.1	253.0	301.4
20-50	3,957.4	50.0	46.0	13.2	179.4	17.3	115.7	205.5	95.9
More than 50	1,360.4	14.8	20.0	3.2	48.2	24.6	132.2	40.1	68.6
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Average d.b.h. of growing-stock trees (inches)									
More than 10	1,581.6	30.8	50.3	13.3	35.4	6.9	10.0	18.0	12.4
6-10	10,764.5	423.5	170.5	50.4	783.4	48.4	655.4	445.8	314.3
Less than 6	1,357.8	50.1	26.2	1.9	38.8	23.9	376.6	34.8	139.2
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Average merchantable height of growing-stock trees (feet)									
More than 28	8,543.7	249.1	172.8	54.4	374.9	28.9	230.1	65.5	118.8
16-28	4,469.6	236.3	55.6	9.3	470.0	29.8	691.6	408.1	292.6
Less than 16	690.6	19.0	18.6	1.9	12.7	20.5	120.3	25.0	54.5
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9
Distance to road (miles)									
Less than 1/4	4,690.3	270.6	111.1	21.1	201.0	38.0	163.7	92.0	102.6
1/4 - 3/4	6,173.2	195.4	106.8	38.7	404.6	16.1	430.8	198.6	187.7
More than 3/4	2,840.4	38.4	29.1	5.8	252.0	25.1	447.5	208.0	175.6
All classes	13,703.9	504.4	247.0	65.6	857.6	79.2	1,042.0	498.6	465.9

(Table 6 continued on the next page)

(Table 6 continued)

Operability class component	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
Stand area (acres)							
More than 60	438.6	106.1	378.7	1,329.1	288.7	45.4	7.7
10-60	262.6	210.3	491.8	1,753.9	348.6	158.0	34.4
Less than 10	196.3	421.8	415.3	2,222.1	361.4	345.2	127.6
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Growing-stock volume per acre (cubic feet/acre)							
More than 800	464.7	314.7	731.3	2,610.5	587.8	203.8	--
300-800	345.0	302.4	433.1	1,694.8	310.3	192.2	8.8
Less than 300	87.8	121.1	121.4	999.8	100.6	152.6	160.9
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Sawtimber volume per acre (board feet/acre)							
More than 3000	364.2	151.5	578.5	770.8	125.1	85.1	--
1100-3000	308.3	266.6	397.8	1,519.4	373.9	135.4	2.8
Less than 1100	225.0	320.1	309.5	3,014.9	499.7	328.1	166.9
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Percent cull trees (percent)							
Less than 20	537.1	427.2	632.6	3,005.8	702.7	343.5	51.6
20-50	286.9	253.4	518.3	1,762.4	247.1	150.4	15.9
More than 50	73.5	57.6	134.9	536.9	48.9	54.7	102.2
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Average d.b.h. of growing-stock trees (inches)							
More than 10	338.1	84.1	425.8	428.7	54.5	50.6	22.7
6-10	546.1	633.1	846.8	4,442.9	892.9	431.6	79.4
Less than 6	13.3	21.0	13.2	433.5	51.3	66.4	67.6
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Average merchantable height of growing-stock trees (feet)							
More than 28	718.1	464.4	1,088.0	3,892.4	704.5	340.7	41.1
16-28	167.6	263.1	194.8	1,149.8	269.1	170.0	61.9
Less than 16	11.8	10.7	3.0	262.9	25.1	37.9	66.7
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7
Distance to road (miles)							
Less than 1/4	407.1	257.5	532.9	1,938.2	296.4	215.2	42.9
1/4 - 3/4	456.3	353.1	584.7	2,422.8	444.8	251.0	81.8
More than 3/4	34.1	127.6	168.2	944.1	257.5	82.4	45.0
All classes	897.5	738.2	1,285.8	5,305.1	998.7	548.6	169.7

Table 7.--Area of timberland by forest type and operability class, Minnesota, 1977

(In thousand acres)

Forest type	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack pine	504.4	2.4	126.1	294.6	81.3
Red pine	247.0	--	60.2	103.5	83.3
White pine	65.6	--	24.9	37.4	3.3
Balsam fir	857.6	--	119.6	510.8	227.2
White spruce	79.2	--	3.6	37.7	37.9
Black spruce	1,042.0	--	36.3	404.7	601.0
Northern white-cedar	498.6	--	51.5	372.4	74.7
Tamarack	465.9	--	25.1	216.4	224.4
Oak-hickory	897.5	24.5	460.0	332.7	80.3
Elm-ash-cottonwood	738.2	1.4	145.9	435.2	155.7
Maple-basswood	1,285.8	22.4	521.8	625.9	115.7
Aspen	5,305.1	1.4	1,065.4	2,731.0	1,507.3
Paper birch	998.7	--	219.1	682.7	96.9
Balsam poplar	548.6	--	75.5	288.8	184.3
Nonstocked	169.7	--	--	--	169.7
All types	13,703.9	52.1	2,935.0	7,073.8	3,643.0

Table 8.--Area of timberland in operability class II (medium) by limiting factor and forest type, Minnesota, 1977

(In thousand acres)

Limiting factor	All types	Forest type							
		Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1	52.7	--	5.9	1.4	--	--	--	--	--
2	6.5	--	0.4	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--
4	32.2	--	--	--	--	--	--	--	--
5	79.5	8.9	--	5.2	--	--	--	1.4	--
6	--	--	--	--	--	--	--	--	--
7	74.9	--	5.8	1.4	--	--	--	--	--
1 & 2	8.7	--	--	--	--	--	--	--	--
1 & 3	3.1	--	--	--	--	--	--	--	--
1 & 4	44.7	--	--	--	--	--	--	1.3	--
1 & 5	134.9	16.2	13.4	1.6	4.0	--	--	3.5	--
1 & 6	--	--	--	--	--	--	--	--	--
1 & 7	56.8	4.9	2.8	1.4	--	1.3	--	--	--
2 & 3	4.6	--	--	--	--	--	--	--	--
2 & 4	10.6	--	--	--	--	--	--	--	--
2 & 5	1.5	--	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--	--	--
2 & 7	15.0	1.7	--	--	--	--	--	--	1.6
3 & 4	5.4	--	--	--	--	--	--	--	--
3 & 5	83.6	2.8	1.4	--	--	--	--	--	--
3 & 6	--	--	--	--	--	--	--	--	--
3 & 7	--	--	--	--	--	--	--	--	--
4 & 5	26.3	--	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--	--	--
4 & 7	86.2	--	--	--	--	--	--	--	--
5 & 6	3.5	2.0	--	--	--	--	--	--	--
5 & 7	200.2	13.4	1.1	5.2	9.8	--	1.4	1.4	--
6 & 7	--	--	--	--	--	--	--	--	--

(Table 8 continued on the next page)

(Table 8 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1	11.1	--	24.6	8.3	--	1.4	--
2	4.6	--	1.5	--	--	--	--
3	--	--	--	--	--	--	--
4	9.9	2.6	19.7	--	--	--	--
5	19.2	1.3	11.2	26.8	2.7	2.8	--
6	--	--	--	--	--	--	--
7	39.9	4.2	17.6	6.0	--	--	--
1 & 2	1.5	--	5.8	1.4	--	--	--
1 & 3	--	--	1.6	1.5	--	--	--
1 & 4	17.1	1.3	14.4	9.3	1.3	--	--
1 & 5	14.7	6.9	24.8	38.0	9.0	2.8	--
1 & 6	--	--	--	--	--	--	--
1 & 7	10.9	1.4	22.2	7.8	2.7	1.4	--
2 & 3	1.7	--	1.5	1.4	--	--	--
2 & 4	9.0	--	1.6	--	--	--	--
2 & 5	1.5	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--
2 & 7	8.5	1.6	1.6	--	--	--	--
3 & 4	--	--	1.4	4.0	--	--	--
3 & 5	16.0	--	7.2	41.2	15.0	--	--
3 & 6	--	--	--	--	--	--	--
3 & 7	--	--	--	--	--	--	--
4 & 5	2.8	1.1	7.7	14.7	--	--	--
4 & 6	--	--	--	--	--	--	--
4 & 7	30.0	--	31.8	24.4	--	--	--
5 & 6	1.5	--	--	--	--	--	--
5 & 7	40.6	5.9	39.0	73.9	4.3	4.2	--
6 & 7	--	--	--	--	--	--	--

(Table 8 continued on the next page)

(Table 8 continued)

Limiting factor	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1 & 2 & 3	17.3	--	--	--	1.6	--	--	--	--
1 & 2 & 4	2.8	--	--	--	--	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--	--	--
1 & 2 & 7	4.7	--	1.4	--	--	--	--	--	--
1 & 3 & 4	3.9	--	--	--	--	--	--	--	--
1 & 3 & 5	145.1	8.1	1.4	--	6.7	--	--	--	--
1 & 3 & 6	--	--	--	--	--	--	--	--	--
1 & 3 & 7	5.4	1.4	--	--	--	--	--	--	--
1 & 4 & 5	43.6	--	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--	--	--
1 & 4 & 7	68.6	--	5.8	1.4	--	--	--	2.6	--
1 & 5 & 6	10.6	--	--	--	1.4	--	--	1.4	1.4
1 & 5 & 7	204.8	15.7	8.2	2.1	10.5	--	3.9	2.7	1.1
1 & 6 & 7	--	--	--	--	--	--	--	--	--
2 & 3 & 4	5.8	--	--	--	--	--	--	--	--
2 & 3 & 5	25.6	--	--	--	--	--	--	5.3	--
2 & 3 & 6	--	--	--	--	--	--	--	--	--
2 & 3 & 7	4.4	--	--	--	--	--	--	--	--
2 & 4 & 5	1.3	--	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--	--	--
2 & 4 & 7	9.4	--	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--	--	--
2 & 5 & 7	2.6	--	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--	--	--
3 & 4 & 5	39.6	--	--	--	8.5	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--	--	--
3 & 4 & 7	4.0	--	--	--	--	--	--	--	--
3 & 5 & 6	9.5	3.9	--	--	--	--	--	--	--
3 & 5 & 7	226.5	7.8	--	--	11.0	--	1.4	--	1.3
3 & 6 & 7	--	--	--	--	--	--	--	--	--
4 & 5 & 6	1.6	--	--	--	--	--	--	--	--
4 & 5 & 7	49.9	--	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--	--	--
5 & 6 & 7	11.9	--	--	3.8	--	--	--	3.9	--
4 or more	1,105.2	39.3	12.6	1.4	66.1	2.3	29.6	28.0	19.7
All factors	2,935.0	126.1	60.2	24.9	119.6	3.6	36.3	51.5	25.1

(Table 8 continued on the next page)

