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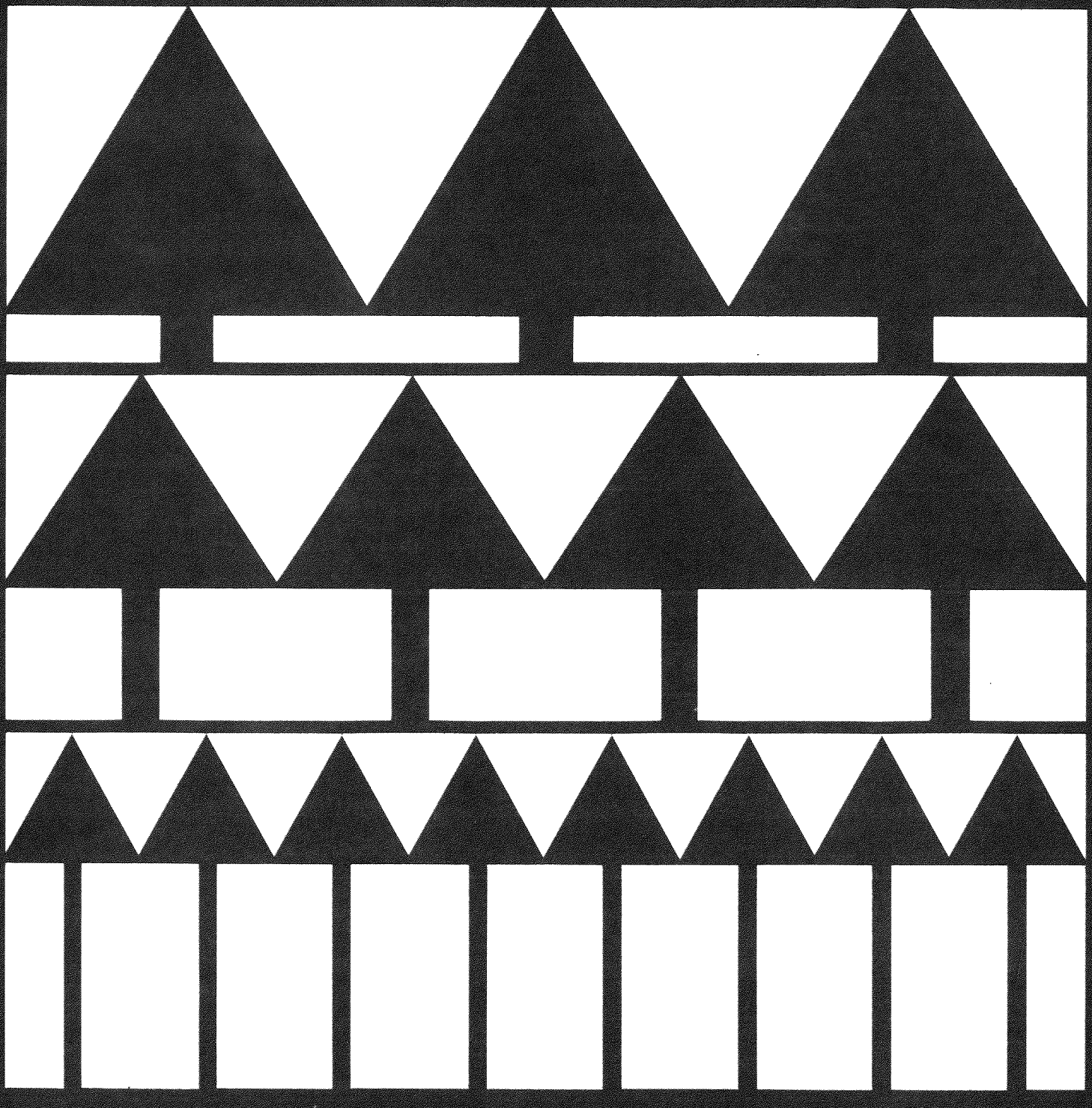

DEVELOPMENT OF UNTHINNED WHITE SPRUCE PLANTATIONS TO AGE 50 AT PETAWAWA FOREST EXPERIMENT STATION

by

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Résumé en français

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ABSTRACT

Yield tables for unmanaged, high-survival, white spruce plantations are presented by 5-year-age classes up to 50 years from planting, for six planted spacings and four site index classes. Each table includes data for numbers of trees per acre, mean d.b.h., basal area, total volume, and merchantable cubic volume. This publication supersedes Stiell and Berry, Forest. Br. Dep. Pub. No. 1200, Ottawa. 1967. p. 15.

