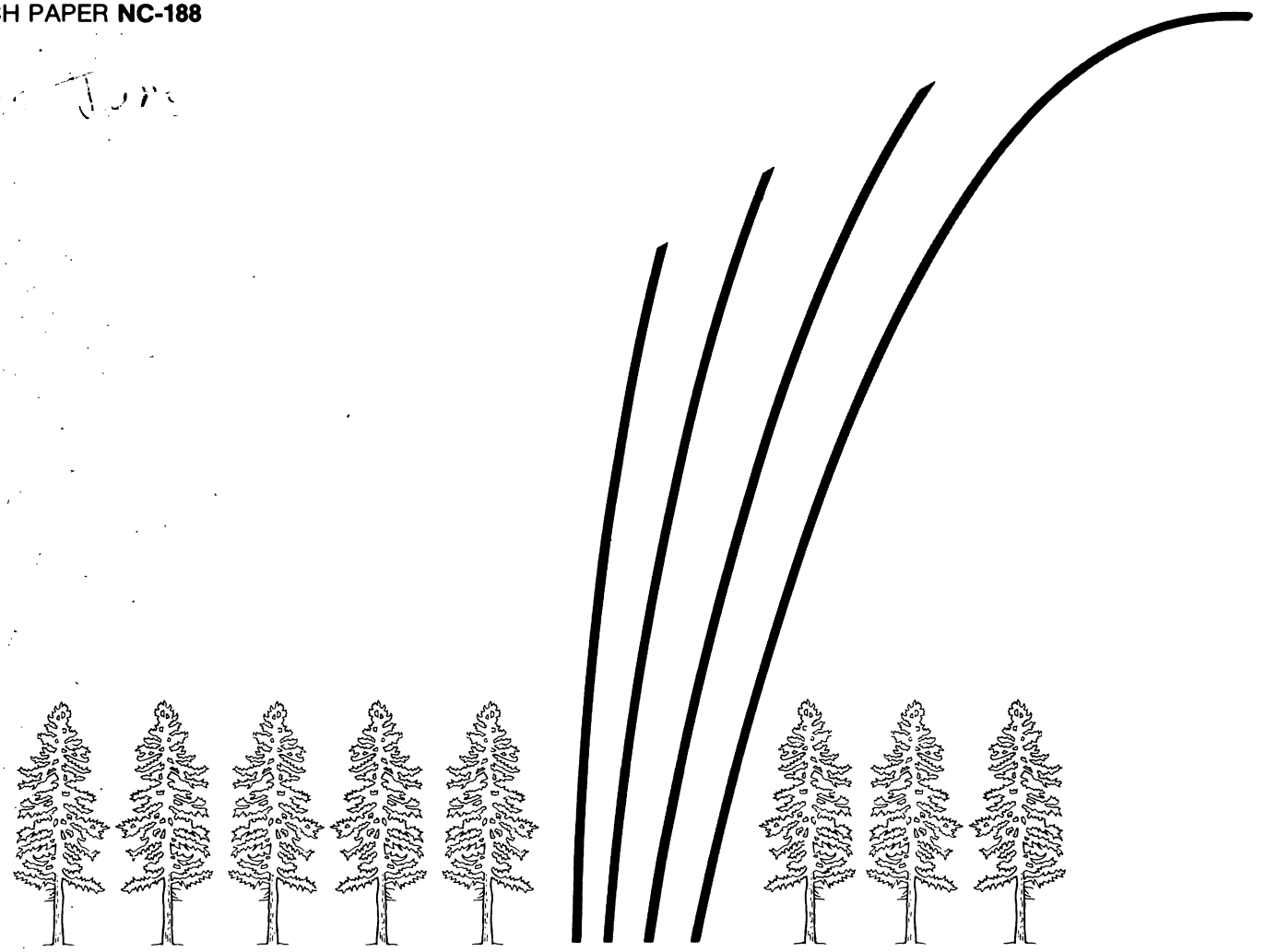
NC-188
RP.
C-1
USDA FOREST SERVICE
RESEARCH PAPER **NC-188**



Predicted yields from selected cutting prescriptions in northern Minnesota

Pamela J. Jakes and W. Brad Smith

North Central Forest Experiment Station
Forest Service, U.S. Department of Agriculture

North Central Forest Experiment Station
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108
Manuscript approved for publication February 22, 1980

1980

CONTENTS

	Page
Methods	1
Assumptions	3
Findings	3
Discussion	5
Appendix	27
Specifying cutting prescriptions	27
Definition of terms	27
Metric equivalents of units used in this report	28
Principal tree species groups in northern Minnesota	29

PREDICTED YIELDS FROM SELECTED CUTTING PRESCRIPTIONS IN NORTHERN MINNESOTA

Pamela J. Jakes, *Associate Resource Analyst,*
and **W. Brad Smith,** *Associate Mensurationist*

As demand for forest products grows, it will become increasingly important to use forest resources efficiently. In Minnesota, the commercial forest area decreased 11 percent between 1962 and 1977, yet existing forest industries are expanding and new wood-using industries are entering the State. This increase in demand for timber coupled with a shrinking commercial forest land base, emphasizes the need for improved utilization of Minnesota's timber resources.

By calculating predicted yields from selected cutting prescriptions, we identified deficiencies or surpluses in the forest resource. The two sets of cutting prescriptions used in this report should not be construed as management goals, but rather as sideboards defining a range of future yields, using current Minnesota forest conditions as a base. Predicted yields resulting from the prescriptions are only one facet of the total resource picture; they should be used in conjunction with other resource information in planning for the future.

METHODS

The first step involved in calculating predicted yields was specifying cutting prescriptions. We considered two prescriptions, each defined by a set of rotation ages for 14 Minnesota forest types (table 1). The long rotation age option is a prescription based on criteria established jointly by representatives from Minnesota forest industries and the Minnesota Department of Natural Resources. The rotation ages used in this prescription approximate current harvest practices, where the final product (sawtimber or pulpwood) depends on the forest type and site quality (specified by site index ranges). The short rotation age option uses current empirical yields to select rotation age at the age of maximum total volume yield. The final product from this prescription is primarily poletimber (see Appendix).

For both prescriptions, an area control algorithm was used to calculate the number of acres cut in each forest type and site index range. The number of acres cut was set so that an even distribution of area among age classes would be achieved in each forest type by the end of one rotation. Harvest areas were calculated for the decade 1977-1986; after 1986, the areas must be recalculated to account for changes in stand characteristics and the commercial forest land base.

Plot data from the 1977 Minnesota Forest Inventory were then used in a modified version of the Tree Growth Projection System of the Forest Resources Evaluation Program (FREP).[1] The System "grew" each plot for 5 years and then scanned data from each commercial forest plot, selected plots that met the cutting prescription criteria, and calculated the area and volume represented by the plot. Since yields are estimated for a 10-year period, it was necessary to project each plot 5 years as an estimate of average growth on all harvest plots for the decade.

The System assigns the highest cutting priority to overmature stands (fig. 1). In some forest types, there are large areas of stands too young to harvest. Some of these stands were "harvested" before rotation age

[1]*U.S. Department of Agriculture, Forest Service. 1979. A generalized forest growth projection system applied to the Lake States region. U.S. Department of Agriculture Forest Service, General Technical Report NC-49, 96 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.*

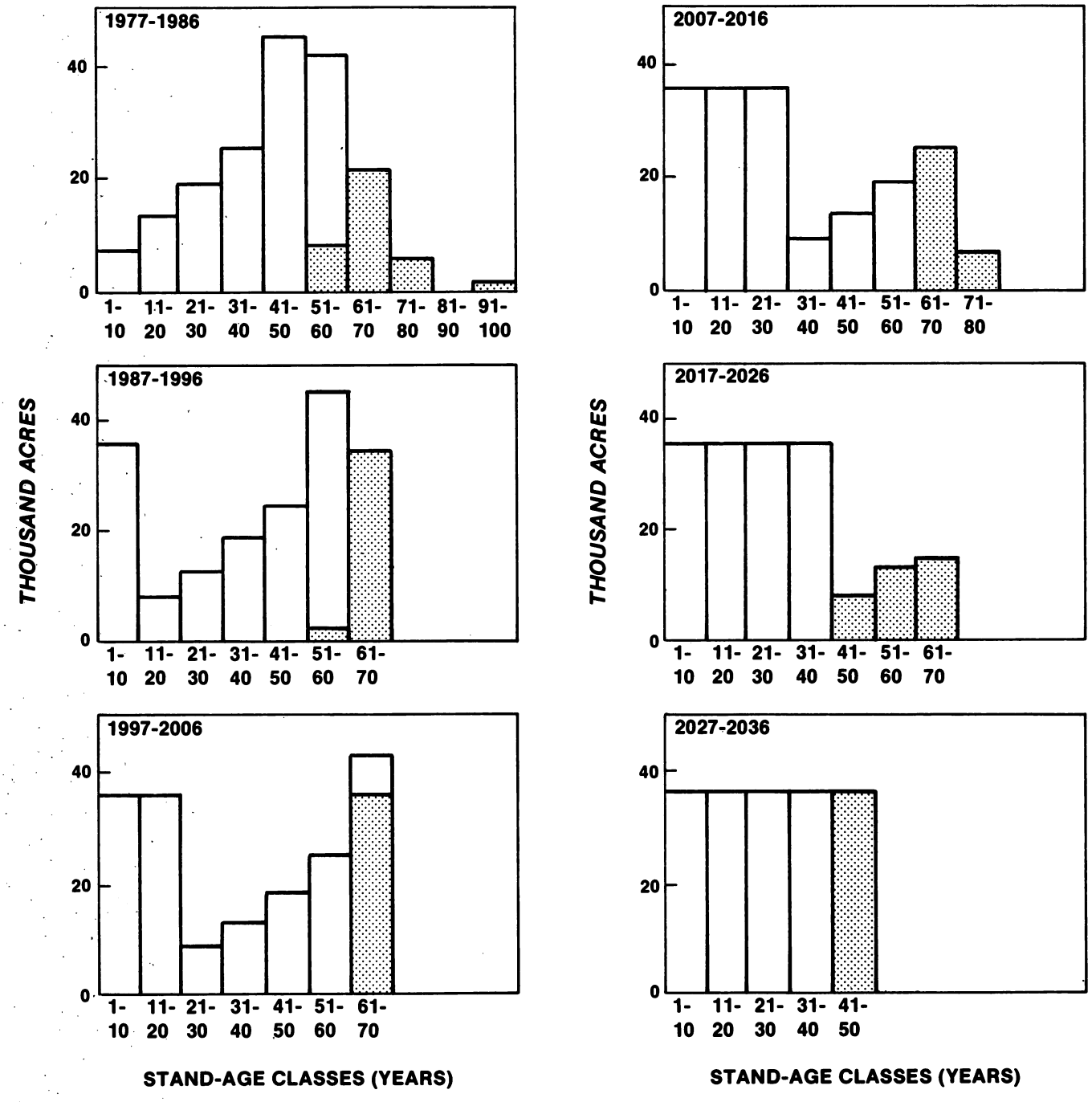


Figure 1.—*Example of the progression of the area control program to even area distribution among stand-age classes for a 50-year rotation by decades. Shaded portions show area cut per decade.*

to bring about an even area distribution among age classes by the end of one rotation. The number of acres harvested in an age class cannot be directly compared to the number of acres in the age class as reported in the 1977 Forest Inventory of Minnesota. Because plots were grown for 5 years before harvest, a shift in commercial land between age classes resulted.

ASSUMPTIONS

Calculations of yields from selected cutting prescriptions are based on these assumptions: (1) the area of commercial forest land will remain stable for the decade 1977-1986; (2) the current mix of area by forest type will remain stable—i.e., no stand conversion will occur; and (3) all timber is available for harvest and a ready market exists for all species and products. The method does not account for possible economic, social, political, or silvicultural constraints on timber removals.

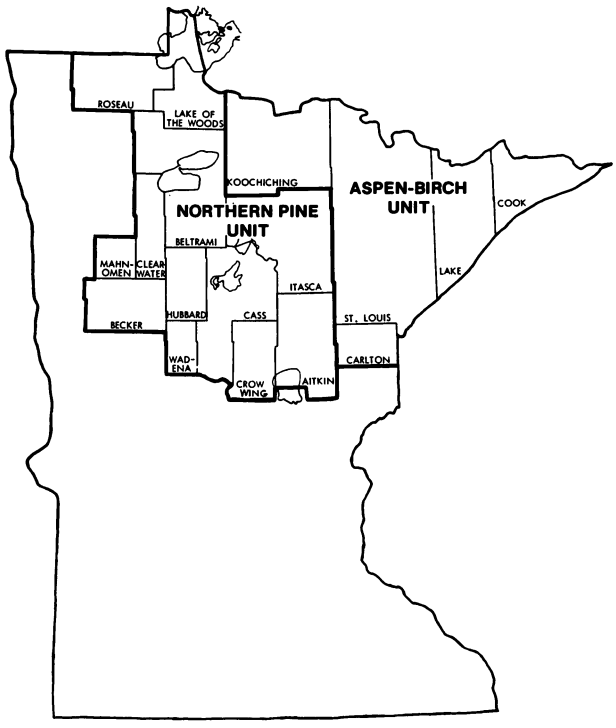


Figure 2.—*Northern Minnesota region.*

FINDINGS

Predicted yields from selected cutting prescriptions are presented for the Aspen-Birch and the Northern Pine Forest Survey Units, referred to here as the northern Minnesota region (fig. 2). Data from the 1977 Minnesota Forest Inventory show that these two Units contain 82 percent of the State's commercial forest land. Of the 11.2 million acres of commercial forest land in these Units, 62 percent is in public ownership. The State of Minnesota owns the largest portion of the commercial forest land base, 2.4 million acres. Growing-stock volume in the region totals 9.5 billion cubic feet. The region has 98 percent of the State's softwood growing-stock volume. In 1976, growing-stock removals totaled 150.7 million cubic feet, 78 percent of the State total.