(Table 8 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1 & 2 & 3	3.3	2.7	5.5	4.2	--	--	--
1 & 2 & 4	1.3	--	1.5	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--
1 & 2 & 7	--	--	3.3	--	--	--	--
1 & 3 & 4	--	--	1.1	2.8	--	--	--
1 & 3 & 5	10.2	9.9	12.8	70.2	16.4	9.4	--
1 & 3 & 6	--	--	--	--	--	--	--
1 & 3 & 7	--	--	--	4.0	--	--	--
1 & 4 & 5	2.5	3.3	6.8	24.4	4.0	2.6	--
1 & 4 & 6	--	--	--	--	--	--	--
1 & 4 & 7	8.7	2.5	22.8	20.4	1.3	3.1	--
1 & 5 & 6	--	--	5.0	1.4	--	--	--
1 & 5 & 7	9.8	11.2	31.7	80.6	17.7	9.6	--
1 & 6 & 7	--	--	--	--	--	--	--
2 & 3 & 4	4.5	--	1.3	--	--	--	--
2 & 3 & 5	7.8	1.6	1.4	9.5	--	--	--
2 & 3 & 6	--	--	--	--	--	--	--
2 & 3 & 7	1.7	--	1.3	1.4	--	--	--
2 & 4 & 5	1.3	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--
2 & 4 & 7	9.4	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--
2 & 5 & 7	--	1.3	1.3	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--
3 & 4 & 5	4.0	1.4	5.5	17.4	1.4	1.4	--
3 & 4 & 6	--	--	--	--	--	--	--
3 & 4 & 7	2.6	--	--	1.4	--	--	--
3 & 5 & 6	3.0	1.3	--	1.3	--	--	--
3 & 5 & 7	17.5	5.6	16.5	128.2	33.0	4.2	--
3 & 6 & 7	--	--	--	--	--	--	--
4 & 5 & 6	--	--	1.6	--	--	--	--
4 & 5 & 7	4.1	1.4	12.4	32.0	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--
5 & 6 & 7	--	--	4.2	--	--	--	--
4 or more	127.8	77.4	150.6	407.5	110.3	32.6	--
All factors	460.0	145.9	521.8	1,065.4	219.1	75.5	--

Table 9.--Area of timberland in operability class III (poor) by limiting factor and forest type, Minnesota, 1977

(In thousand acres)

Limiting factor	All types	Forest type							
		Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1	1,901.2	139.0	58.9	31.7	144.6	15.6	24.8	105.6	32.2
2	9.7	--	1.1	--	--	--	--	--	1.6
3	1,404.6	46.1	6.6	--	45.7	3.2	66.9	18.9	22.5
4	105.1	--	--	--	1.4	--	--	3.1	1.6
5	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	--	--	--	--
7	685.5	6.9	20.0	2.7	39.2	5.6	31.7	42.0	14.3
1 & 2	10.0	--	--	--	--	--	--	1.2	--
1 & 3	1,118.1	73.1	2.4	--	113.6	7.4	79.4	33.4	36.1
1 & 4	81.3	--	1.4	1.3	--	--	--	3.9	--
1 & 5	--	--	--	--	--	--	--	--	--
1 & 6	--	--	--	--	--	--	--	--	--
1 & 7	449.0	15.0	7.7	1.7	72.8	3.9	32.9	64.1	11.9
2 & 3	86.6	--	--	--	2.5	--	2.9	6.7	2.8
2 & 4	3.8	--	--	--	--	--	--	--	--
2 & 5	--	--	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--	--	--
2 & 7	--	--	--	--	--	--	--	--	--
3 & 4	49.7	--	--	--	--	--	--	1.5	--
3 & 5	65.6	1.4	1.9	--	1.3	--	18.4	--	10.0
3 & 6	--	--	--	--	--	--	--	--	--
3 & 7	401.2	1.7	--	--	33.6	--	45.7	19.2	33.5
4 & 5	--	--	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--	--	--
4 & 7	19.9	--	--	--	1.5	0.7	--	3.0	--
5 & 6	--	--	--	--	--	--	--	--	--
5 & 7	--	--	--	--	--	--	--	--	--
6 & 7	--	--	--	--	--	--	--	--	--

(Table 9 continued on the next page)

(Table 9 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1	110.7	160.4	214.7	610.5	158.3	94.2	--
2	3.1	--	2.5	--	1.4	--	--
3	92.0	49.6	67.9	784.3	168.5	32.4	--
4	21.3	8.7	43.8	23.8	1.4	--	--
5	--	--	--	--	--	--	--
6	--	--	--	--	--	--	--
7	15.2	40.1	72.4	299.2	82.2	14.0	--
1 & 2	2.2	1.6	2.5	2.5	--	--	--
1 & 3	26.2	82.6	62.9	443.7	80.7	76.6	--
1 & 4	17.0	10.8	23.1	19.4	1.4	3.0	--
1 & 5	--	--	--	--	--	--	--
1 & 6	--	--	--	--	--	--	--
1 & 7	1.4	33.0	32.2	127.1	27.8	17.5	--
2 & 3	13.7	11.8	16.9	17.9	7.1	4.3	--
2 & 4	0.7	--	3.1	--	--	--	--
2 & 5	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--
2 & 7	--	--	--	--	--	--	--
3 & 4	6.1	2.7	6.8	27.2	4.0	1.4	--
3 & 5	--	1.4	2.8	25.7	1.4	1.3	--
3 & 6	--	--	--	--	--	--	--
3 & 7	8.3	11.7	24.9	145.7	61.9	15.0	--
4 & 5	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--
4 & 7	--	--	7.8	5.5	--	1.4	--
5 & 6	--	--	--	--	--	--	--
5 & 7	--	--	--	--	--	--	--
6 & 7	--	--	--	--	--	--	--

(Table 9 continued on the next page)

(Table 9 continued)

Limiting factor	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1 & 2 & 3	119.9	2.6	--	--	10.2	--	12.7	6.4	7.7
1 & 2 & 4	4.4	--	--	--	--	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--	--	--
1 & 2 & 7	2.3	--	--	--	--	--	--	1.1	1.2
1 & 3 & 4	21.5	--	--	--	--	--	1.1	--	--
1 & 3 & 5	27.7	1.4	2.1	--	1.1	--	6.3	1.6	3.6
1 & 3 & 6	1.6	--	--	--	--	--	--	1.6	--
1 & 3 & 7	270.1	1.5	1.4	--	32.4	1.3	46.1	19.8	17.0
1 & 4 & 5	--	--	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--	--	--
1 & 4 & 7	20.9	1.3	--	--	1.3	--	1.3	2.2	--
1 & 5 & 6	--	--	--	--	--	--	--	--	--
1 & 5 & 7	--	--	--	--	--	--	--	--	--
1 & 6 & 7	--	--	--	--	--	--	--	--	--
2 & 3 & 4	22.9	--	--	--	2.7	--	--	--	--
2 & 3 & 5	3.0	--	--	--	--	--	1.3	--	--
2 & 3 & 6	--	--	--	--	--	--	--	--	--
2 & 3 & 7	22.7	--	--	--	1.4	--	3.8	1.3	4.3
2 & 4 & 5	--	--	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--	--	--
2 & 4 & 7	--	--	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--	--	--
2 & 5 & 7	--	--	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--	--	--
3 & 4 & 5	--	--	--	--	--	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--	--	--
3 & 4 & 7	4.0	--	--	--	--	--	--	--	--
3 & 5 & 6	1.1	--	--	--	--	--	--	1.1	--
3 & 5 & 7	54.9	4.6	--	--	4.1	--	19.8	5.6	8.8
3 & 6 & 7	1.4	--	--	--	--	--	--	1.4	--
4 & 5 & 6	--	--	--	--	--	--	--	--	--
4 & 5 & 7	--	--	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--	--	--
5 & 6 & 7	--	--	--	--	--	--	--	--	--
4 or more	104.1	--	--	--	1.4	--	9.6	27.7	7.3
All factors	7,073.8	294.6	103.5	37.4	510.8	37.7	404.7	372.4	216.4

(Table 9 continued on the next page)

(Table 9 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1 & 2 & 3	7.5	6.8	12.3	33.5	7.3	12.9	--
1 & 2 & 4	--	1.4	1.3	1.7	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--
1 & 2 & 7	--	--	--	--	--	--	--
1 & 3 & 4	--	2.6	--	13.9	3.9	--	--
1 & 3 & 5	--	--	1.6	7.0	--	3.0	--
1 & 3 & 6	--	--	--	--	--	--	--
1 & 3 & 7	--	5.8	7.0	100.1	31.2	6.5	--
1 & 4 & 5	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--
1 & 4 & 7	1.4	--	2.7	8.3	1.4	1.0	--
1 & 5 & 6	--	--	--	--	--	--	--
1 & 5 & 7	--	--	--	--	--	--	--
1 & 6 & 7	--	--	--	--	--	--	--
2 & 3 & 4	4.6	1.3	5.9	7.0	1.4	--	--
2 & 3 & 5	--	--	--	--	1.7	--	--
2 & 3 & 6	--	--	--	--	--	--	--
2 & 3 & 7	--	--	--	2.7	9.2	--	--
2 & 4 & 5	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--
2 & 4 & 7	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--
2 & 5 & 7	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--
3 & 4 & 5	--	--	--	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--
3 & 4 & 7	1.3	--	--	2.7	--	--	--
3 & 5 & 6	--	--	--	--	--	--	--
3 & 5 & 7	--	--	--	1.4	9.2	1.4	--
3 & 6 & 7	--	--	--	--	--	--	--
4 & 5 & 6	--	--	--	--	--	--	--
4 & 5 & 7	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--
5 & 6 & 7	--	--	--	--	--	--	--
4 or more	--	2.9	10.8	20.2	21.3	2.9	--
All factors	332.7	435.2	625.9	2,731.0	682.7	288.8	--

Table 10.--Area of timberland by forest type, average growing-stock volume per acre, and operability class, Minnesota, 1977

(In thousand acres)

Forest type and average growing-stock volume per acre (cu.ft. per acre)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
More than 800	294.8	2.4	113.0	176.5	2.9
300-800	170.3	--	13.1	115.5	41.7
Less than 300	39.3	--	--	2.6	36.7
Total	504.4	2.4	126.1	294.6	81.3
Red pine					
More than 800	183.4	--	57.1	88.4	37.9
300-800	35.5	--	3.1	14.0	18.4
Less than 300	28.1	--	--	1.1	27.0
Total	247.0	--	60.2	103.5	83.3
White pine					
More than 800	59.5	--	24.9	34.6	--
300-800	4.2	--	--	2.8	1.4
Less than 300	1.9	--	--	--	1.9
Total	65.6	--	24.9	37.4	3.3
Balsam fir					
More than 800	384.0	--	95.7	285.3	3.0
300-800	335.8	--	23.9	208.7	103.2
Less than 300	137.8	--	--	16.8	121.0
Total	857.6	--	119.6	510.8	227.2
White spruce					
More than 800	20.7	--	2.9	17.8	--
300-800	26.4	--	0.7	19.9	5.8
Less than 300	32.1	--	--	--	32.1
Total	79.2	--	3.6	37.7	37.9
Black spruce					
More than 800	221.4	--	28.6	191.4	1.4
300-800	352.2	--	7.7	189.9	154.6
Less than 300	468.4	--	--	23.4	445.0
Total	1,042.0	--	36.3	404.7	601.0
Northern white-cedar					
More than 800	212.6	--	29.7	182.9	--
300-800	189.7	--	21.8	151.6	16.3
Less than 300	96.3	--	--	37.9	58.4
Total	498.6	--	51.5	372.4	74.7
Tamarack					
More than 800	81.1	--	13.6	67.5	--
300-800	181.0	--	11.5	124.0	45.5
Less than 300	203.8	--	--	24.9	178.9
Total	465.9	--	25.1	216.4	224.4