RÉSUMÉ

Les auteurs présentent des tables de rendement concernant des plantations non aménagées mais vigoureuses d'Épinettes blanches (*Picea glauca*), situées à la Station d'expérimentation forestière de Petawawa, Ontario. Elles tiennent compte de classes d'âge de 5 ans d'intervalle jusqu'à 50 ans, de 6 espacements différents et de 4 classes de fertilité. Elles renseignent sur le nombre d'arbres à l'acre, le diamètre moyen à hauteur de poitrine, la surface terrière, le volume total et le volume marchand en pieds cubes. Ce travail remplace celui de Stiell & Berry, publication du ministère n° 1200, Ottawa, 1967, 15 pages.

FOREWORD

This paper is a revision of Forestry Branch Departmental Publication No. 1200 (Stiell and Berry, 1967), which it supersedes. An additional 10-year remeasurement of permanent sample plots allowed strengthening the data on which the tables are based, as well as their extension from 40 to 50 years. The methodology employed in developing the revised tables is largely unchanged, with the exception of a new procedure devised for estimating mortality.

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INTRODUCTION

Large-scale planting of white spruce (*Picea glauca* [Moench] Voss) in Canada is a recent development. The relatively few long-established plantations of this species are the only sources of growth data for predicting what could be expected from today's planting. In Ontario, the largest aggregate of older white spruce plantations, which is at Petawawa, does not yet approach rotation age but can provide useful interim information.

Two harvesting approaches are possible for plantations. Periodic yields can be obtained by regular thinnings that conform to yield tables constructed for the purpose. Alternatively, it may be considered that clear-cutting at an appropriate age, without any intermediate treatment, is most economical. Research into both approaches is being conducted in spruce plantations at the Petawawa Forest Experiment Station. Results of thinning experiments are reported periodically (Berry, 1968; Stiell, 1970); in addition, sufficient data from untreated plantations have been accumulated to indicate relative growth at various stocking levels, which is the subject of this paper.

The following, then, deals with high-survival plantations which have developed without gross disturbance and in which any mortality that has occurred was due almost entirely to mutual competition.

THE PLANTATIONS

The 34 plantations of white spruce used as a basis for this study total about 80 acres. The first was established in 1922. Most planting sites were old fields, and soils include waterlaid sands, lacustrine silt loams, and sandy and loamy tills. Trees were planted in regular rows at average spacings of from 4 x 4 to 7 x 7 feet. Survival up to 30 years after planting was generally in excess of 75 per cent. Early sampling by measuring a proportion of rows in each plantation was replaced by a series of permanent

sample plots, established in uniform conditions of best survival. A full description of the plantations, including their establishment, sites, and early development, is given by Stiell (1955).

METHODS AND RESULTS

Sample Plots

Data for this study were provided by 46 plots, each measured from one to four times, representing stand ages of from 12 to 50 years from the planting date. On each plot all trees were tagged; after each measurement, tables of numbers of trees, basal area, and total and merchantable[1] cubic volume according to Form-class Volume Tables (Anon. 1948), were compiled. Measurements taken in about half the plots showed the range of average form class to be between 63 and 67; in the remaining plots it was assumed to be 65. Mean diameter (d.b.h. of tree of mean basal area), height of the tree of mean d.b.h. (from the height/diameter curve), and dominant height (average height of the tallest 10 per cent[2]) were also calculated.

Site Index Curves

All dominant height values were plotted over age on one graph, and the points for individual plots were joined. The data were divided arbitrarily into two groups (representing poorer and better growth) and a free-hand guide curve fitted to each group. A set of anamorphic site index curves, representing 10-foot height classes at age 50 years, was drawn to encompass the range of data for each group. The two sets were harmonized by adjusting the curve common to both by about one-half foot at the lower ages (Figure 1). Data from the latest 10-year remeasurement clearly indicate that growth rates start to decline at about 35 years, a feature not apparent from the earlier data.

No consistent pattern of height growth could be related to physiographic site whether considered by parent material or by moisture regime (Hills and Pierpoint, 1960). Although average site class increased very slightly with moisture regime, plots over the whole range of moistures encountered (1 to 5) were found in each site class. Considerable variation in early growth rate was observed — i.e., time to reach breast height ranged from 6 to 12 years. The causes of this were not clear, but even when growth rates above breast height only are considered, there is still no correlation with moisture regime. The unsatisfactory conclusion is reached that height growth in this area cannot be predicted with much assurance before a stand age of about 15 years.

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[1] Merchantable volume includes the bole to a 4-inch top d.i.b.