Predicted Yields and Area Harvested—Long Rotation Age Option

Between 1977 and 1986, 1.9 million acres of commercial forest land in northern Minnesota can be harvested, according to long rotation age criteria (table 2). The harvest acreage is equally divided between the Aspen-Birch Unit and the Northern Pine Unit, with each having approximately 1.0 million acres available for harvest over the decade (tables 3 and 4). Of the 11.2 million acres of commercial forest land in the region, 2 percent would be cut annually under this harvest plan.

The aspen forest type accounts for 49 percent of the harvest acreage, and the paper birch, balsam fir, and jack pine forest types cover an additional 25 percent. Although the distribution of harvest acreage among forest types differs slightly between the Survey Units, aspen makes up the largest portion of the harvest acreage in both—45 percent in the Aspen-Birch Unit, 52 percent in the Northern Pine Unit. In the Aspen-Birch Unit, balsam fir accounts for 13 percent of the harvest acreage, while in the Northern Pine Unit the type accounts for 5 percent. Black spruce occurs on 7 percent of the harvest acreage in the Aspen-Birch Unit, but on only 2 percent in the Northern Pine Unit.

In most forest types, distribution of harvest acreage among age classes is concentrated in overmature stands (tables 5-7). As the System works toward establishing an even distribution among age classes for each forest type by the end of one rotation, it cuts an equal number of acres every year. During this process, overmature stands are assigned the highest cutting priority. For example, the rotation age of low site index jack pine is 50 years, yet during the decade

1977-1986, 52 percent of the jack pine harvest acreage would be over 70 years old. In low site index aspen, all the harvest acreage would be at least 10 years past rotation age.

A different problem arises in forest types where young stands dominate large areas. In the case of high site index red pine with a rotation age of 120 years, all of the acreage harvested in the decade 1977-1986 would be in stands less than 120 years of age. Again, this is necessary to achieve an equal area distribution among all classes by the end of one rotation.

Harvest volume under long rotation age criteria would total 279.5 million cubic feet annually (table 8). Of this total, 253.9 million cubic feet are growing stock and 25.6 million cubic feet are cull. Although harvest acreage is evenly divided between the Aspen-Birch Unit and the Northern Pine Unit, the greatest harvest volume would occur in the Aspen-Birch Unit (tables 9 and 10). This discrepancy is due to differences in the volume per acre on commercial forest land between the two Units. The average growing-stock volume per acre on commercial forest land harvested in the Aspen-Birch Unit is 1,621 cubic feet, while in the Northern Pine Unit the volume per acre on commercial forest land harvested is 1,117 cubic feet.

Hardwood species comprise 65 percent of the harvest volume. Aspen accounts for 36 percent of the growing-stock harvest, the largest percentage of any species. The softwood species accounting for the most harvest volume is balsam fir, with 8 percent of total harvest.

A large portion of the harvest volume of many species is found in the aspen forest type (tables 11-13). Of the 5.4 million cubic feet of white pine harvest volume, 55 percent is in the aspen type; only 12 percent is in the white pine type. Over one-third of the total softwood harvest volume is in aspen stands. The dominance of the aspen type in the hardwood harvest volume would be expected—nearly three-quarters of the hardwood harvest volume is found in the type.

The hardwood annual harvest is fairly evenly divided between poletimber and sawtimber. The annual harvest of hardwood poletimber would total 83.8 million cubic feet, while the annual harvest of hardwood sawtimber would total 82.1 million cubic feet. Softwood annual harvest is composed primarily of sawtimber, which accounts for 62 percent of the softwood growing-stock harvest.

Predicted Yields and Area Harvested—Short Rotation Age Option

In changing harvest criteria from a long rotation age option to a short rotation age option (or from sawtimber to poletimber harvest ages), the area of commercial forest land available for harvest over the decade increases from 1.9 million acres to 2.5 million acres (table 2). Under short rotation age criteria, timber would be harvested on 254,700 acres annually. Harvest acreage remains fairly evenly divided between the Aspen-Birch Unit and the Northern Pine Unit (tables 3 and 4).

As in the long rotation age option, the largest portion (50 percent) of the harvest acreage is in the aspen forest type. Paper birch, balsam fir, and black spruce types account for an additional 23 percent of the harvest acreage. The 1.3 million acres of aspen that would be harvested during the decade under the short rotation age option are 42 percent more than the acreage that would be harvested under the long rotation age option. Black spruce harvest acreage would increase 68 percent under short rotation age harvest criteria. Harvest acreages in the northern white-cedar and oak forest types would more than double.

Although a large portion of the harvest acreage in the short rotation age option remains concentrated in overmature stands, additional younger aged stands would also be harvested (tables 5-7). For example, in the aspen forest type, 904,000 acres would be harvested during the decade under long rotation age criteria, all in stands over 50 years old. Under short rotation age criteria, an additional 2,900 acres would be cut in the 61-70 age class, 357,800 acres in the 51-60 years age class and 18,000 acres in the 41-50 years age class, for a total of 1.3 million acres.

Harvest volume under short rotation age criteria would total 372.7 million cubic feet annually—337.3 million cubic feet in growing-stock trees, and 35.4 million cubic feet in cull (table 8). Harvest volumes under the short rotation age option are about 33 percent higher than volumes under the high rotation age option. Differences between Survey Units in the growing-stock volume per acre on commercial forest land harvested result in more volume being harvested in the Aspen-Birch Unit than in the Northern Pine Unit (tables 9 and 10). Harvest volume in the Aspen-Birch Unit would total 188.7 million cubic feet (1,526 cubic feet per acre) and in the Northern Pine

Unit it would total 148.6 million cubic feet (1,134 cubic feet per acre).

Of the 337.3 million cubic feet of growing-stock harvest volume, 65 percent is hardwood (primarily aspen), and 35 percent is softwood. The 123.5 million cubic feet of aspen harvested is 37 percent of the total harvest and 56 percent of the hardwood harvest. Under short rotation age criteria, aspen harvest volume alone is greater than the total softwood harvest volume. Balsam fir accounts for the largest portion of the softwood harvest volume (28.5 million cubic feet), and jack pine and black spruce harvest volumes are 20.2 million and 20.9 million cubic feet, respectively.

The aspen forest type, which is important in supplying softwood as well as hardwood harvest volume, contains 59 percent of total growing-stock harvest volume (tables 11-13). Fifty percent of the white pine, 49 percent of the balsam fir, and 60 percent of the white spruce harvest volumes are found in the aspen forest type.

Most of the increase in harvest volume resulting from the change in harvest criteria from long rotation age to short rotation age occurs in poletimber stands. Harvest volumes under short rotation age criteria are fairly evenly divided between sawtimber and poletimber stands; however the harvest volumes of species in the two size classes vary widely. Most of the softwood harvest volumes are concentrated in sawtimber trees—95 percent of both the red pine and white pine harvest volume is in sawtimber stands. Three softwood species—balsam fir, black spruce, and tamarack—have the majority of their harvest volumes in pole-timber stands. Hardwood species are evenly divided between those with a majority of their volume in poletimber and those with a majority in sawtimber stands.

DISCUSSION

This study indicates that, under the assumptions specified above, the supply of timber from Minnesota's commercial forest land would be much higher than current timber removals (fig. 3). Under the long and short rotation cutting prescriptions considered, average annual growing-stock removals for the decade would be from 69 percent to 124 percent higher than the 1976 growing-stock removals (tables 14-16).[2] In reality, however, these yields may never be realized for the following reasons: (1) the objectives of some landowners may be incompatible with timber production, (2) edaphic, topographic, or hydrologic characteristics of some sites may make it impossible to harvest timber, (3) some areas may be inaccessible, (4) markets may not exist for the products or species harvested. By using their knowledge of the local resource and other inventory data, forest managers and planners can temper the findings of this report to fit the circumstances of their areas.

[2]*Removals resulting from the transfer of commercial forest land to productive-reserved forest land are not included.*

Hardwood Removals Would More than Double Between 1977 and 1986

Opportunities for increasing hardwood removals are greater than those for increasing softwood removals. Under the long rotation age option, average annual hardwood removals over the decade would be 165.9 million cubic feet—nearly twice the 1976 removals of 83.4 million cubic feet. The annual removals under low rotation age criteria would be 220.9 million cubic feet, 137.5 million cubic feet higher than the 1976 removals. For every hardwood species, empirical yields from harvests are higher than 1976 removals.

The distribution of hardwood removals volume among species is different under both cutting prescriptions from that in the 1976 harvest (fig. 4). Aspen will continue to provide the largest portion of hardwood removals volume; however, the relative importance of aspen in supplying harvest volume will decline. In 1976, aspen removals were 79 percent of total hardwood removals, while under the cutting prescriptions outlined here, aspen will contribute an average of 55 percent of harvest volume. The importance of paper birch, balsam poplar and ash will increase under these cutting prescriptions.

Softwood Removals Would Increase More than 38 Percent

Under long rotation age criteria, softwood annual removals would total 88.0 million cubic feet—20.7 million cubic feet higher than the 67.3 million cubic feet of softwood growing-stock removals in 1976. The difference between 1976 removals and predicted

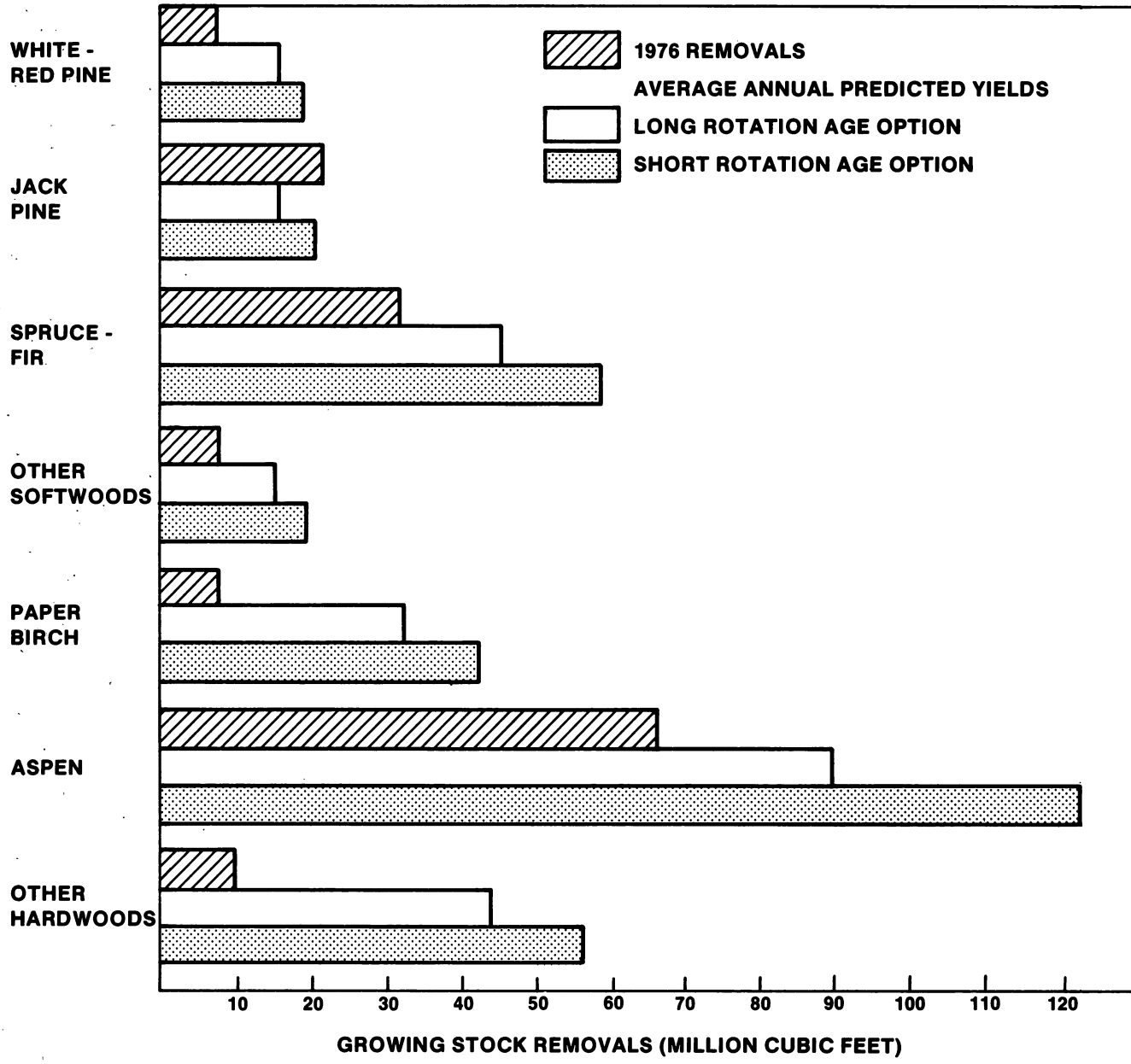
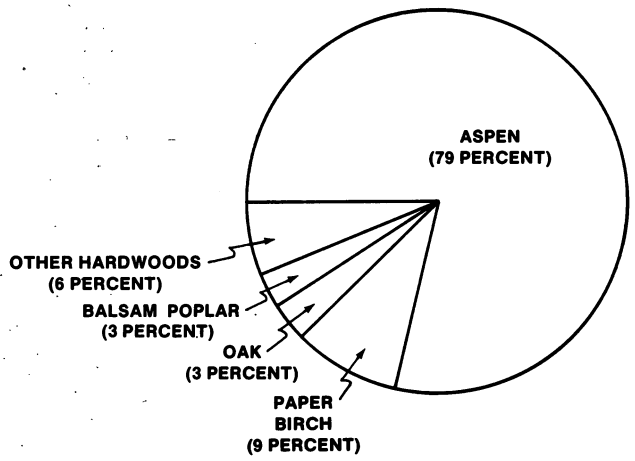
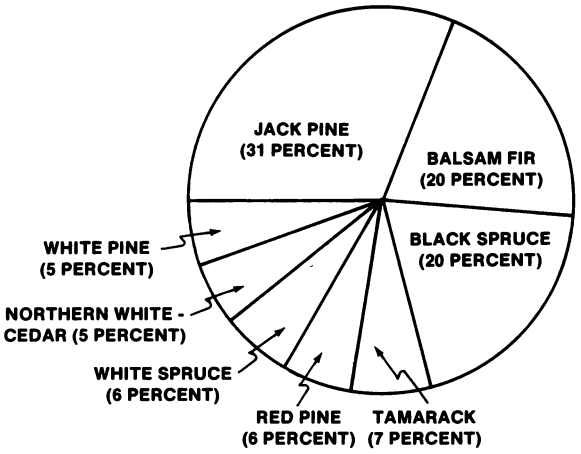