(Table 10 continued on the next page)

(Table 10 continued)

Forest type and average growing-stock volume per acre (cu.ft. per acre)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Oak-hickory					
More than 800	464.7	24.5	317.6	122.6	--
300-800	345.0	--	142.4	178.3	24.3
Less than 300	87.8	--	--	31.8	56.0
Total	897.5	24.5	460.0	332.7	80.3
Elm-ash-cottonwood					
More than 800	314.7	1.4	97.6	215.7	--
300-800	302.4	--	48.3	193.7	60.4
Less than 300	121.1	--	.0	25.8	95.3
Total	738.2	1.4	145.9	435.2	155.7
Maple-basswood					
More than 800	731.3	22.4	414.1	294.8	--
300-800	433.1	--	107.7	275.8	49.6
Less than 300	121.4	--	--	55.3	66.1
Total	1,285.8	22.4	521.8	625.9	115.7
Aspen					
More than 800	2,610.5	1.4	940.9	1,637.9	30.3
300-800	1,694.8	--	124.5	1,010.4	559.9
Less than 300	999.8	--	--	82.7	917.1
Total	5,305.1	1.4	1,065.4	2,731.0	1,507.3
Paper birch					
More than 800	587.8	--	194.2	388.8	4.8
300-800	310.3	--	24.9	244.5	40.9
Less than 300	100.6	--	--	49.4	51.2
Total	998.7	--	219.1	682.7	96.9
Balsam poplar					
More than 800	203.8	--	68.4	135.4	--
300-800	192.2	--	7.1	133.3	51.8
Less than 300	152.6	--	--	20.1	132.5
Total	548.6	--	75.5	288.8	184.3
Nonstocked					
More than 800	--	--	--	--	--
300-800	8.8	--	--	--	8.8
Less than 300	160.9	--	--	--	160.9
Total	169.7	--	--	--	169.7
All types					
More than 800	6,370.3	52.1	2,398.3	3,839.6	80.3
300-800	4,581.7	--	536.7	2,862.4	1,182.6
Less than 300	2,751.9	--	--	371.8	2,380.1
Total	13,703.9	52.1	2,935.0	7,073.8	3,643.0

Table 11.--Area of timberland by forest type, stand-age class, and operability class, Minnesota, 1977

(In thousand acres)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
less than 21	57.6	--	--	--	57.6
21-40	162.3	--	17.4	121.2	23.7
41-60	218.1	--	79.0	139.1	--
61-80	54.3	--	28.3	26.0	--
81-100	9.4	2.4	1.4	5.6	--
101-120	2.7	--	--	2.7	--
More than 120	--	--	--	--	--
Total	504.4	2.4	126.1	294.6	81.3
Red pine					
less than 21	28.9	--	--	1.9	27.0
21-40	85.8	--	6.0	23.5	56.3
41-60	40.7	--	22.9	17.8	--
61-80	44.3	--	10.6	33.7	--
81-100	33.0	--	13.5	19.5	--
101-120	8.5	--	7.2	1.3	--
More than 120	5.8	--	--	5.8	--
Total	247.0	--	60.2	103.5	83.3
White pine					
less than 21	3.3	--	--	--	3.3
21-40	5.1	--	3.8	1.3	--
41-60	11.0	--	2.8	8.2	--
61-80	19.5	--	3.7	15.8	--
81-100	20.2	--	9.4	10.8	--
101-120	6.5	--	5.2	1.3	--
More than 120	--	--	--	--	--
Total	65.6	--	24.9	37.4	3.3
Balsam fir					
less than 21	132.7	--	--	1.6	131.1
21-40	188.0	--	13.7	78.2	96.1
41-60	413.1	--	73.5	339.6	--
61-80	92.0	--	18.8	73.2	--
81-100	22.3	--	6.8	15.5	--
101-120	9.5	--	6.8	2.7	--
More than 120	--	--	--	--	--
Total	857.6	--	119.6	510.8	227.2

(Table 11 continued on the next page)

(Table 11 continued)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
White spruce					
less than 21	33.8	--	--	--	33.8
21-40	8.7	--	--	4.6	4.1
41-60	22.6	--	1.6	21.0	--
61-80	10.5	--	0.7	9.8	--
81-100	2.5	--	1.3	1.2	--
101-120	1.1	--	--	1.1	--
More than 120	--	--	--	--	--
Total	79.2	--	3.6	37.7	37.9
Black spruce					
less than 21	172.4	--	--	--	172.4
21-40	335.3	--	--	16.3	319.0
41-60	218.2	--	21.1	123.1	74.0
61-80	176.4	--	10.9	145.3	20.2
81-100	110.1	--	2.7	94.7	12.7
101-120	17.1	--	1.6	12.8	2.7
More than 120	12.5	--	--	12.5	--
Total	1,042.0	--	36.3	404.7	601.0
Northern white-cedar					
less than 21	23.0	--	--	5.4	17.6
21-40	46.5	--	--	9.4	37.1
41-60	67.3	--	11.7	44.0	11.6
61-80	108.1	--	7.7	96.3	4.1
81-100	114.6	--	10.3	100.0	4.3
101-120	60.4	--	6.7	53.7	--
More than 120	78.7	--	15.1	63.6	--
Total	498.6	--	51.5	372.4	74.7
Tamarack					
less than 21	112.0	--	--	--	112.0
21-40	80.2	--	--	6.8	73.4
41-60	99.9	--	10.7	61.9	27.3
61-80	63.3	--	7.3	46.8	9.2
81-100	44.4	--	2.7	39.2	2.5
101-120	38.1	--	2.8	35.3	--
More than 120	28.0	--	1.6	26.4	--
Total	465.9	--	25.1	216.4	224.4
Oak-hickory					
less than 21	66.7	--	--	--	66.7
21-40	69.7	--	25.7	30.4	13.6
41-60	277.1	--	132.5	144.6	--
61-80	242.4	5.5	153.4	83.5	--
81-100	186.4	15.0	114.4	57.0	--
101-120	47.6	4.0	27.9	15.7	--
More than 120	7.6	--	6.1	1.5	--
Total	897.5	24.5	460.0	332.7	80.3
Elm-ash-cottonwood					
less than 21	99.3	--	--	--	99.3
21-40	87.0	--	14.5	22.6	49.9
41-60	195.9	--	51.4	139.6	4.9
61-80	187.7	1.4	51.0	133.7	1.6
81-100	116.7	--	20.4	96.3	--
101-120	32.3	--	4.1	28.2	--
More than 120	19.3	--	4.5	14.8	--
Total	738.2	1.4	145.9	435.2	155.7

(Table 11 continued on the next page)

(Table 11 continued)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Maple-basswood					
less than 21	83.5	--	--	0.5	83.0
21-40	133.8	--	26.8	75.7	31.3
41-60	419.3	3.0	164.5	251.8	--
61-80	376.2	7.8	187.4	181.0	--
81-100	180.6	5.6	98.9	76.1	--
101-120	66.9	6.0	34.4	25.1	1.4
More than 120	25.5	--	9.8	15.7	--
Total	1,285.8	22.4	521.8	625.9	115.7
Aspen					
less than 21	1,253.0	--	--	13.3	1,239.7
21-40	1,264.4	--	155.6	852.5	256.3
41-60	2,132.9	--	652.1	1,472.4	8.4
61-80	555.1	1.4	222.2	331.5	--
81-100	90.9	--	34.1	56.8	--
101-120	4.5	--	--	4.5	--
More than 120	4.3	--	1.4	--	2.9
Total	5,305.1	1.4	1,065.4	2,731.0	1,507.3
Paper birch					
less than 21	91.8	--	--	25.8	66.0
21-40	151.0	--	24.2	95.9	30.9
41-60	510.6	--	113.3	397.3	--
61-80	187.6	--	69.5	118.1	--
81-100	37.5	--	10.8	26.7	--
101-120	20.2	--	1.3	18.9	--
More than 120	--	--	--	--	--
Total	998.7	--	219.1	682.7	96.9
Balsam poplar					
less than 21	143.3	--	--	--	143.3
21-40	133.9	--	6.7	87.6	39.6
41-60	199.2	--	45.3	152.5	1.4
61-80	63.6	--	17.9	45.7	--
81-100	8.6	--	5.6	3.0	--
101-120	--	--	--	--	--
More than 120	--	--	--	--	--
Total	548.6	--	75.5	288.8	184.3
Nonstocked					
less than 21	160.6	--	--	--	160.6
21-40	2.9	--	--	--	2.9
41-60	4.8	--	--	--	4.8
61-80	1.4	--	--	--	1.4
81-100	--	--	--	--	--
101-120	--	--	--	--	--
More than 120	--	--	--	--	--
Total	169.7	--	--	--	169.7
All types					
less than 21	2,461.9	--		48.5	2,413.4
21-40	2,754.6	--	294.4	1,426.0	1,034.2
41-60	4,830.7	3.0	1,382.4	3,312.9	132.4
61-80	2,182.4	16.1	789.4	1,340.4	36.5
81-100	977.2	23.0	332.3	602.4	19.5
101-120	315.4	10.0	98.0	203.3	4.1
More than 120	181.7	--	38.5	140.3	2.9
Total	13,703.9	52.1	2,935.0	7,073.8	3,643.0

Table 12.--Area of timberland by forest type, ownership class, and operability class, Minnesota, 1977