[2] Dominant height so defined (H) can be estimated from height of tree of mean basal area ($\bar{H}$) by the equation $H = -2.4855 + 1.5965\bar{H} - .00721(\bar{H})^2$ ($R^2 = .978$)

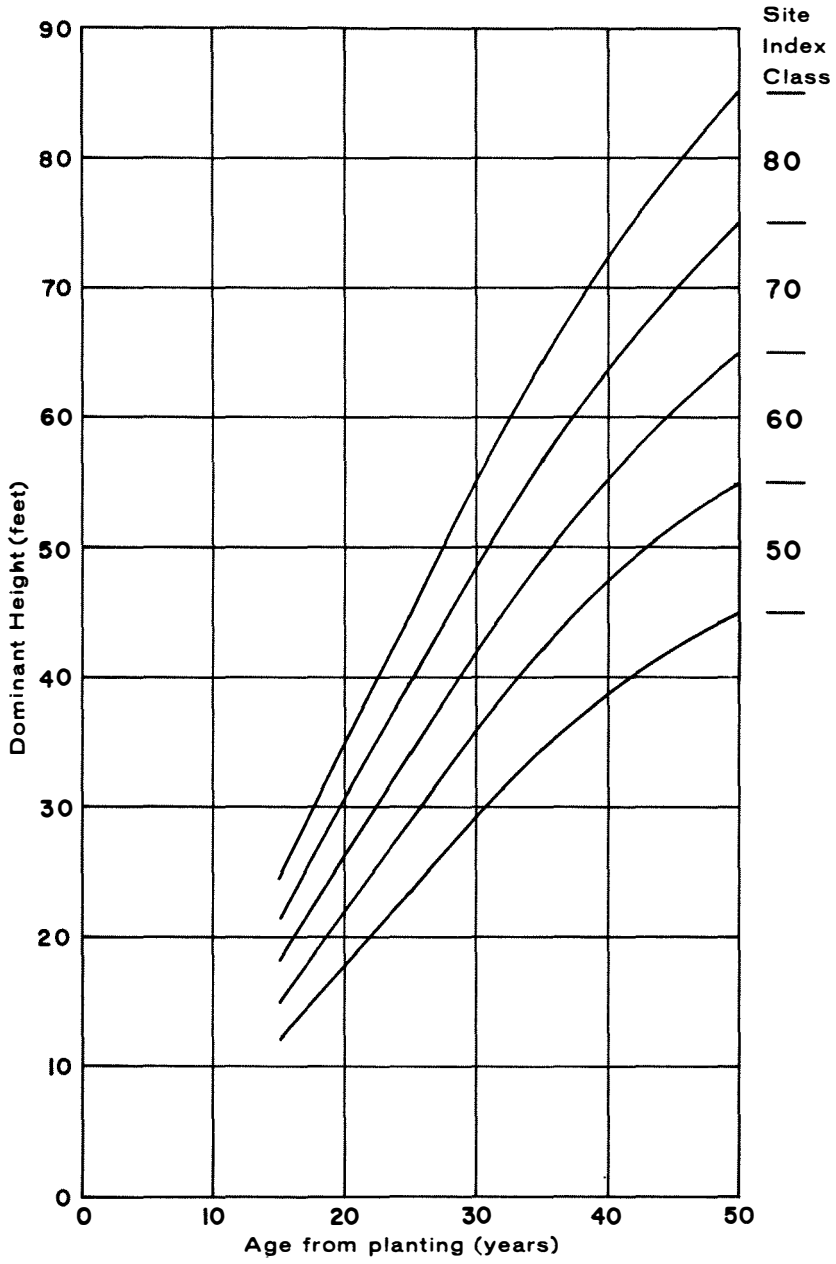

Figure 1. Site index curves at base age 50 years for planted white spruce.

Mortality Rates

Mortality resulting from mutual competition is taken to be a function of increasing stature of individual trees. Relating mortality to stand height, therefore, is not only reasonable but also has the advantage of incorporating the effects of both age and site.

Numbers of trees per acre were plotted over dominant height for each sample plot and measurement date, and the points for individual plots were joined. The resulting lines were somewhat erratic, but they clearly indicated trends of decreasing tree numbers with increasing height. Numbers diminished more rapidly for high than for low initial stockings.

The data were pooled, and the following relationship ($P > 0.01$) determined:

$$M = -111.8887 + 0.4669NH + 0.00022(NH)^2 \qquad (R^2 = .620),$$

where M = number of trees per acre dying for the next 10 feet of dominant height growth, N = present number of trees per acre and H = dominant height in feet/100. This relationship is independent of site and age. No mortality is evident for low values of NH, nor would it be expected since these represent short or open stands in which there is no severe mutual competition.