Figure 3.—*1976 growing-stock removals and average annual predicted yields from selected cutting prescriptions, by species groups, northern Minnesota.*





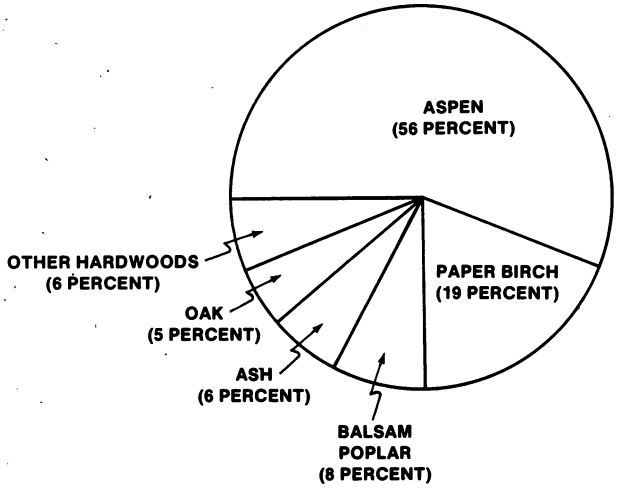


Figure 4.—*(a) 1976 hardwood growing-stock removals by species and (b) average annual predicted yields under short-rotation-age criteria, northern Minnesota.*

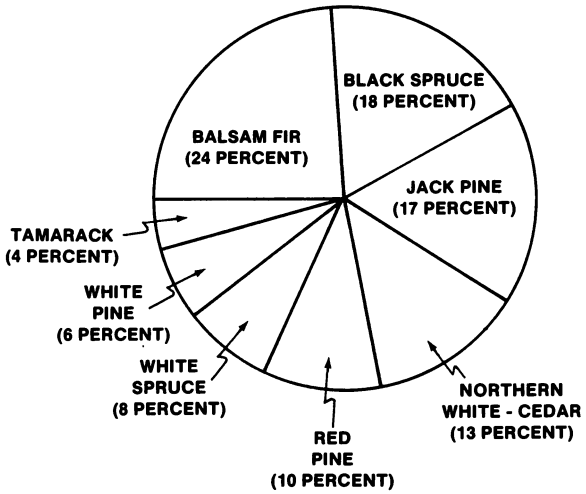


Figure 5.—*(a) 1976 softwood growing-stock removals by species and (b) average annual predicted yields under short-rotation-age criteria, northern Minnesota.*

harvest volume is even greater under short rotation age criteria, where removals would be 116.5 million cubic feet.

Opportunities exist for increased removals from all softwood species, with the exception of tamarack and jack pine. Under both sets of harvest prescriptions, tamarack removals in 1976 exceed predicted harvest yields. The 1976 level of tamarack removals cannot be maintained if the objectives of the cutting prescriptions are to be achieved. Jack pine yields from the long and short rotation age criteria fall below the level of removals in 1976.

Softwood removals are more evenly distributed among species under the harvest prescriptions than they were in the 1976 removals. Jack pine, balsam fir, and black spruce will continue to contribute the bulk of softwood removals, but their percentages will decline during the decade as removals of the other species increase (fig. 5).

Aspen-Birch Unit has Greatest Potential

Under the harvest prescriptions, the Aspen-Birch Unit will supply a greater proportion of total removals than it did in 1976. Growing-stock removals in northern Minnesota in 1976 were fairly evenly divided between the Aspen-Birch Unit and the Northern Pine Unit. Under the cutting prescriptions, the

Aspen-Birch Unit will contribute approximately 57 percent of harvest volume.

Predicted yields from cutting prescriptions range from 103.2 million cubic feet to 186.7 million cubic feet higher than 1976 removals. Most of this increase in removals volume would be in the Aspen-Birch Unit. The Unit would account for 69 percent of the increase in the long rotation age option, and 60 percent of the increase in the short rotation age option. Softwood yields are concentrated in the Aspen-Birch Unit.

The Northern Pine Unit plays an increasingly important role in supplying harvest volume of some species under the cutting prescriptions. For example, in 1976, jack pine removals were evenly divided between the two northern Survey Units; under the prescriptions, the Northern Pine Unit would supply a majority of the jack pine harvest volume.

Table 1.--Site index and rotation age by forest type for long and short rotation age cutting prescriptions, northern Minnesota, 1977-1986

Forest type	Long rotation age option		Short rotation age option	
	Site index	Rotation age	Site index	Rotation age
		years		years
Jack pine	0-60	50	all	40
	61+	60		
Red pine	0-55	100	all	75
	56+	120		
White pine	0-55	100	all	75
	56+	120		
Balsam fir	all	50	all	45
White spruce	all	80	all	65
Black spruce	0-40	120	all	60
	41+	90		
Northern white-cedar	all	100	all	85
Tamarack	0-40	120	all	45
	41+	90		
Oak	0-55	100	all	40
	56+	80		
Elm-ash-cottonwood	0-55	70	all	50
	56+	90		
Maple-basswood	all	90[1/]	all	90[1/]
Aspen	0-65	40	all	35
	66+	60		
Paper birch	0-65	40	all	35
	66+	60		
Balsam poplar	0-65	40	all	40
	66+	60		

1/Tubbs, Carl H. 1977. Manager's handbook for northern hardwoods in the North Central States. U.S. Department of Agriculture Forest Service, General Technical Report NC-29, 29 p. U.S Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota (applied to stands over age 90).

Table 2.-- Average annual predicted yields from selected cutting prescriptions by forest type and tree class, northern Minnesota, 1977-1986

Forest type	Harvest area	Number growing-stock trees harvested	Total volume	Pole-timber volume	Saw-timber volume	Short-log volume	Other cull volume [1]
	Thousand acres	Thousand trees	Thousand cubic feet				
LONG ROTATION AGE OPTION							
Jack pine	9.2	1,593	14,933	4,207	9,870	696	160
Red pine	2.2	377	4,963	814	3,969	93	87
White pine	0.5	69	1,262	172	965	100	25
Balsam fir	16.5	2,634	16,488	8,294	7,002	923	269
White spruce	1.0	104	1,240	127	1,049	43	21
Black spruce	8.4	2,442	8,960	6,504	2,230	61	165
Northern white-cedar	4.6	1,044	4,738	1,208	2,950	324	256
Tamarack	4.1	760	3,281	2,050	1,001	72	158
Oak-hickory	2.8	361	3,128	950	1,825	284	69
Elm-ash-cottonwood	7.3	1,121	7,825	3,037	3,697	559	532
Maple-basswood	7.4	139	1,903	558	11	977	357
Aspen	90.4	16,473	166,916	71,455	80,291	9,126	6,044
Paper birch	20.9	3,607	30,603	13,562	14,136	1,882	1,023
Balsam poplar	10.7	1,366	13,227	4,747	7,213	760	507
All types	186.0	32,090	279,467	117,685	136,209	15,900	9,673
SHORT ROTATION AGE OPTION							
Jack pine	12.2	2,570	21,165	7,614	12,553	765	233
Red pine	3.2	405	5,896	626	5,113	113	44
White pine	0.7	85	1,703	128	1,424	135	16
Balsam fir	18.4	3,066	19,837	9,601	8,680	1,194	362
White spruce	1.2	216	1,628	399	1,165	43	21
Black spruce	14.0	4,117	13,570	10,529	2,703	57	281
Northern white-cedar	10.0	2,163	9,972	2,589	6,124	790	469
Tamarack	5.1	1,046	3,600	2,601	738	60	201
Oak-hickory	6.3	855	6,631	2,195	3,713	559	164
Elm-ash-cottonwood	10.9	1,651	11,801	4,956	5,423	719	703
Maple-basswood	7.4	139	1,903	558	11	977	357
Aspen	128.3	22,362	222,925	97,175	103,515	13,115	9,120
Paper birch	25.6	4,854	37,420	18,626	15,383	2,127	1,284
Balsam poplar	11.4	1,442	14,633	5,236	7,979	815	603
All types	254.7	44,971	372,684	162,833	174,524	21,469	13,858

[1] Rough and rotten cull.

Table 3.-- Average annual predicted yields from selected cutting prescriptions by forest type and tree class, Aspen-Birch Unit, Minnesota, 1977-1986

Forest type	Harvest area	Number growing-stock trees harvested	Total volume	Pole-timber volume	Saw-timber volume	Short-log volume	Other cull volume 1/
	Thousand acres	Thousand trees	Thousand cubic feet				
LONG ROTATION AGE OPTION							
Jack pine	3.1	525	5,539	1,698	3,307	495	39
Red pine	1.2	274	3,043	630	2,334	32	47
White pine	0.3	29	605	78	415	97	15
Balsam fir	12.2	2,045	13,797	6,685	6,099	825	188
White spruce	0.8	68	902	78	792	32	0
Black spruce	6.0	1,739	7,046	5,010	1,865	61	110
Northern white-cedar	3.1	620	3,042	687	1,983	238	134
Tamarack	1.6	235	1,228	632	492	46	58
Oak-hickory	0.1	12	94	50	36	8	0
Elm-ash-cottonwood	3.4	504	3,335	1,485	1,540	188	122
Maple-basswood	2.2	27	553	133	11	294	115
Aspen	40.9	9,501	95,114	44,577	45,520	3,102	1,915
Paper birch	12.2	2,025	18,490	8,150	8,535	1,252	553
Balsam poplar	4.5	623	6,370	2,395	3,257	431	287
All types	91.6	18,227	159,158	72,288	76,186	7,101	3,583
SHORT ROTATION AGE OPTION							
Jack pine	4.0	1,057	8,512	3,787	4,227	458	40
Red pine	1.6	277	2,981	395	2,580	6	0
White pine	0.4	39	795	90	569	125	11
Balsam fir	13.6	2,436	16,908	7,880	7,665	1,084	279
White spruce	0.9	163	1,198	329	837	32	0
Black spruce	9.9	2,961	10,239	7,992	2,033	41	173
Northern white-cedar	6.8	1,411	6,755	1,697	4,299	498	261
Tamarack	1.9	347	1,299	835	382	29	53
Oak-hickory	0.1	27	239	120	93	26	0
Elm-ash-cottonwood	4.9	816	5,463	2,541	2,422	279	221
Maple-basswood	2.2	27	553	133	11	294	115
Aspen	57.5	12,089	117,826	56,127	54,537	4,267	2,895
Paper birch	14.8	3,013	22,779	11,986	8,960	1,290	543
Balsam poplar	5.1	721	6,977	2,757	3,446	463	311
All types	123.7	25,384	202,524	96,669	92,061	8,892	4,902

1/Rough and rotten cull.

Table 4.-- Average annual predicted yields from selected cutting prescriptions by forest type and tree class, Northern Pine Unit, Minnesota, 1977-1986

Forest type	Harvest area	Number growing-stock trees harvested	Total volume	Pole-timber volume	Saw-timber volume	Short-log volume	Other cull volume [1/]
	Thousand acres	Thousand trees	Thousand cubic feet				
LONG ROTATION AGE OPTION							
Jack pine	6.1	1,068	9,394	2,509	6,563	201	121
Red pine	1.0	103	1,920	184	1,635	61	40
White pine	0.2	40	657	94	550	3	10
Balsam fir	4.3	589	2,691	1,609	903	98	81
White spruce	0.2	36	338	49	257	11	21
Black spruce	2.4	703	1,914	1,494	365	0	55
Northern white-cedar	1.5	424	1,696	521	967	86	122
Tamarack	2.5	525	2,053	1,418	509	26	100
Oak-hickory	2.7	349	3,034	900	1,789	276	69
Elm-ash-cottonwood	3.9	617	4,490	1,552	2,157	371	410
Maple-basswood	5.2	112	1,350	425	0	683	242
Aspen	49.5	6,972	71,802	26,878	34,771	6,024	4,129
Paper birch	8.7	1,582	12,113	5,412	5,601	630	470
Balsam poplar	6.2	743	6,857	2,352	3,956	329	220
All types	94.4	13,863	120,309	45,397	60,023	8,799	6,090
SHORT ROTATION AGE OPTION							
Jack pine	8.2	1,513	12,653	3,827	8,326	307	193
Red pine	1.6	128	2,915	231	2,533	107	44
White pine	0.3	46	908	38	855	10	5
Balsam fir	4.8	630	2,929	1,721	1,015	110	83
White spruce	0.3	53	430	70	328	11	21
Black spruce	4.2	1,156	3,331	2,537	670	16	108
Northern white-cedar	3.2	752	3,217	892	1,825	292	208
Tamarack	3.2	699	2,301	1,766	356	31	148
Oak-hickory	6.2	828	6,392	2,075	3,620	533	164
Elm-ash-cottonwood	6.0	835	6,338	2,415	3,001	440	482
Maple-basswood	5.2	112	1,350	425	0	683	242
Aspen	70.8	10,273	105,099	41,048	48,978	8,848	6,225
Paper birch	10.8	1,841	14,641	6,640	6,423	837	741
Balsam poplar	6.3	721	7,656	2,479	4,533	352	292
All types	131.1	19,587	170,160	66,164	82,463	12,577	8,956

[1/] Rough and rotten cull.