(In thousand acres)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
National Forest	116.9	2.4	20.1	69.7	24.7
Other federal	12.1	--	5.3	5.4	1.4
Indian	5.2	--	2.8	1.1	1.3
State	93.8	--	27.9	47.9	18.0
County and municipal	82.4	--	18.9	52.2	11.3
Forest industry	52.4	--	10.9	32.9	8.6
Farmer	80.9	--	24.0	49.2	7.7
Miscellaneous private	60.7	--	16.2	36.2	8.3
Total	504.4	2.4	126.1	294.6	81.3
Red pine					
National Forest	130.7	--	31.3	35.3	64.1
Other federal	2.7	--	1.4	1.3	--
Indian	8.8	--	6.4	2.4	--
State	23.7	--	2.3	14.6	6.8
County and municipal	24.5	--	6.5	15.6	2.4
Forest industry	13.5	--	2.5	7.4	3.6
Farmer	21.5	--	5.7	11.8	4.0
Miscellaneous private	21.6	--	4.1	15.1	2.4
Total	247.0	--	60.2	103.5	83.3
White pine					
National Forest	19.4	--	14.2	5.2	--
Other federal	1.4	--	--	1.4	--
Indian	7.5	--	2.8	4.7	--
State	2.6	--	--	1.2	1.4
County and municipal	4.4	--	--	4.4	--
Forest industry	5.1	--	--	5.1	--
Farmer	16.7	--	6.5	10.2	--
Miscellaneous private	8.5	--	1.4	5.2	1.9
Total	65.6	--	24.9	37.4	3.3
Balsam fir					
National Forest	184.4	--	63.6	89.2	31.6
Other federal	6.1	--	--	2.8	3.3
Indian	23.0	--	4.1	10.9	8.0
State	198.6	--	11.3	116.9	70.4
County and municipal	196.4	--	22.2	129.2	45.0
Forest industry	80.6	--	5.5	46.8	28.3
Farmer	75.6	--	4.8	47.3	23.5
Miscellaneous private	92.9	--	8.1	67.7	17.1
Total	857.6	--	119.6	510.8	227.2

(Table 12 continued on next page)

(Table 12 continued)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
White spruce					
National Forest	26.3	--	0.7	4.7	20.9
Other federal	1.4	--	--	1.4	--
Indian	6.5	--	--	5.0	1.5
State	22.3	--	1.6	11.3	9.4
County and municipal	4.1	--	--	4.1	--
Forest industry	2.7	--	--	1.3	1.4
Farmer	7.8	--	--	3.1	4.7
Miscellaneous private	8.1	--	1.3	6.8	--
Total	79.2	--	3.6	37.7	37.9
Black spruce					
National Forest	184.4	--	15.0	85.0	84.4
Other federal	11.1	--	--	4.4	6.7
Indian	51.4	--	--	17.9	33.5
State	421.3	--	14.2	163.7	243.4
County and municipal	160.6	--	3.0	47.6	110.0
Forest industry	66.8	--	--	25.8	41.0
Farmer	69.9	--	4.1	28.3	37.5
Miscellaneous private	76.5	--	--	32.0	44.5
Total	1,042.0	--	36.3	404.7	601.0
Northern white-cedar					
National Forest	61.5	--	15.7	41.5	4.3
Other federal	7.8	--	--	7.8	--
Indian	48.7	--	2.7	40.2	5.8
State	202.0	--	14.2	147.2	40.6
County and municipal	68.7	--	2.8	49.6	16.3
Forest industry	49.9	--	7.8	37.6	4.5
Farmer	25.4	--	2.8	21.1	1.5
Miscellaneous private	34.6	--	5.5	27.4	1.7
Total	498.6	--	51.5	372.4	74.7
Tamarack					
National Forest	7.2	--	--	4.5	2.7
Other federal	5.6	--	--	2.4	3.2
Indian	25.5	--	--	19.8	5.7
State	223.8	--	12.2	101.8	109.8
County and municipal	73.1	--	--	35.1	38.0
Forest industry	10.0	--	--	6.7	3.3
Farmer	76.3	--	6.9	29.0	40.4
Miscellaneous private	44.4	--	6.0	17.1	21.3
Total	465.9	--	25.1	216.4	224.4
Oak-hickory					
National Forest	11.1	4.7	6.4	--	--
Other federal	6.6	--	2.6	4.0	--
Indian	8.6	--	--	5.6	3.0
State	66.3	3.0	33.5	24.0	5.8
County and municipal	38.9	--	7.3	21.1	10.5
Forest industry	10.3	--	--	4.1	6.2
Farmer	583.3	14.4	320.6	205.2	43.1
Miscellaneous private	172.4	2.4	89.6	68.7	11.7
Total	897.5	24.5	460.0	332.7	80.3
Elm-ash-cottonwood					
National Forest	44.6	--	11.5	30.8	2.3
Other federal	15.9	--	4.4	10.5	1.0
Indian	19.0	--	1.5	11.2	6.3
State	123.4	--	23.1	63.7	36.6
County and municipal	122.9	--	11.0	82.9	29.0
Forest industry	38.5	--	5.7	25.3	7.5
Farmer	234.6	1.4	64.9	137.9	30.4
Miscellaneous private	139.3	--	23.8	72.9	42.6
Total	738.2	1.4	145.9	435.2	155.7

(Table 12 continued on next page)

(Table 12 continued)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Maple-basswood					
National Forest	98.7	--	64.9	31.0	2.8
Other federal	11.7	--	3.8	7.9	--
Indian	24.9	1.4	12.4	9.7	1.4
State	117.3	--	30.7	73.7	12.9
County and municipal	163.1	--	40.3	105.5	17.3
Forest industry	40.2	--	11.7	21.4	7.1
Farmer	587.0	16.3	254.8	259.0	56.9
Miscellaneous private	242.9	4.7	103.2	117.7	17.3
Total	1,285.8	22.4	521.8	625.9	115.7
Aspen					
National Forest	598.5	--	174.6	300.2	123.7
Other federal	46.9	--	6.8	28.1	12.0
Indian	187.2	--	41.4	85.9	59.9
State	847.1	--	117.1	471.2	258.8
County and municipal	1,058.2	--	195.0	599.7	263.5
Forest industry	315.8	--	54.5	141.4	119.9
Farmer	1,279.2	--	271.1	609.6	398.5
Miscellaneous private	972.2	1.4	204.9	494.9	271.0
Total	5,305.1	1.4	1,065.4	2,731.0	1,507.3
Paper birch					
National Forest	196.5	--	48.7	146.6	1.2
Other federal	8.7	--	2.7	4.6	1.4
Indian	26.9	--	8.6	12.8	5.5
State	130.0	--	20.4	94.5	15.1
County and municipal	224.0	--	53.9	153.1	17.0
Forest industry	49.0	--	5.9	26.9	16.2
Farmer	161.8	--	49.1	91.6	21.1
Miscellaneous private	201.8	--	29.8	152.6	19.4
Total	998.7	--	219.1	682.7	96.9
Balsam poplar					
National Forest	--	--	--	--	--
Other federal	11.5	--	--	6.8	4.7
Indian	20.3	--	2.8	12.1	5.4
State	140.3	--	18.4	66.6	55.3
County and municipal	97.4	--	22.1	61.1	14.2
Forest industry	29.0	--	6.9	14.9	7.2
Farmer	152.2	--	17.1	77.8	57.3
Miscellaneous private	97.9	--	8.2	49.5	40.2
Total	548.6	--	75.5	288.8	184.3
Nonstocked					
National Forest	33.4	--	--	--	33.4
Other federal	4.7	--	--	--	4.7
Indian	3.3	--	--	--	3.3
State	39.3	--	--	--	39.3
County and municipal	23.4	--	--	--	23.4
Forest industry	8.2	--	--	--	8.2
Farmer	35.8	--	--	--	35.8
Miscellaneous private	21.6	--	--	--	21.6
Total	169.7	--	--	--	169.7
All types					
National Forest	1,713.6	7.1	466.7	843.7	396.1
Other federal	154.2	--	27.0	88.8	38.4
Indian	466.8	1.4	85.5	239.3	140.6
State	2,651.8	3.0	326.9	1,398.3	923.6
County and municipal	2,342.1	--	383.0	1,361.2	597.9
Forest industry	772.0	--	111.4	397.6	263.0
Farmer	3,408.0	32.1	1,032.4	1,581.1	762.4
Miscellaneous private	2,195.4	8.5	502.1	1,163.8	521.0
Total	13,703.9	52.1	2,935.0	7,073.8	3,643.0

Table 13.--Area of timberland by distance from major wood-using center and operability class, Minnesota, 1977

(In thousand acres)

Wood-using center and distance (miles)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Bemidji					
Less than 20	476.9	--	153.6	231.7	91.6
20-50	2,105.2	14.1	568.5	1,047.9	474.7
More than 50	11,121.8	38.0	2,212.9	5,794.2	3,076.7
Brainerd					
Less than 20	358.2	1.4	123.3	172.1	61.4
20-50	1,613.8	4.7	395.1	846.5	367.5
More than 50	11,731.9	46.0	2,416.6	6,055.2	3,214.1
Cloquet					
Less than 20	398.5	--	39.9	219.3	139.3
20-50	1,796.9	--	272.0	997.1	527.8
More than 50	11,508.5	52.1	2,623.1	5,857.4	2,975.9
Cook					
Less than 20	525.2	--	85.6	291.6	148.0
20-50	2,355.1	--	320.4	1,305.4	729.3
More than 50	10,823.6	52.1	2,529.0	5,476.8	2,765.7
Grand Rapids					
Less than 20	477.3	--	113.9	259.9	103.5
20-50	2,609.4	7.1	514.2	1,320.6	767.5
More than 50	10,617.2	45.0	2,306.9	5,493.3	2,772.0
International Falls					
Less than 20	175.9	--	6.9	94.0	75.0
20-50	1,284.6	--	139.1	707.2	438.3
More than 50	12,243.4	52.1	2,789.0	6,272.6	3,129.7
Sartell					
Less than 20	78.4	--	32.8	33.7	11.9
20-50	604.5	10.6	218.9	249.6	125.4
More than 50	13,021.0	41.5	2,683.3	6,790.5	3,505.7
Twin cities					
Less than 20	12.5	--	4.6	4.7	3.2
20-50	237.7	4.3	76.9	126.7	29.8
More than 50	13,453.7	47.8	2,853.5	6,942.4	3,610.0
Winona					
Less than 20	129.6	5.7	94.7	21.9	7.3
20-50	278.7	8.7	156.0	86.7	27.3
More than 50	13,295.6	37.7	2,684.3	6,965.2	3,608.4
Closest wood-using center					
Less than 20	2,632.3	7.1	655.2	1,328.8	641.2
20-50	8,068.7	33.4	1,688.3	4,195.0	2,152.0
More than 50	3,002.9	11.6	591.5	1,550.0	849.8

Table 14.--Growing-stock volume on timberland by operability class component and forest type, Minnesota, 1977

(In thousand cubic feet)