For each initial spacing class the point at which mortality begins was identified by starting with a very low stand height, e.g. 5 feet, and then substituting greater heights until mortality of at least one tree was indicated. The number of trees per acre was reduced accordingly, dominant height increased by 10 feet, and mortality for that combination calculated. The procedure was repeated for 10-foot height increments and each new indicated stocking level. The result is a series of number/height curves, each based on a different initial spacing (Figure 2). Mortality first occurs with a dominant height of 18 feet where the planted spacing is 4 x 4 feet, and at increasingly greater heights as spacings widen.

These curves conform well to those produced previously by graphical methods for part of the data (Stiell and Berry, 1967), and are consistent with the mortality patterns based on "relative spacing" described for pine species by Beekhuis (1966). It is concluded that the mortality curves reasonably represent changes in stocking associated with increasing stand height. It should be clear that the maximum values of these curves represent numbers of established trees — i.e., numbers surviving immediate post-planting mortality.

Stand Diameters

Mean diameter was found to be closely related to the product of average spacing and dominant height (Figure 3), and, when D = mean d.b.h. in inches and SH = average spacing in feet x dominant height in feet, can be estimated from the equation:

$$D = 1.2553 + 0.0154SH - 0.00000642(SH)^2 \qquad (R^2 = .927)$$

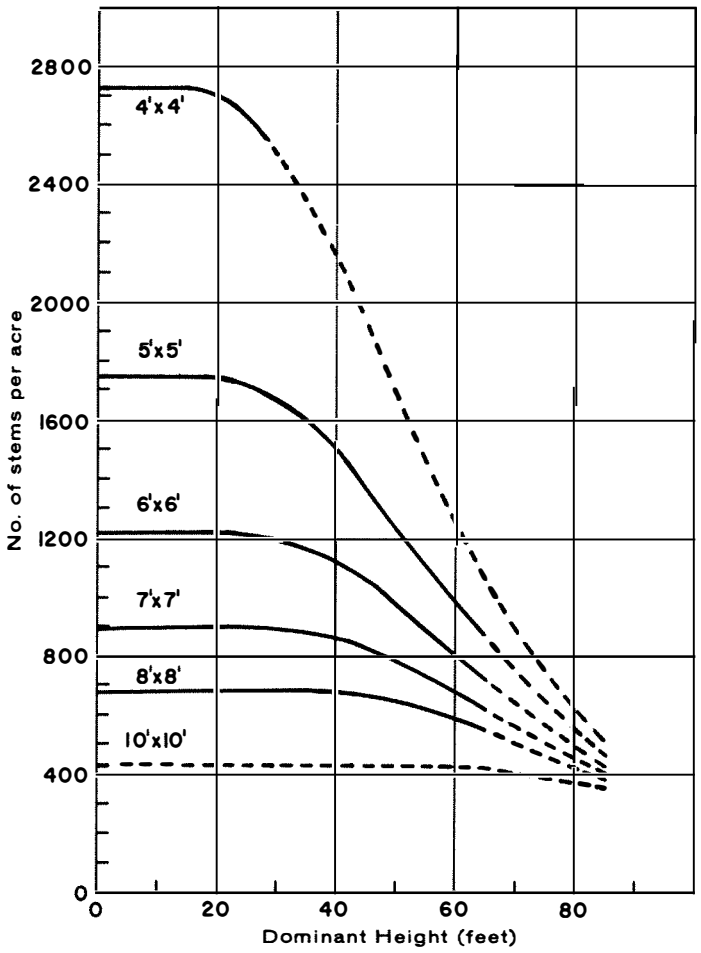

Figure 2. Relationship of numbers of trees to dominant height, by initial spacing, for planted white spruce.

This quadratic function is constrained to culminate at SH = 1200. This value was selected to include the maximum height (100 feet) to which white spruce would likely be grown and the corresponding number of trees as obtained by extrapolation of the curve for 10 x 10 feet in Figure 2.

A summary of diameter distributions within stands at various current stocking levels is shown in Table 1. These data, which have not been harmonized, indicate the following trends:

(a) The range in diameters increases with mean d.b.h. but does not vary with spacing.

(b) The proportion of trees in the mean diameter class decreases as the stand develops, but for a given mean d.b.h. is higher at wider spacings.

(c) The number of trees below the mean diameter class is considerably greater than those above.