Table 5.--Ten-year harvest area from selected cutting prescriptions by forest type, site index class, and stand-age class, northern Minnesota, 1977-1986

(In thousand acres)

Forest type	Site index class	Total	Stand-age class (years) 1-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
LONG ROTATION AGE OPTION												
Jack pine	0-60	64.1	0	0	7.8	22.9	7.4	12.4	11.8	1.8	0	0
	61+	27.9	0	0	20.1	7.8	0	0	0	0	0	0
Red pine	0-55	8.9	0	0	0	0	0	4.4	2.0	2.5	0	0
	56+	13.4	0	0	2.2	2.1	0	1.1	8.0	0	0	0
White pine	0-55	3.7	0	0	0	0	0	0	1.6	2.1	0	0
	56+	1.6	0	0	0	0	0	0	1.6	0	0	0
Balsam fir	All	165.1	0	0	27.5	80.3	35.8	9.7	9.2	2.6	0	0
White spruce	All	10.0	0	0	0	2.5	1.2	2.4	2.8	1.1	0	0
Black spruce	0-40	54.4	0	0	0	0	0	8.7	21.1	12.5	12.1	0
	41+	29.0	0	0	0	1.8	8.4	9.5	7.8	1.5	0	0
Northern white-cedar	All	46.3	0	0	0	0	0	0	0	0	43.3	3.0
Tamarack	0-40	20.9	0	0	0	0	0	0	0	2.9	16.8	1.2
	41+	20.0	0	0	0	1.9	3.1	0	0.7	9.8	4.5	0
Oak-hickory	0-55	17.2	0	0.3	0	0	0	1.4	9.6	5.9	0	0
	56+	10.4	0	0	0.4	4.4	2.8	1.4	0	1.4	0	0
Elm-ash-cottonwood	0-55	55.9	0	0	0	0	0	0	17.9	25.8	12.2	0
	56+	16.9	0	0	0	0	0	1.7	7.9	3.4	3.9	0
Maple-basswood	All	73.7	0	0	0	0	0	0	24.5	20.5	28.7	0
Aspen	0-65	504.9	0	0	177.9	209.5	80.9	26.9	5.3	3.0	1.4	0
	66+	399.1	0	0	229.5	104.4	32.9	21.8	9.1	1.4	0	0
Paper birch	0-65	179.3	0	0	0	71.9	61.7	34.9	5.5	5.3	0	0
	66+	29.3	0	0	1.1	18.0	6.3	1.2	2.7	0	0	0
Balsam poplar	0-65	76.6	0	1.9	26.1	24.4	20.1	2.8	1.3	0	0	0
	66+	30.4	0	0	10.4	12.2	5.1	2.7	0	0	0	0
All types		1,859.0	0	2.2	503.0	564.1	265.7	143.0	150.4	103.5	122.9	4.2
SHORT ROTATION AGE OPTION												
Jack pine	All	122.2	0	0	47.5	41.3	7.4	12.4	11.8	1.8	0	0
Red pine	All	32.4	0	0	0	0	0	14.3	15.6	2.5	0	0
White pine	All	7.2	0	0	0	0	0	0	2.8	4.4	0	0
Balsam fir	All	183.8	0	0	41.3	85.2	35.8	9.7	9.2	2.6	0	0
White spruce	All	12.3	0	0	1.7	3.0	1.2	2.4	2.9	1.1	0	0
Black spruce	All	140.1	0	0	0	4.5	14.1	45.2	50.2	14.0	12.1	0
Northern white-cedar	All	99.7	0	0	0	0	0	0	0.5	30.2	66.0	3.0
Tamarack	All	51.2	0	0	0	0	0	1.0	1.4	23.8	23.8	1.2
Oak-hickory	All	63.3	0	0	1.3	12.8	25.3	7.0	9.6	7.3	0	0
Elm-ash-cottonwood	All	108.4	0	0	0	0	0	21.6	41.6	29.1	16.1	0
Maple-basswood	All	73.7	0	0	0	0	0	0	24.5	20.5	28.7	0
Aspen	All	1,282.9	0	18.0	765.2	316.8	114.0	48.8	14.3	4.4	1.4	0
Paper birch	All	256.1	0	0	28.1	110.3	68.1	36.1	8.2	5.3	0	0
Balsam poplar	All	114.0	0	1.9	39.9	37.5	27.8	5.5	1.4	0	0	0
All types		2,547.3	0	19.9	925.0	611.4	293.7	204.0	194.0	147.0	148.1	4.2

Table 6.--Ten-year harvest area from selected cutting prescriptions by forest type, site index class, and stand-age class, Aspen-Birch Unit, Minnesota, 1977-1986

(In thousand acres)

Forest type	Site index class	Total	Stand-age class (years) 1-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
LONG ROTATION AGE OPTION												
Jack pine	0-60	28.1	0	0	0	2.2	1.0	12.4	10.7	1.8	0	0
	61+	3.1	0	0	2.0	1.1	0	0	0	0	0	0
Red pine	0-55	6.4	0	0	0	0	0	4.4	0.9	1.1	0	0
	56+	5.4	0	0	2.2	2.1	0	1.1	0	0	0	0
White pine	0-55	2.7	0	0	0	0	0	0	1.6	1.1	0	0
	56+	0.3	0	0	0	0	0	0	0.3	0	0	0
Balsam fir	ALL	121.7	0	0	27.5	50.8	24.9	8.1	9.2	1.2	0	0
White spruce	ALL	7.6	0	0	0	1.3	1.2	1.2	2.8	1.1	0	0
Black spruce	0-40	37.2	0	0	0	0	0	0	17.1	10.9	9.2	0
	41+	22.6	0	0	0	0	6.9	7.9	7.8	0	0	0
Northern white-cedar	ALL	30.9	0	0	0	0	0	0	0	0	30.9	0
Tamarack	0-40	7.8	0	0	0	0	0	0	0	2.9	3.7	1.2
	41+	7.7	0	0	0	1.9	3.1	0	0	1.4	1.3	0
Oak-hickory	0-55	0.3	0	0.3	0	0	0	0	0	0	0	0
	56+	0.4	0	0	0.4	0	0	0	0	0	0	0
Elm-ash-cottonwood	0-55	29.5	0	0	0	0	0	0	10.5	12.3	6.7	0
	56+	4.3	0	0	0	0	0	1.7	0	0	2.6	0
Maple-basswood	ALL	21.9	0	0	0	0	0	0	0	12.9	9.0	0
Aspen	0-65	267.3	0	0	88.7	111.8	46.0	16.8	2.7	1.3	0	0
	66+	141.4	0	0	72.4	38.5	15.8	9.7	5.0	0	0	0
Paper birch	0-65	107.5	0	0	0	34.6	45.3	23.9	2.4	1.3	0	0
	66+	13.9	0	0	1.1	6.6	4.9	0	1.3	0	0	0
Balsam poplar	0-65	30.9	0	0	7.1	11.1	8.6	2.8	1.3	0	0	0
	66+	13.6	0	0	4.3	4.2	3.8	1.3	0	0	0	0
All types		912.5	0	0.3	205.7	266.2	161.5	91.3	73.6	49.3	63.4	1.2
SHORT ROTATION AGE OPTION												
Jack pine	All	39.8	0	0	0	13.9	1.0	12.4	10.7	1.8	0	0
Red pine	All	16.3	0	0	0	0	0	14.3	0.9	1.1	0	0
White pine	All	3.9	0	0	0	0	0	0	2.8	1.1	0	0
Balsam fir	All	135.6	0	0	41.3	50.9	24.9	8.1	9.2	1.2	0	0
White spruce	All	9.4	0	0	1.7	1.3	1.2	1.2	2.9	1.1	0	0
Black spruce	All	98.6	0	0	0	0	5.9	26.4	46.2	10.9	9.2	0
Northern white-cedar	All	67.7	0	0	0	0	0	0	0.5	25.8	41.4	0
Tamarack	All	19.1	0	0	0	0	0	1.0	1.4	10.5	5.0	1.2
Oak-hickory	All	1.3	0	0	1.3	0	0	0	0	0	0	0
Elm-ash-cottonwood	All	48.9	0	0	0	0	0	8.1	19.3	12.2	9.3	0
Maple-basswood	All	21.9	0	0	0	0	0	0	0	12.9	9.0	0
Aspen	All	574.5	0	0	324.1	153.1	61.8	26.5	7.7	1.3	0	0
Paper birch	All	147.8	0	0	10.6	58.0	50.3	23.9	3.7	1.3	0	0
Balsam poplar	All	51.4	0	0	18.3	15.2	12.4	4.1	1.4	0	0	0
All types		1,236.2	0	0	397.3	292.4	157.5	126.0	106.7	81.2	73.9	1.2

Table 7.--Ten-year harvest area from selected cutting prescriptions by forest type, site index class, and stand-age class, Northern Pine Unit, Minnesota, 1977-1986

(In thousand acres)

Forest type	Site index class	Total	Stand-age class (years) 1-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
LONG ROTATION AGE OPTION												
Jack pine	0-60	36.0	0	0	7.8	20.7	6.4	0	1.1	0	0	0
	61+	24.8	0	0	18.1	6.7	0	0	0	0	0	0
Red pine	0-55	2.5	0	0	0	0	0	0	1.1	1.4	0	0
	56+	8.0	0	0	0	0	0	0	8.0	0	0	0
White pine	0-55	1.0	0	0	0	0	0	0	0	1.0	0	0
	56+	1.3	0	0	0	0	0	0	1.3	0	0	0
Balsam fir	All	43.4	0	0	0	29.5	10.9	1.6	0	1.4	0	0
White spruce	All	2.4	0	0	0	1.2	0	1.2	0	0	0	0
Black spruce	0-40	17.2	0	0	0	0	0	8.7	4.0	1.6	2.9	0
	41+	6.4	0	0	0	1.8	1.5	1.6	0	1.5	0	0
Northern white-cedar	All	15.4	0	0	0	0	0	0	0	0	12.4	3.0
Tamarack	0-40	13.1	0	0	0	0	0	0	0	0	13.1	0
	41+	12.3	0	0	0	0	0	0	0.7	8.4	3.2	0
Oak-hickory	0-55	16.9	0	0	0	0	0	1.4	9.6	5.9	0	0
	56+	10.0	0	0	0	4.4	2.8	1.4	0	1.4	0	0
Elm-ash-cottonwood	0-55	26.4	0	0	0	0	0	0	7.4	13.5	5.5	0
	56+	12.6	0	0	0	0	0	0	7.9	3.4	1.3	0
Maple-basswood	All	51.8	0	0	0	0	0	0	24.5	7.6	19.7	0
Aspen	0-65	237.6	0	0	89.2	97.7	34.9	10.1	2.6	1.7	1.4	0
	66+	257.7	0	0	157.1	65.9	17.1	12.1	4.1	1.4	0	0
Paper birch	0-65	71.8	0	0	0	37.3	16.4	11.0	3.1	4.0	0	0
	66+	15.4	0	0	0	11.4	1.4	1.2	1.4	0	0	0
Balsam poplar	0-65	45.7	0	1.9	19.0	13.3	11.5	0	0	0	0	0
	66+	16.8	0	0	6.1	8.0	1.3	1.4	0	0	0	0
All types		946.5	0	1.9	297.3	297.9	104.2	51.7	76.8	54.2	59.5	3.0
SHORT ROTATION AGE OPTION												
Jack pine	All	82.4	0	0	47.5	27.4	6.4	0	1.1	0	0	0
Red pine	All	16.1	0	0	0	0	0	0	14.7	1.4	0	0
White pine	All	3.3	0	0	0	0	0	0	0	3.3	0	0
Balsam fir	All	48.2	0	0	0	34.3	10.9	1.6	0	1.4	0	0
White spruce	All	2.9	0	0	0	1.7	0	1.2	0	0	0	0
Black spruce	All	41.5	0	0	0	4.5	8.2	18.8	4.0	3.1	2.9	0
Northern white-cedar	All	32.0	0	0	0	0	0	0	0	4.4	24.6	3.0
Tamarack	All	32.1	0	0	0	0	0	0	0	13.3	18.8	0
Oak-hickory	All	62.0	0	0	0	12.8	25.3	7.0	9.6	7.3	0	0
Elm-ash-cottonwood	All	59.5	0	0	0	0	0	13.5	22.3	16.9	6.8	0
Maple-basswood	All	51.8	0	0	0	0	0	0	24.5	7.6	19.7	0
Aspen	All	708.4	0	18.0	441.1	163.7	52.2	22.3	6.6	3.1	1.4	0
Paper birch	All	108.3	0	0	17.5	52.3	17.8	12.2	4.5	4.0	0	0
Balsam poplar	All	62.6	0	1.9	21.6	22.3	15.4	1.4	0	0	0	0
All types		1,311.1	0	19.9	527.7	319.0	136.2	78.0	87.3	65.8	74.2	3.0