Operability class component	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
Stand area (acres)									
More than 60	3,101,191	112,702	43,496	25,911	73,675	14,187	124,282	49,763	37,193
10-60	3,984,889	169,663	204,145	18,780	193,729	7,974	138,255	98,471	70,938
Less than 10	4,375,948	277,972	131,795	59,451	411,744	27,800	231,005	230,334	96,006
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Growing-stock volume per acre (cubic feet/acre)									
More than 800	8,540,129	449,702	353,674	101,651	473,440	33,326	255,923	254,781	82,712
300-800	2,557,522	105,836	24,232	2,491	183,958	14,249	181,916	104,963	96,390
Less than 300	364,377	4,799	1,530	--	21,750	2,386	55,703	18,824	25,035
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Sawtimber volume per acre (board feet/acre)									
More than 3000	4,128,986	253,002	314,874	98,539	194,137	27,382	28,862	153,298	12,823
1100-3000	3,697,279	165,660	32,440	5,603	263,595	10,478	118,991	127,568	58,244
Less than 1100	3,635,763	141,675	32,122	--	221,416	12,101	345,689	97,702	133,070
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Percent cull trees (percent)									
Less than 20	8,073,947	515,942	313,234	82,477	563,440	38,812	447,773	224,023	159,739
20-50	3,109,393	43,485	65,238	19,241	106,768	10,504	43,291	143,934	41,186
More than 50	278,688	910	964	2,424	8,940	645	2,478	10,611	3,212
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Average d.b.h. of growing-stock trees (inches)									
More than 10	1,504,257	34,592	110,405	23,050	23,552	8,078	1,558	20,626	2,383
6-10	9,702,762	506,653	263,745	81,092	646,861	39,847	407,224	347,174	170,043
Less than 6	255,009	19,092	5,286	--	8,735	2,036	84,760	10,768	31,711
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Average merchantable height of growing-stock trees (feet)									
More than 28	8,883,170	352,613	328,612	93,871	374,299	35,578	172,505	75,111	71,044
16-28	2,566,044	206,281	50,776	10,271	304,712	14,188	320,378	297,323	132,217
Less than 16	12,814	1,443	48	--	137	195	659	6,134	876
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137
Distance to road (miles)									
Less than 1/4	3,831,086	279,029	155,436	37,557	154,189	17,518	76,882	73,573	42,199
1/4 - 3/4	5,330,378	235,178	156,834	60,759	329,841	13,227	208,146	144,808	82,904
More than 3/4	2,300,564	46,130	67,166	5,826	195,118	19,216	208,514	160,187	79,034
All classes	11,462,028	560,337	379,436	104,142	679,148	49,961	493,542	378,568	204,137

(Table 14 continued on the next page)

(Table 14 continued)

Operability class component	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
Stand area (acres)							
More than 60	421,661	89,468	387,515	1,411,772	264,000	44,927	639
10-60	228,671	187,878	482,250	1,698,667	342,509	140,167	2,792
Less than 10	137,610	306,652	344,047	1,574,089	314,001	222,288	11,154
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Growing-stock volume per acre (cubic feet/acre)							
More than 800	573,151	403,599	942,464	3,605,075	727,303	283,328	--
300-800	199,055	160,569	248,226	948,752	178,554	104,498	3,833
Less than 300	15,736	19,830	23,122	130,701	14,653	19,556	10,752
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Sawtimber volume per acre (board feet/acre)							
More than 3000	427,011	214,648	761,761	1,315,242	186,259	141,148	--
1100-3000	245,439	221,335	308,132	1,610,890	393,000	134,841	1,063
Less than 1100	115,492	148,015	143,919	1,758,396	341,251	131,393	13,522
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Percent cull trees (percent)							
Less than 20	531,282	400,823	687,017	3,083,763	724,412	297,216	3,994
20-50	226,891	162,700	460,409	1,494,315	185,302	102,330	3,799
More than 50	29,769	20,475	66,386	106,450	10,796	7,836	6,792
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Average d.b.h. of growing-stock trees (inches)							
More than 10	313,924	76,606	443,598	346,778	51,613	43,305	4,189
6-10	473,585	504,485	767,502	4,271,915	855,644	357,185	9,807
Less than 6	433	2,907	2,712	65,835	13,253	6,892	589
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Average merchantable height of growing-stock trees (feet)							
More than 28	689,214	435,869	1,114,660	4,060,649	732,010	339,539	7,596
16-28	98,392	147,748	99,152	622,338	187,929	67,614	6,725
Less than 16	336	381	--	1,541	571	229	264
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585
Distance to road (miles)							
Less than 1/4	347,209	201,634	498,292	1,530,226	265,338	147,590	4,414
1/4 - 3/4	413,355	272,620	569,187	2,232,759	416,623	189,278	4,859
More than 3/4	27,378	109,744	146,333	921,543	238,549	70,514	5,312
All classes	787,942	583,998	1,213,812	4,684,528	920,510	407,382	14,585

Table 15.--Growing-stock volume on timberland by forest type and operability class, Minnesota, 1977

(In thousand cubic feet)

Forest type	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack pine	560,337	6,270	197,795	327,235	29,037
Red pine	379,436	--	120,104	191,509	67,823
White pine	104,142	--	41,868	61,835	439
Balsam fir	679,148	--	136,387	473,286	69,475
White spruce	49,961	--	3,939	40,970	5,052
Black spruce	493,542	--	37,626	336,152	119,764
Northern white-cedar	378,568	--	57,048	303,692	17,828
Tamarack	204,137	--	21,585	143,603	38,949
Oak-hickory	787,942	29,631	492,176	247,847	18,288
Elm-ash-cottonwood	583,998	1,985	154,685	387,865	39,463
Maple-basswood	1,213,812	30,793	625,428	524,750	32,841
Aspen	4,684,528	3,214	1,492,086	2,787,849	401,379
Paper birch	920,510	--	252,728	638,621	29,161
Balsam poplar	407,382	--	110,123	257,452	39,807
Nonstocked	14,585	--	--	--	14,585
All types	11,462,028	71,893	3,743,578	6,722,666	923,891

Table 16.--Growing-stock volume on timberland in operability class II (medium) by limiting factor and forest type, Minnesota, 1977

(In thousand cubic feet)

Limiting factor	All types	Forest type							
		Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1	90,453	--	16,713	1,327	--	--	--	--	--
2	4,651	--	268	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--
4	37,684	--	--	--	--	--	--	--	--
5	139,339	16,964	--	9,531	--	--	--	2,369	--
6	--	--	--	--	--	--	--	--	--
7	105,828	--	14,875	1,706	--	--	--	--	--
1 & 2	5,829	--	--	--	--	--	--	--	--
1 & 3	2,716	--	--	--	--	--	--	--	--
1 & 4	61,770	--	--	--	--	--	--	1,211	--
1 & 5	231,303	29,386	30,187	2,071	9,100	--	--	7,767	--
1 & 6	--	--	--	--	--	--	--	--	--
1 & 7	92,306	8,876	8,189	2,652	--	1,807	--	--	--
2 & 3	2,455	--	--	--	--	--	--	--	--
2 & 4	7,445	--	--	--	--	--	--	--	--
2 & 5	1,027	--	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--	--	--
2 & 7	10,923	1,249	--	--	--	--	--	--	938
3 & 4	4,741	--	--	--	--	--	--	--	--
3 & 5	104,751	2,560	1,384	--	--	--	--	--	--
3 & 6	--	--	--	--	--	--	--	--	--
3 & 7	--	--	--	--	--	--	--	--	--
4 & 5	39,863	--	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--	--	--
4 & 7	102,931	--	--	--	--	--	--	--	--
5 & 6	4,317	2,616	--	--	--	--	--	--	--
5 & 7	354,817	30,431	1,765	8,957	17,642	--	2,491	2,176	--
6 & 7	--	--	--	--	--	--	--	--	--

(Table 16 continued on the next page)

(Table 16 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1	13,352	--	39,581	16,885	--	2,595	--
2	3,321	--	1,062	--	--	--	--
3	--	--	--	--	--	--	--
4	10,999	2,473	24,212	--	--	--	--
5	25,549	2,078	17,847	54,093	4,692	6,216	--
6	--	--	--	--	--	--	--
7	51,690	7,097	22,464	7,838	--	158	--
1 & 2	844	--	4,072	913	--	--	--
1 & 3	--	--	1,375	1,341	--	--	--
1 & 4	23,490	1,457	20,186	13,964	1,462	--	--
1 & 5	21,089	12,621	34,164	68,268	11,935	4,715	--
1 & 6	--	--	--	--	--	--	--
1 & 7	15,758	1,197	35,740	12,692	3,165	2,230	--
2 & 3	1,086	--	484	885	--	--	--
2 & 4	6,409	--	1,036	--	--	--	--
2 & 5	1,027	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--
2 & 7	6,262	1,272	1,202	--	--	--	--
3 & 4	--	--	1,131	3,610	--	--	--
3 & 5	19,975	--	8,310	54,876	17,646	--	--
3 & 6	--	--	--	--	--	--	--
3 & 7	--	--	--	--	--	--	--
4 & 5	3,136	1,476	11,922	23,329	--	--	--
4 & 6	--	--	--	--	--	--	--
4 & 7	35,151	--	37,383	30,397	--	--	--
5 & 6	1,701	--	--	--	--	--	--
5 & 7	55,268	8,179	66,727	148,954	6,078	6,149	--
6 & 7	--	--	--	--	--	--	--

(Table 16 continued on the next page)

(Table 16 continued)

Limiting factor	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1 & 2 & 3	10,451	--	--	--	916	--	--	--	--
1 & 2 & 4	1,880	--	--	--	--	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--	--	--
1 & 2 & 7	3,608	--	1,023	--	--	--	--	--	--
1 & 3 & 4	3,621	--	--	--	--	--	--	--	--
1 & 3 & 5	201,044	14,048	2,610	--	12,143	--	--	--	--
1 & 3 & 6	--	--	--	--	--	--	--	--	--
1 & 3 & 7	5,118	1,306	--	--	--	--	--	--	--
1 & 4 & 5	58,129	--	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--	--	--
1 & 4 & 7	95,601	--	13,966	3,949	--	--	--	4,038	--
1 & 5 & 6	11,354	--	--	--	1,453	--	--	2,191	1,524
1 & 5 & 7	357,258	28,960	15,445	4,346	19,008	--	4,634	3,828	905
1 & 6 & 7	--	--	--	--	--	--	--	--	--
2 & 3 & 4	3,895	--	--	--	--	--	--	--	--
2 & 3 & 5	17,629	--	--	--	--	--	--	5,179	--
2 & 3 & 6	--	--	--	--	--	--	--	--	--
2 & 3 & 7	2,702	--	--	--	--	--	--	--	--
2 & 4 & 5	897	--	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--	--	--
2 & 4 & 7	6,671	--	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--	--	--
2 & 5 & 7	1,950	--	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--	--	--
3 & 4 & 5	45,928	--	--	--	7,384	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--	--	--
3 & 4 & 7	3,810	--	--	--	--	--	--	--	--
3 & 5 & 6	10,687	5,402	--	--	--	--	--	--	--
3 & 5 & 7	283,791	11,912	--	--	9,985	--	1,629	--	2,178
3 & 6 & 7	--	--	--	--	--	--	--	--	--
4 & 5 & 6	1,374	--	--	--	--	--	--	--	--
4 & 5 & 7	73,083	--	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--	--	--
5 & 6 & 7	16,025	--	--	5,717	--	--	--	5,456	--
4 or more	1,121,923	44,085	13,679	1,612	58,756	2,132	28,872	22,833	16,040
All factors	3,743,578	197,795	120,104	41,868	136,387	3,939	37,626	57,048	21,585