Table 8.--Average annual predicted yields from selected cutting prescriptions by species group and tree class, northern Minnesota, 1977-1986

Species group	Growing stock			Cull			
	Total	Pole-timber	Saw-timber	Total	Shortlog	Other [1]	Saw-timber
	Thousand cubic feet						Thousand board feet [2]
LONG ROTATION AGE OPTION							
SOFTWOODS:							
White pine	5,444	107	5,337	195	172	23	36,267
Red pine	9,404	595	8,809	58	44	14	53,498
Jack pine	14,083	2,842	11,241	480	338	142	57,737
White spruce	8,099	2,314	5,785	64	48	16	27,239
Black spruce	15,924	10,166	5,758	177	20	157	26,569
Balsam fir	21,464	13,022	8,442	612	259	353	39,201
Tamarack	3,778	2,255	1,523	302	97	205	6,586
Northern white-cedar	9,787	2,554	7,233	1,613	1,237	376	39,587
Other softwoods	0	0	0	0	0	0	0
Total	87,983	33,855	54,128	3,501	2,215	1,286	286,684
HARDWOODS:							
White oak	2,616	1,206	1,410	235	142	93	7,337
Select red oak	4,686	1,730	2,956	583	416	167	14,781
Other red oak	0	0	0	0	0	0	0
Hickory	16	8	8	0	0	0	41
Yellow birch	140	56	84	116	87	29	392
Hard maple	1,327	991	336	1,102	735	367	1,925
Soft maple	1,337	942	395	661	288	373	1,938
Ash	11,360	7,354	4,006	710	265	445	22,874
Balsam poplar	15,493	7,141	8,352	890	505	385	43,021
Paper birch	32,070	23,591	8,479	2,963	1,356	1,607	43,791
Bigtooth aspen	4,109	1,866	2,243	616	392	224	10,627
Quaking aspen	86,253	36,593	49,660	13,330	8,971	4,359	265,170
Basswood	2,428	1,344	1,084	346	168	178	5,410
Elm	4,027	981	3,046	447	355	92	17,172
Select hardwoods	28	6	22	12	0	12	108
Other hardwoods	21	21	0	27	5	22	0
Noncommercial species	0	0	0	58	0	58	0
Total	165,911	83,830	82,081	22,096	13,685	8,411	434,587
All species	253,894	117,685	136,209	25,597	15,900	9,697	721,271
SHORT ROTATION AGE OPTION							
SOFTWOODS:							
White pine	6,978	346	6,632	230	202	28	44,928
Red pine	11,317	542	10,775	70	62	8	66,228
Jack pine	20,183	5,522	14,661	664	484	180	75,472
White spruce	9,343	2,726	6,617	81	48	33	31,348
Black spruce	20,887	14,518	6,369	252	21	231	29,537
Balsam fir	28,469	17,323	11,146	808	394	414	51,479
Tamarack	4,332	2,863	1,469	406	115	291	6,338
Northern white-cedar	14,964	3,727	11,237	2,390	1,817	573	61,891
Other softwoods	23	23	0	3	0	3	0
Total	116,496	47,590	68,906	4,904	3,143	1,761	367,221
HARDWOODS:							
White oak	3,944	1,852	2,092	410	254	156	10,872
Select red oak	7,415	3,020	4,395	880	645	235	22,032
Other red oak	78	67	11	3	0	3	54
Hickory	16	8	8	0	0	0	41
Yellow birch	206	63	143	139	102	37	701
Hard maple	1,783	1,358	425	1,211	770	441	2,430
Soft maple	1,838	1,295	543	844	338	506	2,676
Ash	14,003	9,155	4,848	877	323	554	27,792
Balsam poplar	17,607	8,386	9,221	1,150	619	531	47,548
Paper birch	41,822	31,425	10,397	4,226	1,909	2,317	53,937
Bigtooth aspen	5,921	2,935	2,986	774	466	308	14,075
Quaking aspen	117,574	52,181	65,393	18,757	12,197	6,560	349,142
Basswood	3,657	2,225	1,432	505	243	262	7,091
Elm	4,922	1,226	3,696	565	454	111	20,648
Select hardwoods	40	12	28	18	0	18	140
Other hardwoods	35	35	0	28	6	22	0
Noncommercial species	0	0	0	69	0	69	0
Total	220,861	115,243	105,618	30,456	18,326	12,130	559,179
All species	337,357	162,833	174,524	35,360	21,469	13,891	926,400

[1] Rough and rotten cull.

[2] International 1/4-inch rule.

Table 9.--Average annual predicted yields from selected cutting prescriptions by species group and tree class, Aspen-Birch Unit, Minnesota, 1977-1986

Species group	Growing stock			Cull			Sawtimber
	Total	Poletimber	Sawtimber	Total	Shortlog	Other [1]	
	Thousand cubic feet						Thousand board feet [2]
LONG ROTATION AGE OPTION							
SOFTWOODS:							
White pine	3,690	54	3,636	101	84	17	26,092
Red pine	4,383	388	3,995	27	13	14	26,805
Jack pine	4,671	713	3,958	122	87	35	21,366
White spruce	6,875	2,124	4,751	53	43	10	21,775
Black spruce	13,049	7,948	5,101	108	6	102	23,890
Balsam fir	14,876	9,555	5,321	452	219	233	26,097
Tamarack	1,562	891	671	141	42	99	2,441
Northern white-cedar	5,760	1,405	4,355	887	734	153	25,448
Other softwoods	0	0	0	0	0	0	0
Total	54,866	23,078	31,788	1,891	1,228	663	173,914
HARDWOODS:							
White oak	101	12	89	22	10	12	369
Select red oak	123	50	73	13	11	2	353
Other red oak	0	0	0	0	0	0	0
Hickory	0	0	0	0	0	0	0
Yellow birch	102	25	77	67	57	10	355
Hard maple	343	287	56	328	212	116	355
Soft maple	579	393	186	372	163	209	907
Ash	7,120	4,526	2,594	214	89	125	15,740
Balsam poplar	10,133	5,007	5,126	587	386	201	26,814
Paper birch	19,887	15,295	4,592	1,504	853	651	24,507
Bigtooth aspen	542	226	316	67	38	29	1,692
Quaking aspen	52,775	22,987	29,788	5,403	3,880	1,523	161,787
Basswood	272	120	152	49	37	12	800
Elm	1,631	282	1,349	166	137	29	7,784
Select hardwoods	0	0	0	0	0	0	0
Other hardwoods	0	0	0	1	0	1	0
Noncommercial species	0	0	0	24	0	24	0
Total	93,608	49,210	44,398	8,817	5,873	2,944	241,463
All species	148,474	72,288	76,186	10,708	7,101	3,607	415,377
SHORT ROTATION AGE OPTION							
SOFTWOODS:							
White pine	4,595	275	4,320	83	69	14	31,462
Red pine	4,444	288	4,156	25	23	2	29,221
Jack pine	7,205	2,202	5,003	122	80	42	27,396
White spruce	7,713	2,477	5,236	65	43	22	24,037
Black spruce	16,665	11,235	5,430	168	15	153	25,681
Balsam fir	19,335	12,645	6,690	597	303	294	32,822
Tamarack	1,748	1,102	646	168	52	116	2,319
Northern white-cedar	9,437	2,162	7,275	1,334	1,076	258	42,501
Other softwoods	0	0	0	0	0	0	0
Total	71,142	32,386	38,756	2,562	1,661	901	215,439
HARDWOODS:							
White oak	98	31	67	21	9	12	319
Select red oak	270	121	149	36	29	7	783
Other red oak	0	0	0	0	0	0	0
Hickory	0	0	0	0	0	0	0
Yellow birch	168	32	136	92	72	20	664
Hard maple	461	405	56	341	224	117	355
Soft maple	773	556	217	473	196	277	1,081
Ash	8,799	5,671	3,128	293	102	191	19,113
Balsam poplar	11,269	5,727	5,542	702	454	248	28,986
Paper birch	25,711	19,986	5,725	2,009	1,179	830	30,723
Bigtooth aspen	995	580	415	103	54	49	2,225
Quaking aspen	66,790	30,516	36,274	6,930	4,722	2,208	196,831
Basswood	427	282	145	49	37	12	754
Elm	1,827	376	1,451	181	152	29	8,379
Select hardwoods	0	0	0	0	0	0	0
Other hardwoods	0	0	0	2	1	1	0
Noncommercial species	0	0	0	33	0	33	0
Total	117,588	64,283	53,305	11,265	7,231	4,034	290,213
All species	188,730	96,669	92,061	13,827	8,892	4,935	505,652

[1] Rough and rotten cull.

[2] International 1/4-inch rule.

Table 10.--Average annual predicted yields from selected cutting prescriptions by species group and tree class, Northern Pine Unit, Minnesota, 1977-1986

Species Group	Growing stock			Cull			
	Total	Pole-timber	Saw-timber	Total	Shortlog	Other [1]	Saw-timber
	Thousand cubic feet						Thousand board feet [2]
LONG ROTATION AGE OPTION							
SOFTWOODS:							
White pine	1,754	53	1,701	94	88	6	10,175
Red pine	5,021	207	4,814	31	31	0	26,693
Jack pine	9,412	2,129	7,283	358	251	107	36,371
White spruce	1,224	190	1,034	11	5	6	5,464
Black spruce	2,875	2,218	657	69	14	55	2,679
Balsam fir	6,588	3,467	3,121	160	40	120	13,104
Tamarack	2,216	1,364	852	161	55	106	4,145
Northern white-cedar	4,027	1,149	2,878	726	503	223	14,139
Other softwoods	0	0	0	0	0	0	0
Total	33,117	10,777	22,340	1,610	987	623	112,770
HARDWOODS:							
White oak	2,515	1,194	1,321	213	132	81	6,968
Select red oak	4,563	1,680	2,883	570	405	165	14,428
Other red oak	0	0	0	0	0	0	0
Hickory	16	8	8	0	0	0	41
Yellow birch	38	31	7	49	30	19	37
Hard maple	984	704	280	774	523	251	1,570
Soft maple	758	549	209	289	125	164	1,031
Ash	4,240	2,828	1,412	496	176	320	7,134
Balsam poplar	5,360	2,134	3,226	303	119	184	16,207
Paper birch	12,183	8,296	3,887	1,459	503	956	19,284
Bigtooth aspen	3,567	1,640	1,927	549	354	195	8,935
Quaking aspen	33,478	13,606	19,872	7,927	5,091	2,836	103,383
Basswood	2,156	1,224	932	297	131	166	4,610
Elm	2,396	699	1,697	281	218	63	9,388
Select hardwoods	28	6	22	12	0	12	108
Other hardwoods	21	21	0	26	5	21	0
Noncommercial species	0	0	0	34	0	34	0
Total	72,303	34,620	37,683	13,279	7,812	5,467	193,124
All species	105,420	45,397	60,023	14,889	8,799	6,090	305,894
SHORT ROTATION AGE OPTION							
SOFTWOODS:							
White pine	2,383	71	2,312	147	133	14	13,466
Red pine	6,873	254	6,619	45	39	6	37,007
Jack pine	12,978	3,320	9,658	542	404	138	48,076
White spruce	1,630	249	1,381	16	5	11	7,311
Black spruce	4,222	3,283	939	84	6	78	3,856
Balsam fir	9,134	4,678	4,456	211	91	120	18,657
Tamarack	2,584	1,761	823	238	63	175	4,019
Northern white-cedar	5,527	1,565	3,962	1,056	741	315	19,390
Other softwoods	23	23	0	3	0	3	0
Total	45,354	15,204	30,150	2,342	1,482	860	151,782
HARDWOODS:							
White oak	3,846	1,821	2,025	389	245	144	10,553
Select red oak	7,145	2,899	4,246	844	616	228	21,249
Other red oak	78	67	11	3	0	3	54
Hickory	16	8	8	0	0	0	41
Yellow birch	38	31	7	47	30	17	37
Hard maple	1,322	953	369	870	546	324	2,075
Soft maple	1,065	739	326	371	142	229	1,595
Ash	5,204	3,484	1,720	584	221	363	8,679
Balsam poplar	6,338	2,659	3,679	448	165	283	18,562
Paper birch	16,111	11,439	4,672	2,217	730	1,487	23,214
Bigtooth aspen	4,926	2,355	2,571	671	412	259	11,850
Quaking aspen	50,784	21,665	29,119	11,827	7,475	4,352	152,311
Basswood	3,230	1,943	1,287	456	206	250	6,337
Elm	3,095	850	2,245	384	302	82	12,269
Select hardwoods	40	12	28	18	0	18	140
Other hardwoods	35	35	0	26	5	21	0
Noncommercial species	0	0	0	36	0	36	0
Total	103,273	50,960	52,313	19,191	11,095	8,096	268,966
All species	148,627	66,164	82,463	21,533	12,577	8,956	420,748

[1] Rough and rotten cull.

[2] International 1/4-inch rule.