(Table 16 continued on the next page)

(Table 16 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1 & 2 & 3	1,651	1,390	3,649	2,845	--	--	--
1 & 2 & 4	836	--	1,044	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--
1 & 2 & 7	--	--	2,585	--	--	--	--
1 & 3 & 4	--	--	935	2,686	--	--	--
1 & 3 & 5	13,038	11,835	14,458	99,568	19,551	13,793	--
1 & 3 & 6	--	--	--	--	--	--	--
1 & 3 & 7	--	--	--	3,812	--	--	--
1 & 4 & 5	2,900	4,405	8,648	33,289	5,781	3,106	--
1 & 4 & 6	--	--	--	--	--	--	--
1 & 4 & 7	8,568	3,334	27,758	26,945	2,244	4,799	--
1 & 5 & 6	--	--	4,416	1,770	--	--	--
1 & 5 & 7	13,057	17,759	47,598	154,064	28,675	18,979	--
1 & 6 & 7	--	--	--	--	--	--	--
2 & 3 & 4	2,916	--	979	--	--	--	--
2 & 3 & 5	4,918	936	876	5,720	--	--	--
2 & 3 & 6	--	--	--	--	--	--	--
2 & 3 & 7	1,218	--	623	861	--	--	--
2 & 4 & 5	897	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--
2 & 4 & 7	6,671	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--
2 & 5 & 7	--	968	982	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--
3 & 4 & 5	4,634	1,336	6,187	23,126	1,492	1,769	--
3 & 4 & 6	--	--	--	--	--	--	--
3 & 4 & 7	2,168	--	--	1,642	--	--	--
3 & 5 & 6	2,944	1,228	--	1,113	--	--	--
3 & 5 & 7	22,016	6,807	20,150	168,180	35,680	5,254	--
3 & 6 & 7	--	--	--	--	--	--	--
4 & 5 & 6	--	--	1,374	--	--	--	--
4 & 5 & 7	4,478	2,089	16,505	50,011	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--
5 & 6 & 7	--	--	4,852	--	--	--	--
4 or more	103,159	64,748	132,911	478,409	114,327	40,360	--
All factors	492,176	154,685	625,428	1,492,086	252,728	110,123	--

Table 17.--Growing-stock volume on timberland in operability class III (poor) by limiting factor and forest type, Minnesota, 1977

(In thousand cubic feet)

Limiting factor	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1	2,204,759	175,270	108,101	54,024	171,699	16,485	30,663	105,985	25,119
2	2,676	--	277	--	--	--	--	--	398
3	1,295,655	48,796	8,950	--	40,021	1,988	59,905	10,327	16,769
4	75,389	--	--	--	1,295	--	--	1,368	839
5	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	--	--	--	--
7	913,132	9,668	49,548	2,823	42,116	11,302	33,360	44,114	12,212
1 & 2	2,394	--	--	--	--	--	--	262	--
1 & 3	803,881	58,445	1,718	--	78,373	4,916	54,984	21,983	22,180
1 & 4	54,468	--	621	2,424	--	--	--	2,163	--
1 & 5	--	--	--	--	--	--	--	--	--
1 & 6	--	--	--	--	--	--	--	--	--
1 & 7	534,118	23,474	15,651	2,564	83,042	5,152	38,621	66,438	8,762
2 & 3	19,529	--	--	--	586	--	545	1,183	738
2 & 4	954	--	--	--	--	--	--	--	--
2 & 5	--	--	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--	--	--
2 & 7	--	--	--	--	--	--	--	--	--
3 & 4	24,810	--	--	--	--	--	--	637	--
3 & 5	54,570	536	3,374	--	535	--	18,817	--	6,622
3 & 6	--	--	--	--	--	--	--	--	--
3 & 7	368,885	708	--	--	23,920	--	36,598	16,926	24,900
4 & 5	--	--	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--	--	--
4 & 7	14,017	--	--	--	595	352	--	1,499	--
5 & 6	--	--	--	--	--	--	--	--	--
5 & 7	--	--	--	--	--	--	--	--	--
6 & 7	--	--	--	--	--	--	--	--	--

(Table 17 continued on the next page)

(Table 17 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1	104,153	171,954	232,198	718,283	180,217	110,608	--
2	869	--	720	--	412	--	--
3	68,363	39,574	50,698	773,042	153,870	23,352	--
4	12,458	6,157	30,675	20,728	1,869	--	--
5	--	--	--	--	--	--	--
6	--	--	--	--	--	--	--
7	16,675	50,335	80,091	431,466	106,133	23,289	--
1 & 2	456	364	667	645	--	--	--
1 & 3	16,568	53,578	38,143	341,607	59,695	51,691	--
1 & 4	8,771	7,401	16,216	14,491	719	1,662	--
1 & 5	--	--	--	--	--	--	--
1 & 6	--	--	--	--	--	--	--
1 & 7	1,213	36,120	33,759	165,600	32,202	21,520	--
2 & 3	3,307	2,692	3,553	4,167	1,609	1,149	--
2 & 4	161	--	793	--	--	--	--
2 & 5	--	--	--	--	--	--	--
2 & 6	--	--	--	--	--	--	--
2 & 7	--	--	--	--	--	--	--
3 & 4	3,678	1,337	2,960	13,173	2,463	562	--
3 & 5	--	747	1,083	21,789	642	425	--
3 & 6	--	--	--	--	--	--	--
3 & 7	7,347	8,054	16,451	161,724	60,380	11,877	--
4 & 5	--	--	--	--	--	--	--
4 & 6	--	--	--	--	--	--	--
4 & 7	--	--	5,507	5,263	--	801	--
5 & 6	--	--	--	--	--	--	--
5 & 7	--	--	--	--	--	--	--
6 & 7	--	--	--	--	--	--	--

(Table 17 continued on the next page)

(Table 17 continued)

Limiting factor	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack
1 & 2 & 3	27,079	483	--	--	2,496	--	3,005	1,594	1,650
1 & 2 & 4	1,149	--	--	--	--	--	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--	--	--
1 & 2 & 7	577	--	--	--	--	--	--	315	262
1 & 3 & 4	9,878	--	--	--	--	--	389	--	--
1 & 3 & 5	18,059	2,237	1,302	--	480	--	4,247	969	2,026
1 & 3 & 6	1,043	--	--	--	--	--	--	1,043	--
1 & 3 & 7	203,827	2,010	1,967	--	23,050	775	34,912	13,907	11,635
1 & 4 & 5	--	--	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--	--	--
1 & 4 & 7	15,101	685	--	--	421	--	581	895	--
1 & 5 & 6	--	--	--	--	--	--	--	--	--
1 & 5 & 7	--	--	--	--	--	--	--	--	--
1 & 6 & 7	--	--	--	--	--	--	--	--	--
2 & 3 & 4	5,129	--	--	--	681	--	--	--	--
2 & 3 & 5	435	--	--	--	--	--	127	--	--
2 & 3 & 6	--	--	--	--	--	--	--	--	--
2 & 3 & 7	4,652	--	--	--	397	--	800	368	1,140
2 & 4 & 5	--	--	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--	--	--
2 & 4 & 7	--	--	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--	--	--
2 & 5 & 7	--	--	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--	--	--
3 & 4 & 5	--	--	--	--	--	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--	--	--
3 & 4 & 7	2,125	--	--	--	--	--	--	--	--
3 & 5 & 6	608	--	--	--	--	--	--	608	--
3 & 5 & 7	38,042	4,923	--	--	2,723	--	13,489	3,015	6,683
3 & 6 & 7	521	--	--	--	--	--	--	521	--
4 & 5 & 6	--	--	--	--	--	--	--	--	--
4 & 5 & 7	--	--	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--	--	--
5 & 6 & 7	--	--	--	--	--	--	--	--	--
4 or more	25,204	--	--	--	856	--	5,109	7,572	1,668
All factors	6,722,666	327,235	191,509	61,835	473,286	40,970	336,152	303,692	143,603

(Table 17 continued on the next page)

(Table 17 continued)

Limiting factor	Forest type						
	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar	Nonstocked
1 & 2 & 3	1,663	1,583	2,662	7,933	1,638	2,372	--
1 & 2 & 4	--	359	361	429	--	--	--
1 & 2 & 5	--	--	--	--	--	--	--
1 & 2 & 6	--	--	--	--	--	--	--
1 & 2 & 7	--	--	--	--	--	--	--
1 & 3 & 4	--	1,040	--	6,220	2,229	--	--
1 & 3 & 5	--	--	526	4,785	--	1,487	--
1 & 3 & 6	--	--	--	--	--	--	--
1 & 3 & 7	--	5,488	3,200	78,624	24,277	3,982	--
1 & 4 & 5	--	--	--	--	--	--	--
1 & 4 & 6	--	--	--	--	--	--	--
1 & 4 & 7	583	--	1,289	8,044	1,147	1,456	--
1 & 5 & 6	--	--	--	--	--	--	--
1 & 5 & 7	--	--	--	--	--	--	--
1 & 6 & 7	--	--	--	--	--	--	--
2 & 3 & 4	893	318	1,270	1,590	377	--	--
2 & 3 & 5	--	--	--	--	308	--	--
2 & 3 & 6	--	--	--	--	--	--	--
2 & 3 & 7	--	--	--	635	1,312	--	--
2 & 4 & 5	--	--	--	--	--	--	--
2 & 4 & 6	--	--	--	--	--	--	--
2 & 4 & 7	--	--	--	--	--	--	--
2 & 5 & 6	--	--	--	--	--	--	--
2 & 5 & 7	--	--	--	--	--	--	--
2 & 6 & 7	--	--	--	--	--	--	--
3 & 4 & 5	--	--	--	--	--	--	--
3 & 4 & 6	--	--	--	--	--	--	--
3 & 4 & 7	689	--	--	1,436	--	--	--
3 & 5 & 6	--	--	--	--	--	--	--
3 & 5 & 7	--	--	--	655	5,532	1,022	--
3 & 6 & 7	--	--	--	--	--	--	--
4 & 5 & 6	--	--	--	--	--	--	--
4 & 5 & 7	--	--	--	--	--	--	--
4 & 6 & 7	--	--	--	--	--	--	--
5 & 6 & 7	--	--	--	--	--	--	--
4 or more	--	764	1,928	5,520	1,590	197	--
All factors	247,847	387,865	524,750	2,787,849	638,621	257,452	--

Table 18.--Growing-stock volume on timberland by forest type, average growing-stock volume per acre, and operability class, Minnesota, 1977

(In thousand cubic feet)

Forest type and average growing-stock volume per acre (cu.ft. per acre)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
More than 800	449,702	6,270	189,260	251,741	2,431
300-800	105,836	--	8,535	75,011	22,290
Less than 300	4,799	--	--	483	4,316
Total	560,337	6,270	197,795	327,235	29,037
Red pine					
More than 800	353,674	--	117,910	183,289	52,475
300-800	24,232	--	2,194	7,943	14,095
Less than 300	1,530	--	--	277	1,253
Total	379,436	--	120,104	191,509	67,823
White pine					
More than 800	101,651	--	41,868	59,783	--
300-800	2,491	--	--	2,052	439
Less than 300	--	--	--	--	--
Total	104,142	--	41,868	61,835	439
Balsam fir					
More than 800	473,440	--	122,007	348,946	2,487
300-800	183,958	--	14,380	120,180	49,398
Less than 300	21,750	--	--	4,160	17,590
Total	679,148	--	136,387	473,286	69,475
White spruce					
More than 800	33,326	--	3,335	29,991	--
300-800	14,249	--	604	10,979	2,666
Less than 300	2,386	--	--	--	2,386
Total	49,961	--	3,939	40,970	5,052
Black spruce					
More than 800	255,923	--	32,398	222,400	1,125
300-800	181,916	--	5,228	108,589	68,099
Less than 300	55,703	--	--	5,163	50,540
Total	493,542	--	37,626	336,152	119,764
Northern white-cedar					
More than 800	254,781	--	41,972	212,809	--
300-800	104,963	--	15,076	82,882	7,005
Less than 300	18,824	--	--	8,001	10,823
Total	378,568	--	57,048	303,692	17,828
Tamarack					
More than 800	82,712	--	14,816	67,896	--
300-800	96,390	--	6,769	69,851	19,770
Less than 300	25,035	--	--	5,856	19,179
Total	204,137	--	21,585	143,603	38,949

(Table 18 continued on the next page)

(Table 18 continued)

Forest type and average growing-stock volume per acre (cu.ft. per acre)	All classes	Productivity class I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Oak-hickory					
More than 800	573,151	29,631	400,734	142,786	--
300-800	199,055	--	91,442	97,712	9,901
Less than 300	15,736	--	--	7,349	8,387
Total	787,942	29,631	492,176	247,847	18,288
Elm-ash-cottonwood					
More than 800	403,599	1,985	126,597	275,017	--
300-800	160,569	--	28,088	106,768	25,713
Less than 300	19,830	--	--	6,080	13,750
Total	583,998	1,985	154,685	387,865	39,463
Maple-basswood					
More than 800	942,464	30,793	554,559	357,112	--
300-800	248,226	--	70,869	155,684	21,673
Less than 300	23,122	--	--	11,954	11,168
Total	1,213,812	30,793	625,428	524,750	32,841
Aspen					
More than 800	3,605,075	3,214	1,410,074	2,164,362	27,425
300-800	948,752	--	82,012	604,012	262,728
Less than 300	130,701	--	--	19,475	111,226
Total	4,684,528	3,214	1,492,086	2,787,849	401,379
Paper birch					
More than 800	727,303	--	236,110	487,009	4,184
300-800	178,564	--	16,618	144,366	17,570
Less than 300	14,653	--	--	7,246	7,407
Total	920,510	--	252,728	638,621	29,161
Balsam poplar					
More than 800	283,328	--	105,482	177,846	--
300-800	104,498	--	4,641	75,888	23,969
Less than 300	19,556	--	--	3,718	15,838
Total	407,382	--	110,123	257,452	39,807
Nonstocked					
More than 800	--	--	--	--	--
300-800	3,833	--	--	--	3,833
Less than 300	10,752	--	--	--	10,752
Total	14,585	--	--	--	14,585
All types					
More than 800	8,540,129	71,893	3,397,122	4,980,987	90,127
300-800	2,557,522	--	346,456	1,661,917	549,149
Less than 300	364,377	--	--	79,762	284,615
Total	11,462,028	71,893	3,743,578	6,722,666	923,891

Table 19.--Growing-stock volume on timberland by forest type, stand-age class, and operability class, Minnesota, 1977

(In thousand cubic feet)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
less than 21	20,368	--	--	--	20,368
21-40	146,812	--	23,450	114,693	8,669
41-60	293,378	--	128,213	165,165	--
61-80	78,129	--	43,276	34,853	--
81-100	18,064	6,270	2,856	8,938	--
101-120	3,586	--	--	3,586	--
More than 120	--	--	--	--	--
Total	560,337	6,270	197,795	327,235	29,037
Red pine					
less than 21	6,216	--	--	3,374	2,842
21-40	103,585	--	7,399	31,205	64,981
41-60	66,964	--	39,614	27,350	--
61-80	95,350	--	20,657	74,693	--
81-100	73,032	--	35,619	37,413	--
101-120	18,304	--	16,815	1,489	--
More than 120	15,985	--	--	15,985	--
Total	379,436	--	120,104	191,509	67,823
White pine					
less than 21	439	--	--	--	439
21-40	7,227	--	5,717	1,510	--
41-60	19,772	--	7,347	12,425	--
61-80	31,937	--	4,346	27,591	--
81-100	33,386	--	15,501	17,885	--
101-120	11,381	--	8,957	2,424	--
More than 120	--	--	--	--	--
Total	104,142	--	41,868	61,835	439
Balsam fir					
less than 21	36,828	--	--	784	36,044
21-40	109,193	--	14,465	61,297	33,431
41-60	395,576	--	83,333	312,243	--
61-80	107,813	--	26,872	80,941	--
81-100	20,876	--	6,023	14,853	--
101-120	8,862	--	5,694	3,168	--
More than 120	--	--	--	--	--
Total	679,148	--	136,387	473,286	69,475

(Table 19 continued on the next page)

(Table 19 continued)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
White spruce					
less than 21	4,143	--	--	--	4,143
21-40	5,144	--	--	4,235	909
41-60	18,474	--	1,528	16,946	--
61-80	17,267	--	604	16,663	--
81-100	3,772	--	1,807	1,965	--
101-120	1,161	--	--	1,161	--
More than 120	--	--	--	--	--
Total	49,961	--	3,939	40,970	5,052
Black spruce					
less than 21	37,779	--	--	--	37,779
21-40	71,617	--	--	13,151	58,466
41-60	130,644	--	20,859	94,431	15,354
61-80	140,459	--	11,811	124,145	4,503
81-100	92,050	--	3,792	84,972	3,286
101-120	9,738	--	1,164	8,198	376
More than 120	11,255	--	--	11,255	--
Total	493,542	--	37,626	336,152	119,764
Northern white-cedar					
less than 21	6,982	--	--	3,158	3,824
21-40	14,933	--	--	5,801	9,132
41-60	42,831	--	8,529	30,790	3,512
61-80	75,700	--	7,853	66,994	853
81-100	100,252	--	14,870	84,875	507
101-120	56,881	--	7,537	49,344	--
More than 120	80,989	--	18,259	62,730	--
Total	378,568	--	57,048	303,692	17,828
Tamarack					
less than 21	18,077	--	--	--	18,077
21-40	16,879	--	--	4,016	12,863
41-60	55,318	--	9,548	39,745	6,025
61-80	37,801	--	5,822	30,349	1,630
81-100	27,636	--	1,882	25,400	354
101-120	27,720	--	2,313	25,407	--
More than 120	20,706	--	2,020	18,686	--
Total	204,137	--	21,585	143,603	38,949
Oak-hickory					
less than 21	14,893	--	--	--	14,893
21-40	47,465	--	24,776	19,294	3,395
41-60	271,060	--	158,744	112,316	--
61-80	232,943	6,729	163,312	62,902	--
81-100	170,353	18,297	112,913	39,143	--
101-120	45,965	4,605	28,152	13,208	--
More than 120	5,263	--	4,279	984	--
Total	787,942	29,631	492,176	247,847	18,288
Elm-ash-cottonwood					
less than 21	25,304	--	--	--	25,304
21-40	37,743	--	11,516	13,644	12,583
41-60	178,880	--	55,237	122,530	1,113
61-80	168,556	1,985	52,356	113,752	463
81-100	114,690	--	24,497	90,193	--
101-120	33,548	--	3,634	29,914	--
More than 120	25,277	--	7,445	17,832	--
Total	583,998	1,985	154,685	387,865	39,463

(Table 19 continued on the next page)

(Table 19 continued)

Forest type and stand-age class (years)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Maple-basswood					
less than 21	24,137	--	--	281	23,856
21-40	81,869	--	23,736	49,379	8,754
41-60	389,674	3,570	194,923	191,181	--
61-80	412,904	13,266	223,796	175,842	--
81-100	199,495	7,242	126,115	66,138	--
101-120	73,784	6,715	42,975	23,863	231
More than 120	31,949	--	13,883	18,066	--
Total	1,213,812	30,793	625,428	524,750	32,841
Aspen					
less than 21	327,865	--	--	6,897	320,968
21-40	1,021,807	--	201,460	744,928	75,419
41-60	2,461,244	--	904,347	1,551,905	4,992
61-80	729,649	3,214	332,150	394,285	--
81-100	138,177	--	52,213	85,964	--
101-120	3,870	--	--	3,870	--
More than 120	1,916	--	1,916	--	--
Total	4,684,528	3,214	1,492,086	2,787,849	401,379
Paper birch					
less than 21	20,643	--	--	2,320	18,323
21-40	113,100	--	24,629	77,633	10,838
41-60	516,511	--	130,173	386,338	--
61-80	198,266	--	82,096	116,170	--
81-100	44,759	--	14,291	30,468	--
101-120	27,231	--	1,539	25,692	--
More than 120	--	--	--	--	--
Total	920,510	--	252,728	638,621	29,161
Balsam poplar					
less than 21	29,927	--	--	--	29,927
21-40	80,705	--	7,538	63,843	9,324
41-60	205,886	--	67,884	137,446	556
61-80	77,526	--	24,463	53,063	--
81-100	13,187	--	10,087	3,100	--
101-120	151	--	151	--	--
More than 120	--	--	--	--	--
Total	407,382	--	110,123	257,452	39,807
Nonstocked					
less than 21	13,729	--	--	--	13,729
21-40	143	--	--	--	143
41-60	579	--	--	--	579
61-80	134	--	--	--	134
81-100	--	--	--	--	--
101-120	--	--	--	--	--
More than 120	--	--	--	--	--
Total	14,585	--	--	--	14,585
All types					
less than 21	587,330	--	--	16,814	570,516
21-40	1,858,222	--	344,686	1,204,629	308,907
41-60	5,046,791	3,570	1,810,279	3,200,811	32,131
61-80	2,404,434	25,194	999,414	1,372,243	7,583
81-100	1,049,729	31,809	422,466	591,307	4,147
101-120	322,182	11,320	118,931	191,324	607
More than 120	193,340	--	47,802	145,538	--
Total	11,462,028	71,893	3,743,578	6,722,666	923,891

Table 20.--Growing-stock volume on timberland by forest type, ownership class, and operability class, Minnesota, 1977