Table 11.--Average annual predicted yields of growing-stock from selected cutting prescriptions by species group and forest type, northern Minnesota, 1977-1986

(In thousand cubic feet)

LONG ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-cotton-wood	Maple-bass-wood	Aspen	Paper birch	Balsa popla
SOFTWOODS:															
White pine	5,444	48	616	672	427	63	119	40	0	21	0	0	2,990	431	17
Red pine	9,404	563	3,554	140	226	28	63	25	0	143	0	0	3,254	1,408	0
Jack pine	14,083	10,161	10	0	137	2	143	0	16	0	0	0	3,407	188	19
White spruce	8,099	37	15	111	1,287	598	107	23	0	6	64	0	4,769	884	198
Black spruce	15,924	1,229	71	0	2,606	1	7,186	135	306	0	11	0	4,129	167	83
Balsam fir	21,464	119	200	111	5,715	102	203	68	31	11	484	55	10,038	2,999	1,328
Tamarack	3,778	0	0	0	282	1	350	83	2,572	0	7	0	171	0	312
Northern white-cedar	9,787	0	18	0	1,072	107	289	3,368	85	0	1,427	0	1,990	999	432
Other softwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	87,983	12,157	4,484	1,034	11,752	902	8,460	3,742	3,010	181	1,993	55	30,748	7,076	2,389
HARDWOODS:															
White oak	2,616	5	0	0	0	3	0	0	0	561	30	39	1,781	157	40
Select red oak	4,686	26	0	0	0	0	0	0	0	1,252	0	6	2,914	432	56
Other red oak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hickory	16	0	0	0	0	0	0	0	0	0	0	0	0	16	0
Yellow birch	140	0	0	0	0	0	0	24	0	0	8	0	20	65	23
Hard maple	1,327	0	0	0	29	0	0	0	0	20	0	107	810	310	51
Soft maple	1,337	0	0	2	206	0	0	0	0	46	148	14	737	184	0
Ash	11,360	0	0	0	238	0	25	205	5	55	2,941	170	5,550	1,099	1,072
Balsam poplar	15,493	34	0	0	771	1	12	11	14	6	87	6	8,545	421	5,585
Paper birch	32,070	668	73	101	1,303	206	144	169	16	143	368	65	14,904	13,124	786
Bigtooth aspen	4,109	69	44	0	0	0	6	0	0	64	57	0	3,731	118	20
Quaking aspen	86,253	1,089	182	0	978	64	76	0	6	265	119	19	78,197	3,834	1,424
Basswood	2,428	4	0	0	8	0	0	0	0	133	121	28	1,626	414	94
Elm	4,027	9	0	0	11	0	11	7	0	44	862	60	2,155	448	420
Select hardwood	28	0	0	0	0	0	0	0	0	0	0	0	28	0	0
Other hardwoods	21	16	0	0	0	0	0	0	0	5	0	0	0	0	0
Total	165,911	1,920	299	103	3,544	274	274	416	41	2,594	4,741	514	120,998	20,622	9,571
All species	253,894	14,077	4,783	1,137	15,296	1,176	8,734	4,158	3,051	2,775	6,734	569	151,746	27,698	11,960

SHORT ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-cotton-wood	Maple-bass-wood	Aspen	Paper birch	Balsa popla
SOFTWOODS:															
White pine	6,978	48	959	787	427	76	38	100	0	128	63	0	3,472	844	36
Red pine	11,317	891	3,951	461	226	28	82	25	0	212	0	0	3,887	1,554	0
Jack pine	20,183	14,776	229	0	137	26	221	0	16	180	15	0	4,377	187	19
White spruce	9,343	62	15	138	1,288	835	185	73	0	6	78	0	5,620	894	149
Black spruce	20,887	1,599	0	0	2,713	20	10,815	463	401	0	18	0	4,573	210	75
Balsam fir	28,469	163	174	96	7,074	144	408	193	35	9	861	55	14,040	3,512	1,705
Tamarack	4,332	0	0	0	282	10	642	126	2,663	9	7	0	281	0	312
Northern white-cedar	14,964	0	0	0	1,647	107	395	6,834	159	0	1,968	0	2,281	1,011	562
Other softwoods	23	0	0	0	0	0	23	0	0	0	0	0	0	0	0
Total	116,496	17,539	5,328	1,482	13,794	1,246	12,809	7,814	3,274	544	3,010	55	38,531	8,212	2,858
HARDWOODS:															
White oak	3,944	8	0	0	0	3	0	0	0	1,258	91	39	2,249	246	50
Select red oak	7,415	43	0	0	0	0	0	0	0	2,516	0	6	4,146	636	68
Other red oak	78	0	0	0	0	0	0	0	0	0	0	0	78	0	0
Hickory	16	0	0	0	0	0	0	0	0	0	0	0	0	16	0
Yellow birch	206	0	0	0	0	0	0	24	0	0	72	0	20	66	24
Hard maple	1,783	0	0	0	29	0	0	0	0	19	0	107	1,228	339	61
Soft maple	1,838	0	0	0	206	0	0	0	0	71	160	14	1,163	219	5
Ash	14,003	0	0	0	255	0	8	272	5	89	4,557	170	6,477	1,149	1,021
Balsam poplar	17,607	40	0	0	775	12	12	36	14	6	154	6	10,000	459	6,093
Paper birch	41,822	723	119	70	2,052	213	244	483	40	389	497	65	19,736	16,355	836
Bigtooth aspen	5,921	103	81	0	0	0	6	0	0	104	57	0	5,362	188	20
Quaking aspen	117,574	1,682	211	0	1,135	90	142	71	6	609	337	19	106,605	5,074	1,593
Basswood	3,657	4	0	0	24	0	0	0	0	222	204	28	2,469	591	115
Elm	4,922	9	0	0	11	0	11	13	0	64	1,240	60	2,584	459	471
Select hardwood	40	0	0	0	0	0	0	0	0	12	0	0	28	0	0
Other hardwoods	35	16	0	0	0	0	0	0	0	5	0	0	14	0	0
Total	220,861	2,628	411	70	4,487	318	423	899	65	5,364	7,369	514	162,159	25,797	10,357
All species	337,357	20,167	5,739	1,552	18,281	1,564	13,232	8,713	3,339	5,908	10,379	569	200,690	34,009	13,215

Table 12.--Average annual predicted yields of growing-stock from selected cutting prescriptions by species group and forest type, Aspen-Birch Unit, Minnesota, 1977-1986

(In thousand cubic feet)

LONG ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar
SOFTWOODS:															
White pine	3,690	31	411	269	427	0	119	39	0	0	0	0	2,290	104	0
Red pine	4,383	15	2,246	0	208	0	63	25	0	0	0	0	1,074	752	0
Jack pine	4,671	2,316	10	0	137	0	143	0	0	0	0	0	2,036	29	0
White spruce	6,875	22	15	111	1,243	518	107	14	0	0	64	0	3,972	737	72
Black spruce	13,049	1,218	71	0	1,815	0	5,602	86	68	0	0	0	3,980	134	75
Balsam fir	14,876	29	48	75	5,023	54	143	62	31	2	323	23	6,526	1,785	752
Tamarack	1,562	0	0	0	282	0	274	23	939	0	0	0	12	0	32
Northern white-cedar	5,760	0	18	0	584	83	212	2,031	71	0	352	0	1,775	476	158
Other softwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	54,866	3,631	2,819	455	9,719	655	6,663	2,280	1,109	2	739	23	21,665	4,017	1,089
HARDWOODS:															
White oak	101	0	0	0	0	0	0	0	0	8	30	0	51	12	0
Select red oak	123	0	0	0	0	0	0	0	0	55	0	0	23	0	45
Other red oak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hickory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow birch	102	0	0	0	0	0	0	24	0	0	8	0	10	37	23
Hard maple	343	0	0	0	29	0	0	0	0	0	0	37	72	179	26
Soft maple	579	0	0	2	191	0	0	0	0	0	22	0	250	114	0
Ash	7,120	0	0	0	112	0	17	188	5	5	1,451	22	4,301	478	541
Balsam poplar	10,133	0	0	0	699	0	12	11	0	6	54	0	6,402	252	2,697
Paper birch	19,887	515	0	36	1,168	175	101	160	10	0	153	24	8,933	8,258	354
Bigtooth aspen	542	0	0	0	0	0	6	0	0	0	0	0	516	14	6
Quaking aspen	52,775	859	145	0	858	40	76	0	0	8	110	19	46,844	3,184	632
Basswood	272	0	0	0	8	0	0	0	0	0	49	0	103	71	41
Elm	1,631	0	0	0	0	0	0	7	0	2	409	19	927	69	198
Select hardwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other hardwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	93,608	1,374	145	38	3,065	215	212	390	15	84	2,286	121	68,432	12,668	4,563
All species	148,474	5,005	2,964	493	12,784	870	6,875	2,670	1,124	86	3,025	144	90,097	16,685	5,652

SHORT ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Balsam poplar
SOFTWOODS:															
White pine	4,595	31	627	379	427	13	38	99	0	0	63	0	2,511	396	11
Red pine	4,444	175	1,900	0	208	0	82	25	0	0	0	0	1,302	752	0
Jack pine	7,205	4,387	229	0	137	0	189	0	0	0	15	0	2,219	29	0
White spruce	7,713	22	15	138	1,244	732	185	63	0	0	78	0	4,416	748	72
Black spruce	16,665	1,534	0	0	1,818	9	8,174	406	139	0	7	0	4,326	177	75
Balsam fir	19,335	29	24	96	6,305	81	344	157	35	0	353	23	8,820	2,297	771
Tamarack	1,748	0	0	0	282	0	449	39	934	0	0	0	12	0	32
Northern white-cedar	9,437	0	0	0	1,153	83	205	4,512	76	0	569	0	2,066	488	285
Other softwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	71,142	6,178	2,795	613	11,574	918	9,666	5,301	1,184	0	1,085	23	25,672	4,887	1,246
HARDWOODS:															
White oak	98	0	0	0	0	0	0	0	0	0	0	0	63	35	0
Select red oak	270	0	0	0	0	0	0	0	0	185	0	0	23	16	46
Other red oak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hickory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow birch	168	0	0	0	0	0	0	24	0	0	72	0	10	38	24
Hard maple	461	0	0	0	29	0	0	0	0	0	0	37	189	179	27
Soft maple	773	0	0	0	191	0	0	0	0	0	34	0	417	126	5
Ash	8,799	0	0	0	112	0	0	203	5	0	2,662	22	4,705	528	562
Balsam poplar	11,269	0	0	0	699	0	12	32	0	0	121	0	7,138	270	2,997
Paper birch	25,711	478	0	46	1,917	182	199	376	28	0	251	24	11,246	10,559	405
Bigtooth aspen	995	0	0	0	0	0	6	0	0	0	0	0	969	14	6
Quaking aspen	66,790	1,358	180	0	1,015	66	142	53	0	28	208	19	58,950	4,125	646
Basswood	427	0	0	0	8	0	0	0	0	0	28	0	250	100	41
Elm	1,827	0	0	0	0	0	0	7	0	0	502	19	1,032	69	198
Select hardwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other hardwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	117,588	1,836	180	46	3,971	248	359	695	33	213	3,878	121	84,992	16,059	4,957
All species	188,730	8,014	2,975	659	15,545	1,166	10,025	5,996	1,217	213	4,963	144	110,664	20,946	6,203

Table 13.--Average annual predicted yields of growing-stock from selected cutting prescriptions by species group and forest type, Northern Pine Unit, Minnesota, 1977-1986

(In thousand cubic feet)

LONG ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	White spruce	Black spruce	Balsam fir	Tamarack	Northern white-cedar	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Bals popl
SOFTWOODS:															
White pine	1,754	17	205	403	63	0	0	0	1	21	0	0	700	327	1
Red pine	5,021	548	1,308	140	28	0	18	0	0	143	0	0	2,180	656	
Jack pine	9,412	7,845	0	0	2	0	0	16	0	0	0	0	1,371	159	1
White spruce	1,224	15	0	0	80	0	44	0	9	6	0	0	797	147	12
Black spruce	2,875	11	0	0	1	1,584	791	238	49	0	11	0	149	33	
Balsam fir	6,588	90	152	36	48	60	692	0	6	9	161	32	3,512	1,214	57
Tamarack	2,216	0	0	0	1	76	0	1,633	60	0	7	0	159	0	28
Northern white-cedar	4,027	0	0	0	24	77	488	14	1,337	0	1,075	0	215	523	27
Other softwoods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	33,117	8,526	1,665	579	247	1,797	2,033	1,901	1,462	179	1,254	32	9,083	3,059	1,30
HARDWOODS:															
White oak	2,515	5	0	0	3	0	0	0	0	553	0	39	1,730	145	4
Select red oak	4,563	26	0	0	0	0	0	0	0	1,197	0	6	2,891	432	1
Other red oak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hickory	16	0	0	0	0	0	0	0	0	0	0	0	0	16	
Yellow birch	38	0	0	0	0	0	0	0	0	0	0	0	10	28	
Hard maple	984	0	0	0	0	0	0	0	0	20	0	70	738	131	2
Soft maple	758	0	0	0	0	0	15	0	0	46	126	14	487	70	
Ash	4,240	0	0	0	0	8	126	0	17	50	1,490	148	1,249	621	53
Balsam poplar	5,360	34	0	0	1	0	72	14	0	0	33	6	2,143	169	2,88
Paper birch	12,183	153	73	65	31	43	135	6	9	143	215	41	5,971	4,866	43
Bigtooth aspen	3,567	69	44	0	0	0	0	0	0	64	57	0	3,215	104	1
Quaking aspen	33,478	230	37	0	24	0	120	6	0	257	9	0	31,353	650	79
Basswood	2,156	4	0	0	0	0	0	0	0	133	72	28	1,523	343	5
Elm	2,396	9	0	0	0	11	11	0	0	42	453	41	1,228	379	22
Select hardwoods	28	0	0	0	0	0	0	0	0	0	0	0	28	0	
Other hardwoods	21	16	0	0	0	0	0	0	0	5	0	0	0	0	
Total	72,303	546	154	65	59	62	479	26	26	2,510	2,455	393	52,566	7,954	5,00
All species	105,420	9,072	1,819	644	306	1,859	2,512	1,927	1,488	2,689	3,709	425	61,649	11,013	6,30