(In thousand cubic feet)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Jack Pine					
National Forest	104,691	6,270	41,314	46,828	10,279
Other federal	14,577	--	7,105	6,348	1,124
Indian	6,368	--	4,689	1,037	642
State	113,699	--	45,943	61,862	5,894
County and municipal	97,414	--	27,148	66,362	3,904
Forest industry	54,797	--	14,919	38,152	1,726
Farmer	97,578	--	35,637	59,664	2,277
Miscellaneous private	71,213	--	21,040	46,982	3,191
Total	560,337	6,270	197,795	327,235	29,037
Red pine					
National Forest	214,855	--	72,875	77,330	64,650
Other federal	4,157	--	2,610	1,547	--
Indian	17,005	--	12,419	4,586	--
State	25,125	--	3,298	20,220	1,607
County and municipal	41,008	--	12,164	28,183	661
Forest industry	16,026	--	3,993	11,802	231
Farmer	35,665	--	7,645	27,689	331
Miscellaneous private	25,595	--	5,100	20,152	343
Total	379,436	--	120,104	191,509	67,823
White pine					
National Forest	34,227	--	24,205	10,022	--
Other federal	1,119	--	--	1,119	--
Indian	13,621	--	6,050	7,571	--
State	2,041	--	--	1,602	439
County and municipal	7,090	--	--	7,090	--
Forest industry	6,966	--	--	6,966	--
Farmer	29,367	--	10,001	19,366	--
Miscellaneous private	9,711	--	1,612	8,099	--
Total	104,142	--	41,868	61,835	439
Balsam fir					
National Forest	143,532	--	60,083	75,099	8,350
Other federal	3,423	--	--	2,229	1,194
Indian	25,295	--	5,621	16,027	3,647
State	152,462	--	15,140	113,154	24,168
County and municipal	177,491	--	33,083	131,313	13,095
Forest industry	58,787	--	7,773	43,498	7,516
Farmer	47,877	--	4,243	36,674	6,960
Miscellaneous private	70,281	--	10,444	55,292	4,545
Total	679,148	--	136,387	473,286	69,475

(Table 20 continued on next page)

(Table 20 continued)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
White spruce					
National Forest	14,409	--	604	10,134	3,671
Other federal	2,469	--	--	2,469	--
Indian	2,859	--	--	2,859	--
State	12,147	--	1,528	10,145	474
County and municipal	4,063	--	--	4,063	--
Forest industry	1,217	--	--	940	277
Farmer	3,643	--	--	3,013	630
Miscellaneous private	9,154	--	1,807	7,347	--
Total	49,961	--	3,939	40,970	5,052
Black spruce					
National Forest	115,210	--	14,195	74,906	26,109
Other federal	5,034	--	--	3,269	1,765
Indian	16,271	--	--	11,929	4,342
State	198,004	--	16,361	139,156	42,487
County and municipal	61,665	--	2,793	37,319	21,553
Forest industry	29,998	--	--	21,371	8,627
Farmer	34,358	--	4,277	22,287	7,794
Miscellaneous private	33,002	--	--	25,915	7,087
Total	493,542	--	37,626	336,152	119,764
Northern white-cedar					
National Forest	49,820	--	17,325	31,185	1,310
Other federal	5,878	--	--	5,878	--
Indian	38,566	--	3,473	32,718	2,375
State	143,569	--	15,328	119,004	9,237
County and municipal	43,194	--	3,021	37,210	2,963
Forest industry	49,326	--	8,215	40,260	851
Farmer	20,522	--	3,918	15,971	633
Miscellaneous private	27,693	--	5,768	21,466	459
Total	378,568	--	57,048	303,692	17,828
Tamarack					
National Forest	7,003	--	--	5,051	1,952
Other federal	1,891	--	--	1,634	257
Indian	12,098	--	--	10,004	2,094
State	99,266	--	11,181	72,871	15,214
County and municipal	30,355	--	--	22,015	8,340
Forest industry	4,544	--	--	4,118	426
Farmer	29,863	--	6,009	17,150	6,704
Miscellaneous private	19,117	--	4,395	10,760	3,962
Total	204,137	--	21,585	143,603	38,949
Oak-hickory					
National Forest	13,451	4,874	8,577	--	--
Other federal	6,665	--	3,219	3,446	--
Indian	4,188	--	--	3,963	225
State	62,845	3,783	38,407	20,052	603
County and municipal	29,799	--	7,544	19,014	3,241
Forest industry	4,522	--	--	3,809	713
Farmer	504,310	17,654	330,248	144,786	11,622
Miscellaneous private	162,162	3,320	104,181	52,777	1,884
Total	787,942	29,631	492,176	247,847	18,288
Elm-ash-cottonwood					
National Forest	21,795	--	4,913	16,436	446
Other federal	23,281	--	7,037	16,122	122
Indian	16,645	--	1,524	13,289	1,832
State	98,302	--	26,536	61,983	9,783
County and municipal	100,918	--	12,844	80,000	8,074
Forest industry	32,374	--	7,889	23,278	1,207
Farmer	195,668	1,985	66,438	119,203	8,042
Miscellaneous private	95,015	--	27,504	57,554	9,957
Total	583,998	1,985	154,685	387,865	39,463

(Table 20 continued on next page)

(Table 20 continued)

Forest type and ownership class	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Maple-basswood					
National Forest	123,053	--	96,446	24,881	1,726
Other federal	11,261	--	4,061	7,200	--
Indian	25,620	1,657	14,135	9,096	732
State	104,122	--	35,127	66,758	2,237
County and municipal	150,990	--	49,366	95,899	5,725
Forest industry	33,053	--	15,175	15,977	1,901
Farmer	538,833	23,722	289,864	209,169	16,078
Miscellaneous private	226,880	5,414	121,254	95,770	4,442
Total	1,213,812	30,793	625,428	524,750	32,841
Aspen					
National Forest	696,787	--	293,227	377,293	26,267
Other federal	40,336	--	7,210	29,354	3,772
Indian	178,048	--	57,659	101,974	18,415
State	727,782	--	169,812	489,051	68,919
County and municipal	1,001,427	--	274,811	650,595	76,021
Forest industry	276,614	--	85,065	160,983	30,566
Farmer	981,431	--	344,488	533,319	103,624
Miscellaneous private	782,103	3,214	259,814	445,280	73,795
Total	4,684,528	3,214	1,492,086	2,787,849	401,379
Paper birch					
National Forest	179,066	--	50,912	127,002	1,152
Other federal	6,915	--	2,751	3,820	344
Indian	23,503	--	10,149	11,446	1,908
State	127,201	--	24,506	100,383	2,312
County and municipal	216,892	--	64,322	145,993	6,577
Forest industry	36,591	--	7,347	25,142	4,102
Farmer	138,081	--	57,941	73,993	6,147
Miscellaneous private	192,261	--	34,800	150,842	6,619
Total	920,510	--	252,728	638,621	29,161
Balsam poplar					
National Forest	1,295	--	1,059	228	8
Other federal	5,936	--	--	5,326	610
Indian	15,219	--	4,862	9,189	1,168
State	100,216	--	26,852	62,351	11,013
County and municipal	98,095	--	32,622	61,817	3,656
Forest industry	28,654	--	11,223	15,438	1,993
Farmer	98,203	--	22,903	61,760	13,540
Miscellaneous private	59,764	--	10,602	41,343	7,819
Total	407,382	--	110,123	257,452	39,807
Nonstocked					
National Forest	532	--	--	--	532
Other federal	733	--	--	--	733
Indian	418	--	--	--	418
State	2,904	--	--	--	2,904
County and municipal	3,415	--	--	--	3,415
Forest industry	1,236	--	--	--	1,236
Farmer	3,305	--	--	--	3,305
Miscellaneous private	2,042	--	--	--	2,042
Total	14,585	--	--	--	14,585
All types					
National Forest	1,719,726	11,144	685,735	876,395	146,452
Other federal	133,675	--	33,993	89,761	9,921
Indian	395,724	1,657	120,581	235,688	37,798
State	1,969,685	3,783	430,019	1,338,592	197,291
County and municipal	2,063,816	--	519,718	1,386,873	157,225
Forest industry	634,705	--	161,599	411,734	61,372
Farmer	2,758,704	43,361	1,183,612	1,344,044	187,687
Miscellaneous private	1,785,993	11,948	608,321	1,039,579	126,145
Total	11,462,028	71,893	3,743,578	6,722,666	923,891

Table 21.--Growing-stock volume on timberland by distance from major wood-using center and operability class, Minnesota, 1977

(In thousand cubic feet)

Wood-using center and distance (miles)	All classes	Operability class			
		I - Good	II - Medium	III - Poor	IV - Sapling-seedling and nonstocked
Bemidji					
Less than 20	484,703	--	215,727	245,075	23,901
20-50	2,075,099	22,490	802,617	1,142,264	107,728
More than 50	8,902,226	49,403	2,725,234	5,335,327	792,262
Brainerd					
Less than 20	320,159	3,214	148,028	152,858	16,059
20-50	1,317,320	6,669	470,369	749,071	91,211
More than 50	9,824,549	62,010	3,125,181	5,820,737	816,621
Cloquet					
Less than 20	257,905	--	45,274	177,038	35,593
20-50	1,343,768	--	323,639	886,111	134,018
More than 50	9,860,355	71,893	3,374,665	5,659,517	754,280
Cook					
Less than 20	472,761	--	124,246	312,602	35,913
20-50	1,983,300	--	468,535	1,305,516	209,249
More than 50	9,005,967	71,893	3,150,797	5,104,548	678,729
Grand Rapids					
Less than 20	461,147	--	171,397	263,844	25,906
20-50	2,305,190	11,144	752,072	1,362,644	179,330
More than 50	8,695,691	60,749	2,820,109	5,096,178	718,655
International Falls					
Less than 20	122,223	--	9,524	95,727	16,972
20-50	1,037,771	--	194,475	740,470	102,826
More than 50	10,302,034	71,893	3,539,579	5,886,469	804,093
Sartell					
Less than 20	54,462	--	31,108	20,603	2,751
20-50	456,864	14,759	231,590	181,649	28,866
More than 50	10,950,702	57,134	3,480,880	6,520,414	892,274
Twin cities					
Less than 20	6,760	--	4,081	2,516	163
20-50	209,506	4,684	78,769	116,907	9,146
More than 50	11,245,762	67,209	3,660,728	6,603,243	914,582
Winona					
Less than 20	116,284	6,584	95,572	12,688	1,440
20-50	245,631	10,303	166,898	61,933	6,497
More than 50	11,100,113	55,006	3,481,108	6,648,045	915,954
Closest wood-using center					
Less than 20	2,296,404	9,798	844,957	1,282,951	158,698
20-50	6,850,868	46,106	2,168,714	4,083,935	552,113
More than 50	2,314,756	15,989	729,907	1,355,780	213,080

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Operability is the relative ease or difficulty of managing or harvesting timber because of physical conditions in the stand or on the site. Using data collected during standard Statewide forest inventories, we developed a method for classifying timber by operability class based on seven operability components.

KEY WORDS: Management opportunities, Minnesota, forest inventory, prime forest land.