SHORT ROTATION AGE OPTION

Species group	Total	Jack pine	Red pine	White pine	White spruce	Black spruce	Balsam fir	Tamarack	Northern white-cedar	Oak-hickory	Elm-ash-cottonwood	Maple-basswood	Aspen	Paper birch	Bals popl
SOFTWOODS:															
White pine	2,383	17	332	408	63	0	0	0	1	128	0	0	961	448	2
Red pine	6,873	716	2,051	461	28	0	18	0	0	212	0	0	2,585	802	
Jack pine	12,978	10,389	0	0	26	32	0	16	0	180	0	0	2,158	158	1
White spruce	1,630	40	0	0	103	0	44	0	10	6	0	0	1,204	146	7
Black spruce	4,222	65	0	0	11	2,641	895	262	57	0	11	0	247	33	
Balsam fir	9,134	134	150	0	63	64	769	0	36	9	508	32	5,220	1,215	93
Tamarack	2,584	0	0	0	10	193	0	1,729	87	9	7	0	269	0	28
Northern white-cedar	5,527	0	0	0	24	190	494	83	2,322	0	1,399	0	215	523	27
Other softwoods	23	0	0	0	0	23	0	0	0	0	0	0	0	0	
Total	45,354	11,361	2,533	869	328	3,143	2,220	2,090	2,513	544	1,925	32	12,859	3,325	1,61
HARDWOODS:															
White oak	3,846	8	0	0	3	0	0	0	0	1,258	91	39	2,186	211	5
Select red oak	7,145	43	0	0	0	0	0	0	0	2,331	0	6	4,123	620	2
Other red oak	78	0	0	0	0	0	0	0	0	0	0	0	78	0	
Hickory	16	0	0	0	0	0	0	0	0	0	0	0	0	16	
Yellow birch	38	0	0	0	0	0	0	0	0	0	0	0	10	28	
Hard maple	1,322	0	0	0	0	0	0	0	0	19	0	70	1,039	160	3
Soft maple	1,065	0	0	0	0	0	15	0	0	71	126	14	746	93	
Ash	5,204	0	0	0	0	8	143	0	69	89	1,895	148	1,772	621	45
Balsam poplar	6,338	40	0	0	12	0	76	14	4	6	33	6	2,862	189	3,09
Paper birch	16,111	245	119	24	31	45	135	12	107	389	246	41	8,490	5,796	43
Bigtooth aspen	4,926	103	81	0	0	0	0	0	0	104	57	0	4,393	174	1
Quaking aspen	50,784	324	31	0	24	0	120	6	18	581	129	0	47,655	949	94
Basswood	3,230	4	0	0	0	0	16	0	0	222	176	28	2,219	491	7
Elm	3,095	9	0	0	0	11	11	0	6	64	738	41	1,552	390	27
Select hardwoods	40	0	0	0	0	0	0	0	0	12	0	0	28	0	
Other hardwoods	35	16	0	0	0	0	0	0	0	5	0	0	14	0	
Total	103,273	792	231	24	70	64	516	32	204	5,151	3,491	393	77,167	9,738	5,40
All species	148,627	12,153	2,764	893	398	3,207	2,736	2,122	2,717	5,695	5,416	425	90,026	13,063	7,01

Table 14.--Growing-stock removals for 1976[1/] and average annual predicted yields from selected cutting prescriptions for 1977-1986 by species, northern Minnesota

(In thousand cubic feet)

Species group	1976 Growing-stock removals	Predicted yields from selected cutting prescriptions	
		Long rotation age option	Short rotation age option
SOFTWOODS:			
White pine	2,724	5,444	6,978
Red pine	4,025	9,404	11,317
Jack pine	20,977	14,083	20,183
White spruce	4,153	8,099	9,343
Black spruce	13,733	15,924	20,887
Balsam fir	13,768	21,464	28,469
Tamarack	4,629	3,778	4,332
Northern white-cedar	3,296	9,787	14,964
Other softwoods	0	0	23
Total	67,305	87,983	116,496
HARDWOODS:			
White oak	605	2,616	3,944
Select red oak	2,101	4,686	7,415
Other red oak	0	0	78
Hickory	5	16	16
Yellow birch	11	140	206
Hard maple	347	1,327	1,783
Soft maple	346	1,337	1,838
Ash	1,539	11,360	14,003
Balsam poplar	2,499	15,493	17,607
Paper birch	7,793	32,070	41,822
Bigtooth aspen	2,867	4,109	5,921
Quaking aspen	63,126	86,253	117,574
Basswood	853	2,428	3,657
Elm	1,257	4,027	4,922
Select hardwoods	0	28	40
Other hardwoods	22	21	35
Noncommercial species	0	0	0
Total	83,371	165,911	220,861
All species	150,676	253,894	337,357

[1/] 1976 Growing-stock removals are trend removals for the period 1962 to 1976.

Table 15.--Growing-stock removals for 1976[1/] and average annual predicted yields from selected cutting prescriptions for 1977-1986 by species, Aspen-Birch Unit, Minnesota

(In thousand cubic feet)

Species group	1976 Growing-stock removals	Predicted yields from selected cutting prescriptions	
		Long rotation age option	Short rotation age option
SOFTWOODS:			
White pine	1,711	3,690	4,595
Red pine	1,485	4,383	4,444
Jack pine	10,718	4,671	7,205
White spruce	2,888	6,875	7,713
Black spruce	10,275	13,049	16,665
Balsam fir	7,728	14,876	19,335
Tamarack	2,503	1,562	1,748
Northern white-cedar	1,495	5,760	9,437
Other softwoods	0	0	0
Total	38,803	54,866	71,142
HARDWOODS:			
White oak	10	101	98
Select red oak	113	123	270
Other red oak	0	0	0
Hickory	0	0	0
Yellow birch	3	102	168
Hard maple	28	343	461
Soft maple	77	579	773
Ash	302	7,120	8,799
Balsam poplar	1,044	10,133	11,269
Paper birch	3,253	19,887	25,711
Bigtooth aspen	665	542	995
Quaking aspen	32,686	52,775	66,790
Basswood	48	272	427
Elm	207	1,631	1,827
Select hardwoods	0	0	0
Other hardwoods	9	0	0
Noncommercial species	0	0	0
Total	38,445	93,608	117,588
All species	77,248	148,474	188,730

[1/] 1976 Growing-stock removals are trend removals for the period 1962 to 1976.

Table 16.--Growing-stock removals for 1976[1/] and average annual predicted yields for selected cutting prescriptions for 1977-1986 by species, Northern Pine Unit, Minnesota

(In thousand cubic feet)

Species group	1976 Growing-stock removals	Predicted yields from selected cutting prescriptions	
		Long rotation age option	Short rotation age option
SOFTWOODS:			
White pine	1,013	1,754	2,383
Red pine	2,540	5,021	6,873
Jack pine	10,259	9,412	12,978
White spruce	1,265	1,224	1,630
Black spruce	3,458	2,875	4,222
Balsam fir	6,040	6,588	9,134
Tamarack	2,126	2,216	2,584
Northern white-cedar	1,801	4,027	5,527
Other softwoods	0	0	23
Total	28,502	33,117	45,354
HARDWOODS:			
White oak	595	2,515	3,846
Select red oak	1,988	4,563	7,145
Other red oak	0	0	78
Hickory	5	16	16
Yellow birch	8	38	38
Hard maple	319	984	1,322
Soft maple	269	758	1,065
Ash	1,237	4,240	5,204
Balsam poplar	1,455	5,360	6,338
Paper birch	4,540	12,183	16,111
Bigtooth aspen	2,202	3,567	4,926
Quaking aspen	30,440	33,478	50,784
Basswood	805	2,156	3,230
Elm	1,050	2,396	3,095
Select hardwoods	0	28	40
Other hardwoods	13	21	35
Noncommercial species	0	0	0
Total	44,926	72,303	103,273
All species	73,428	105,420	148,627

[1/] 1976 Growing-stock removals are trend removals for the period 1962 to 1976.

Table 17.--Average annual managed harvest growing-stock volume from harvested plots by forest type, site index class and stand-age class, northern Minnesota, 1977-1986

(In thousand cubic feet)

Forest type	Site index class	Total	Stand-age class (years)									
			less than 41	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	more than 140
HIGH ROTATION AGE OPTION												
Jack pine	0-60	8,932	0	0	988	2,745	941	1,961	2,120	177	0	0
	61+	5,145	0	0	3,402	1,743	0	0	0	0	0	0
Red pine	0-55	1,622	0	0	0	0	0	893	442	287	0	0
	56+	3,161	0	0	1,050	374	0	326	1,411	0	0	0
White pine	0-55	742	0	0	0	0	0	0	357	385	0	0
	56+	395	0	0	0	0	0	0	395	0	0	0
White spruce	All	1,176	0	0	0	327	120	294	327	108	0	0
Black spruce	0-40	4,780	0	0	0	0	0	779	2,182	783	1,036	0
	41+	3,954	0	0	0	206	1,153	1,603	911	81	0	0
Balsam fir	All	15,296	0	0	4,149	5,742	3,234	988	935	248	0	0
Tamarack	0-40	1,128	0	0	0	0	0	0	0	220	861	47
	41+	1,923	0	0	0	224	165	0	104	970	460	0
Northern white-cedar	All	4,158	0	0	0	0	0	0	0	0	3,901	257
Oak	0-55	1,213	0	23	0	0	0	84	790	316	0	0
	56+	1,562	0	0	63	594	431	156	0	318	0	0
Elm-ash-cottonwood	0-55	5,030	0	0	0	0	0	0	1,593	2,133	1,304	0
	56+	1,704	0	0	0	0	0	331	236	526	611	0
Maple-basswood	All	569	0	0	0	0	0	0	221	77	271	0
Aspen	0-65	76,758	0	0	31,256	29,397	11,369	3,797	647	154	138	0
	66+	74,988	0	0	42,097	20,025	6,431	4,699	1,541	195	0	0
Paper birch	0-65	22,154	0	0	0	7,555	7,899	5,338	655	707	0	0
	66+	5,544	0	0	253	2,546	1,796	268	681	0	0	0
Balsam poplar	0-65	7,056	0	117	2,265	2,365	1,669	469	171	0	0	0
	66+	4,904	0	0	1,394	2,110	851	549	0	0	0	0
All types		253,894	0	140	86,917	75,953	36,059	22,535	15,719	7,685	8,582	304
LOW ROTATION AGE OPTION												
Jack pine	All	20,167	0	0	7,062	7,906	941	1,961	2,120	177	0	0
Red pine	All	5,739	0	0	0	0	0	2,654	2,798	287	0	0
White pine	All	1,552	0	0	0	0	0	0	544	1,008	0	0
White spruce	All	1,564	0	0	296	419	120	294	327	108	0	0
Black spruce	All	13,232	0	0	0	490	1,158	4,487	5,196	865	1,036	0
Balsam fir	All	18,281	0	0	6,910	5,966	3,234	988	935	248	0	0
Tamarack	All	3,339	0	0	0	0	0	34	66	1,710	1,482	47
Northern white-cedar	All	8,713	0	0	0	0	0	0	71	2,469	5,916	257
Oak	All	5,908	0	0	213	1,391	2,368	509	790	637	0	0
Elm-ash-cottonwood	All	10,379	0	0	0	0	0	2,039	3,753	2,661	1,926	0
Maple-basswood	All	569	0	0	0	0	0	0	221	77	271	0
Aspen	All	200,690	0	2,726	119,189	49,769	17,834	8,503	2,182	349	138	0
Paper birch	All	34,009	0	0	4,466	12,186	9,702	5,611	1,337	707	0	0
Balsam poplar	All	13,215	0	188	4,825	4,481	2,527	1,023	171	0	0	0

Table 18.--Average annual managed harvest growing-stock volume from harvested plots by forest type, site index class, and stand-age class, Aspen-Birch Unit, Minnesota, 1977-1986

(In thousand cubic feet)

Forest type	Site index class	Total	Stand-age class (years)									
			less than 41	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	more than 140
HIGH ROTATION AGE OPTION												
Jack pine	0-60	4,438	0	0	0	168	145	1,961	1,987	177	0	0
	61+	567	0	0	409	158	0	0	0	0	0	0
Red pine	0-55	1,214	0	0	0	0	0	893	205	116	0	0
	56+	1,750	0	0	1,050	374	0	326	0	0	0	0
White pine	0-55	472	0	0	0	0	0	0	357	115	0	0
	56+	21	0	0	0	0	0	0	21	0	0	0
White spruce	All	870	0	0	0	174	120	141	327	108	0	0
Black spruce	0-40	3,509	0	0	0	0	0	0	1,921	690	898	0
	41+	3,366	0	0	0	0	1,105	1,350	911	0	0	0
Balsam fir	All	12,784	0	0	4,149	4,918	1,805	800	935	177	0	0
Tamarack	0-40	488	0	0	0	0	0	0	0	220	221	47
	41+	636	0	0	0	224	165	0	0	128	119	0
Northern white-cedar	All	2,670	0	0	0	0	0	0	0	0	2,670	0
Oak	0-55	23	0	23	0	0	0	0	0	0	0	0
	56+	63	0	0	63	0	0	0	0	0	0	0
Elm-ash-cottonwood	0-55	2,288	0	0	0	0	0	0	623	919	746	0
	56+	737	0	0	0	0	0	331	0	0	406	0
Maple-basswood	All	144	0	0	0	0	0	0	0	73	71	0
Aspen	0-65	53,220	0	0	22,096	19,840	7,800	2,952	442	90	0	0
	66+	36,877	0	0	19,379	9,947	3,979	2,865	707	0	0	0
Paper birch	0-65	13,707	0	0	0	3,331	5,950	3,907	348	171	0	0
	66+	2,978	0	0	253	779	1,594	0	352	0	0	0
Balsam poplar	0-65	3,088	0	0	585	1,081	782	469	171	0	0	0
	66+	2,564	0	0	555	1,037	741	231	0	0	0	0
All types		148,474	0	23	48,539	42,031	24,186	16,226	9,307	2,984	5,131	47
LOW ROTATION AGE OPTION												
Jack pine	All	8,014	0	0	0	3,744	145	1,961	1,987	177	0	0
Red pine	All	2,975	0	0	0	0	0	2,654	205	116	0	0
White pine	All	659	0	0	0	0	0	0	544	115	0	0
White spruce	All	1,166	0	0	296	174	120	141	327	108	0	0
Black spruce	All	10,025	0	0	0	0	625	2,877	4,935	690	898	0
Balsam fir	All	15,545	0	0	6,910	4,918	1,805	800	935	177	0	0
Tamarack	All	1,217	0	0	0	0	0	34	66	731	339	47
Northern white-cedar	All	5,996	0	0	0	0	0	0	71	2,212	3,713	0
Oak	All	213	0	0	213	0	0	0	0	0	0	0
Elm-ash-cottonwood	All	4,963	0	0	0	0	0	1,071	1,812	919	1,161	0
Maple-basswood	All	144	0	0	0	0	0	0	0	73	71	0
Aspen	All	110,664	0	0	61,701	30,134	11,779	5,817	1,143	90	0	0
Paper birch	All	20,946	0	0	2,953	5,666	7,549	3,907	700	171	0	0
Balsam poplar	All	6,203	0	0	1,674	2,124	1,529	705	171	0	0	0
All types		188,730	0	0	73,747	46,760	23,552	19,967	12,896	5,579	6,182	47

Table 19.--Average annual managed harvest growing-stock volume from harvested plots by forest type, site index class, and stand-age class, Northern Pine Unit, Minnesota, 1977-1986

(In thousand cubic feet)

Forest type	Site index class	Total	Stand-age class (years)									
			less than 41	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	more tha 140
HIGH ROTATION AGE OPTION												
Jack pine	0-60	4,494	0	0	988	2,577	796	0	133	0	0	0
	61+	4,578	0	0	2,993	1,585	0	0	0	0	0	0
Red pine	0-55	408	0	0	0	0	0	0	237	171	0	0
	56+	1,411	0	0	0	0	0	0	1,411	0	0	0
White pine	0-55	270	0	0	0	0	0	0	0	270	0	0
	56+	374	0	0	0	0	0	0	374	0	0	0
White spruce	All	306	0	0	0	153	0	153	0	0	0	0
Black spruce	0-40	1,271	0	0	0	0	0	779	261	93	138	0
	41+	588	0	0	0	206	48	253	0	81	0	0
Balsam fir	All	2,512	0	0	0	824	1,429	188	0	71	0	0
Tamarack	0-40	640	0	0	0	0	0	0	0	0	640	0
	41+	1,287	0	0	0	0	0	0	104	842	341	0
Northern white-cedar	All	1,488	0	0	0	0	0	0	0	0	1,231	257
Oak	0-55	1,190	0	0	0	0	0	84	790	316	0	0
	56+	1,499	0	0	0	594	431	156	0	318	0	0
Elm-ash-cottonwood	0-55	2,742	0	0	0	0	0	0	970	1,214	558	0
	56+	967	0	0	0	0	0	0	236	526	205	0
Maple-basswood	ALL	425	0	0	0	0	0	0	221	4	200	0
Aspen	0-65	23,538	0	0	9,160	9,557	3,569	845	205	64	138	0
	66+	38,111	0	0	22,718	10,078	2,452	1,834	834	195	0	0
Paper birch	0-65	8,447	0	0	0	4,224	1,949	1,431	307	536	0	0
	66+	2,566	0	0	0	1,767	202	268	329	0	0	0
Balsam poplar	0-65	3,968	0	117	1,680	1,284	887	0	0	0	0	0
	66+	2,340	0	0	839	1,073	110	318	0	0	0	0
All types		105,420	0	117	38,378	33,922	11,873	6,309	6,412	4,701	3,451	257
LOW ROTATION AGE OPTION												
Jack pine	All	12,153	0	0	7,062	4,162	796	0	133	0	0	0
Red pine	All	2,764	0	0	0	0	0	0	2,593	171	0	0
White pine	All	893	0	0	0	0	0	0	0	893	0	0
White spruce	All	398	0	0	0	245	0	153	0	0	0	0
Black spruce	All	3,207	0	0	0	490	533	1,610	261	175	138	0
Balsam fir	All	2,736	0	0	0	1,048	1,429	188	0	71	0	0
Tamarack	All	2,122	0	0	0	0	0	0	0	979	1,143	0
Northern white-cedar	All	2,717	0	0	0	0	0	0	0	257	2,203	257
Oak	All	5,695	0	0	0	1,391	2,368	509	790	637	0	0
Elm-ash-cottonwood	All	5,416	0	0	0	0	0	968	1,941	1,742	765	0
Maple-basswood	All	425	0	0	0	0	0	0	221	4	200	0
Aspen	All	90,026	0	2,726	57,488	19,635	6,055	2,686	1,039	259	138	0
Paper birch	All	13,063	0	0	1,513	6,520	2,153	1,704	637	536	0	0
Balsam poplar	All	7,012	0	188	3,151	2,357	998	318	0	0	0	0
All types		148,627	0	2,914	69,214	35,848	14,332	8,136	7,615	5,724	4,587	257

APPENDIX

Specifying Cutting Prescriptions

The level of yield from cutting prescriptions varies according to the criteria specified. Two prescriptions are considered here.[3] The long rotation age option uses harvest criteria established jointly by representatives from Minnesota forest industries and the Minnesota Department of Natural Resources (table 1). Harvest criteria for this option are based on forest type, age, and site index.

The short rotation age option is based on current stand conditions, and sets the rotation age for a species at the age of maximum total volume yield. Forest type and age are the stand characteristics considered in this option. Age of maximum total volume yield is calculated for each forest type by (1) determining the number of rotation acres in each age class per year—this is equal to the area in the forest type divided by the midpoint of the age class; (2) calculating the growing-stock volume per acre of commercial forest land for each age class—this is equal to the growing-stock volume in the age class divided by the commercial forest area in the age class; (3) determining the yield of an age class—this is equal to the rotation acres in the age class multiplied by the growing-stock volume per acre of commercial forest in the age class. The rotation age is selected from the age class where total volume yield is highest.

Definition of Terms

Land-use classes

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use. Includes afforested areas. The minimum forest area classified was 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, and clearings in forest areas were classed as forest if less than 120 feet wide.

Commercial forest land.—Forest land that is producing or is capable of producing crops of industrial wood and that is not withdrawn from timber utilization by statute or adiministrative regulation. This includes areas suitable for management to grow crops of industrial wood generally of a site quality capable of producing in excess of 20 cubic feet per acre of annual growth. This includes both inaccessible and inoperable areas.

Tree class

Growing-stock trees.—All live trees of commercial species except rough and rotten trees.

Sawtimber trees.—Growing-stock trees of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs, each 8 feet or longer. At least 33 percent of the gross volume of the tree must be sound wood. Softwoods must be at least 9.0 inches d.b.h. and hardwoods at least 11.0 inches.

Poletimber trees.—Growing-stock trees of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size, and of good form and vigor.

Rotten trees.—Live trees (any size) of commercial species that do not contain a merchantable 12-foot saw log or two noncontiguous 8-foot or longer saw logs, now or prospectively, because of rot (that is, when more than 50 percent of the cull volume of the tree is rotten).

Rough trees.—Live trees that do not contain at least one merchantable 12-foot saw log or two noncontiguous 8-foot or longer saw logs, now or prospectively, because of roughness and poor form, as well as all live noncommercial species.

Short-log (rough trees).—Sawtimber sized trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Other classifications

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

[3] *The Minnesota Department of Natural Resources has made an estimate of yield under a third set of cutting prescriptions.*

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

Forest types

A classification of forest land based upon the species forming a plurality of live-tree stocking. Major forest types in Minnesota 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, jack pine, aspen, birch, and maple.)

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

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

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

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

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

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

Elm-ash-cottonwood.—Forests in which ash, cottonwood and red maple, singly or in com tion, comprise a plurality of the stocking. (Con associates include basswood and balsam popl

Maple-basswood.—Forests in which suga ple, basswood, yellow birch, American elm, an maple, singly or in combination, comprise a plu of the stocking. (Common associates include pine and elm.)

Aspen.—Forests in which quaking aspen o tooth aspen, singly or in combination, compr plurality of the stocking. (Common associate clude balsam poplar, balsam fir, and paper bi

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

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

Timber removals

Timber removals from growing stock.— volume of sound wood in growing-stock tree moved annually for forest products (inclu roundwood products and logging residues) an other removals. Roundwood products are logs, b or other round sections cut and used from trees. ging residues are the unused portions of cut trees unused trees killed by logging. Other removals growing-stock trees removed but not utilized products, or trees left standing but "removed" f the commercial forest land classification by land change—examples are removals from cultural op tions such as timber stand improvement work, l clearing, and changes in land use.

Metric Equivalents of Units Used in this Report

1 acre = 4,046.86 square meters or 0.405 hectar
1,000 acres = 405 hectares.
1,000 board feet (International ¼-inch rule) = 3 cubic meters.
1 cubic foot = 0.0283 cubic meter.

Principal Tree Species Groups in Northern Minnesota[4]

Eastern white pine ..... *Pinus strobus*
Red pine ..... *Pinus resinosa*
Jack pine ..... *Pinus banksiana*
White spruce ..... *Picea glauca*
Black spruce ..... *Picea mariana*
Balsam fir ..... *Abies balsamea*
Tamarack ..... *Larix laricina*
Northern white-cedar ..... *Thuja occidentalis*
Other softwoods:
  Eastern redcedar ..... *Juniperus virginiana*
  Scotch pine ..... *Pinus sylvestris*
White oaks:
  White oak ..... *Quercus alba*
  Bur oak ..... *Quercus macrocarpa*
Select red oak:
  Northern red oak ..... *Quercus rubra*
Other red oaks:
  Northern pin oak ..... *Quercus ellipsoidalis*
Hickories:
  Butternut hickory ..... *Carya cordiformis*
Yellow birch ..... *Betula alleghaniensis*
Hard maples:
  Sugar maple ..... *Acer saccharum*
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:
  Amercian elm ..... *Ulmus americana*
  Slippery elm ..... *Ulmus rubra*
  Rock elm ..... *Ulmus thomasii*
Select hardwoods:
  Butternut ..... *Juglans cinerea*
  Black cherry ..... *Prunus serotina*
Other hardwoods:
  Boxelder ..... *Acer negundo*
  Eastern cottonwood ..... *Populus deltoides*
  Black willow ..... *Salix nigra*

[4]*The common and scientific names are based on: Little, Elbert L., Jr. 1979. Check List of United States Trees (Native and Naturalized). U.S. Department of Agriculture, Agricultural Handbook 541, 375 p.*

U.S. GOVERNMENT PRINTING OFFICE: 1980-669-277/62 REG.#6

Jakes, Pamela J., and W. Brad Smith.

1980. Predicted yields from selected cutting prescriptions in northern Minnesota. U.S. Department of Agriculture Forest Service, Research Paper NC-188, 29 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Includes predicted yields based on two sets of cutting prescriptions in northern Minnesota. Indicates that given a specific set of assumptions, average annual growing-stock removals for the decade 1977-1986 would be from 69 percent to 124 percent higher than 1976 growing-stock removals.

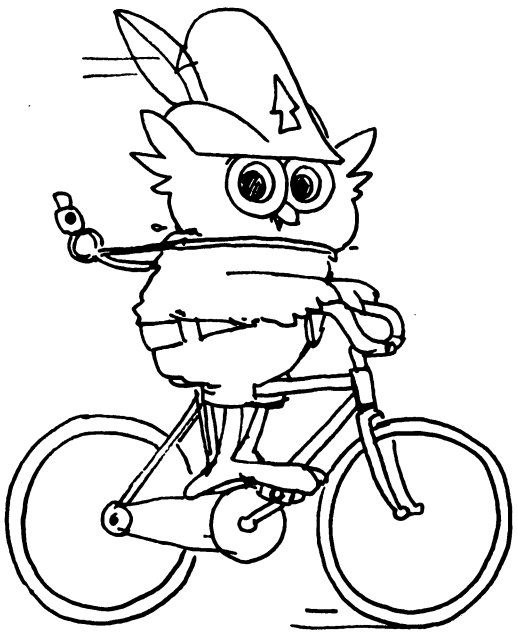
KEY WORDS: Minnesota, timber removals, timber harvest.

Jakes, Pamela J., and W. Brad Smith.

1980. Predicted yields from selected cutting prescriptions in northern Minnesota. U.S. Department of Agriculture Forest Service, Research Paper NC-188, 29 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Includes predicted yields based on two sets of cutting prescriptions in northern Minnesota. Indicates that given a specific set of assumptions, average annual growing-stock removals for the decade 1977-1986 would be from 69 percent to 124 percent higher than 1976 growing-stock removals.

KEY WORDS: Minnesota, timber removals, timber harvest.



More bicycles and shoe leather...less smog.