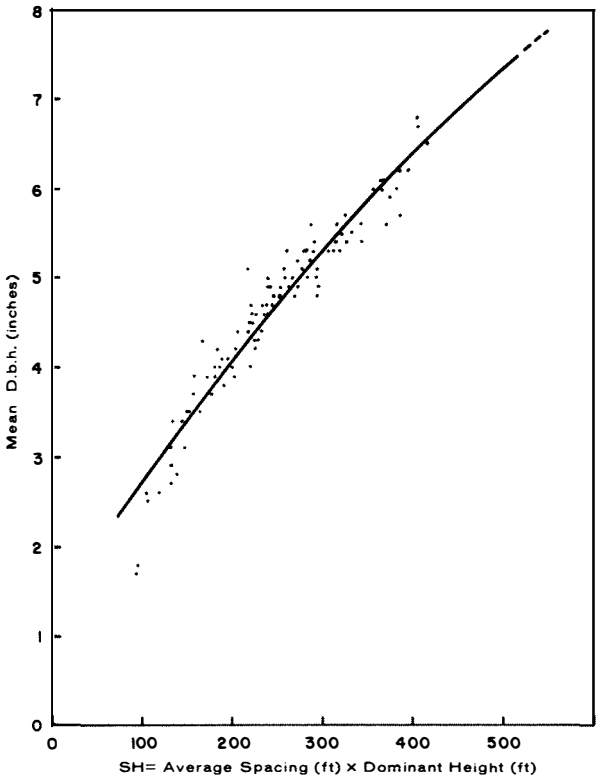

Figure 3. Planted white spruce - relationship of mean diameter to spacing and dominant height.

Stand Volume Tables

Pooled data from all plots showed a good relationship between total cubic foot volume per acre and the combined height-spacing expression of dominant height/$\sqrt[3]{\text{average spacing}}$ (Figure 4), similar to that defined for white spruce by Stiell (1967). Where

Vt = total volume in cubic feet per acre

HS = height-spacing expression

$$Vt = -153.0892 + 2.4852HS + 4.76046(HS)^2 \qquad (R^2 = .947)$$

The individual plot data for merchantable volume (expressed as a percentage of total volume) were pooled, and a harmonized set of curves was prepared to show change in percentage with changes in spacing and dominant height. The curves were used to determine the merchantable volumes corresponding to total volumes derived from the foregoing equation.

From these relationships, theoretical stand volumes were "generated" for a variety of heights and spacings (Table 2). This table demonstrates the

TABLE 1. PERCENTAGE STEM DISTRIBUTION ABOUT MEAN DIAMETER CLASS (D) IN WHITE SPRUCE PLANTATIONS

Mean d.b.h. class (inches)	Spacing class (ft)	One-inch diameter classes												
		D-5	D-4	D-3	D-2	D-1	D	D+1	D+2	D+3	D+4	D+5	ΣD-	ΣD+
2	6 x 6					43.1	51.9	5.0					43.1	5.0
3	5 x 5				12.8	26.0	34.9	16.8	7.3	2.0	0.1	0.1	38.8	26.3
	6 x 6				10.7	29.0	37.5	18.1	4.0	0.7			39.7	22.8
	7 x 7				14.0	29.0	44.1	11.8	1.1				43.0	12.9
4	5 x 5			3.0	13.9	24.9	29.5	17.3	8.3	2.8	0.3		41.8	28.7
	6 x 6			3.2	12.1	23.3	30.5	21.0	7.5	2.1	0.3		38.6	30.9
	7 x 7			2.9	5.6	20.2	31.8	29.6	8.7	1.2			28.7	39.5
5	5 x 5		1.1	5.1	18.0	26.9	21.0	15.7	8.9	2.7	0.6		51.1	27.9
	6 x 6		1.3	7.7	16.8	22.9	23.5	15.4	8.3	3.0	0.8	0.3	48.7	27.8
	7 x 7		0.8	4.2	12.3	21.0	26.4	20.9	9.9	4.0	0.5		38.3	35.3
6	6 x 6		1.1	11.0	21.4	18.3	17.7	14.0	9.8	4.7	1.3	0.7	51.8	30.5
	7 x 7	0.6	0.7	4.9	14.4	24.7	25.5	18.4	8.3	2.2	0.2	0.1	45.3	29.2
7	7 x 7		1.7	13.5	19.1	18.0	19.7	13.5	8.4	4.5	1.1	0.5	52.3	28.0
	8 x 8	0.7	5.4	8.8	19.7	13.6	18.4	15.7	12.2	4.1	1.4		48.2	33.4

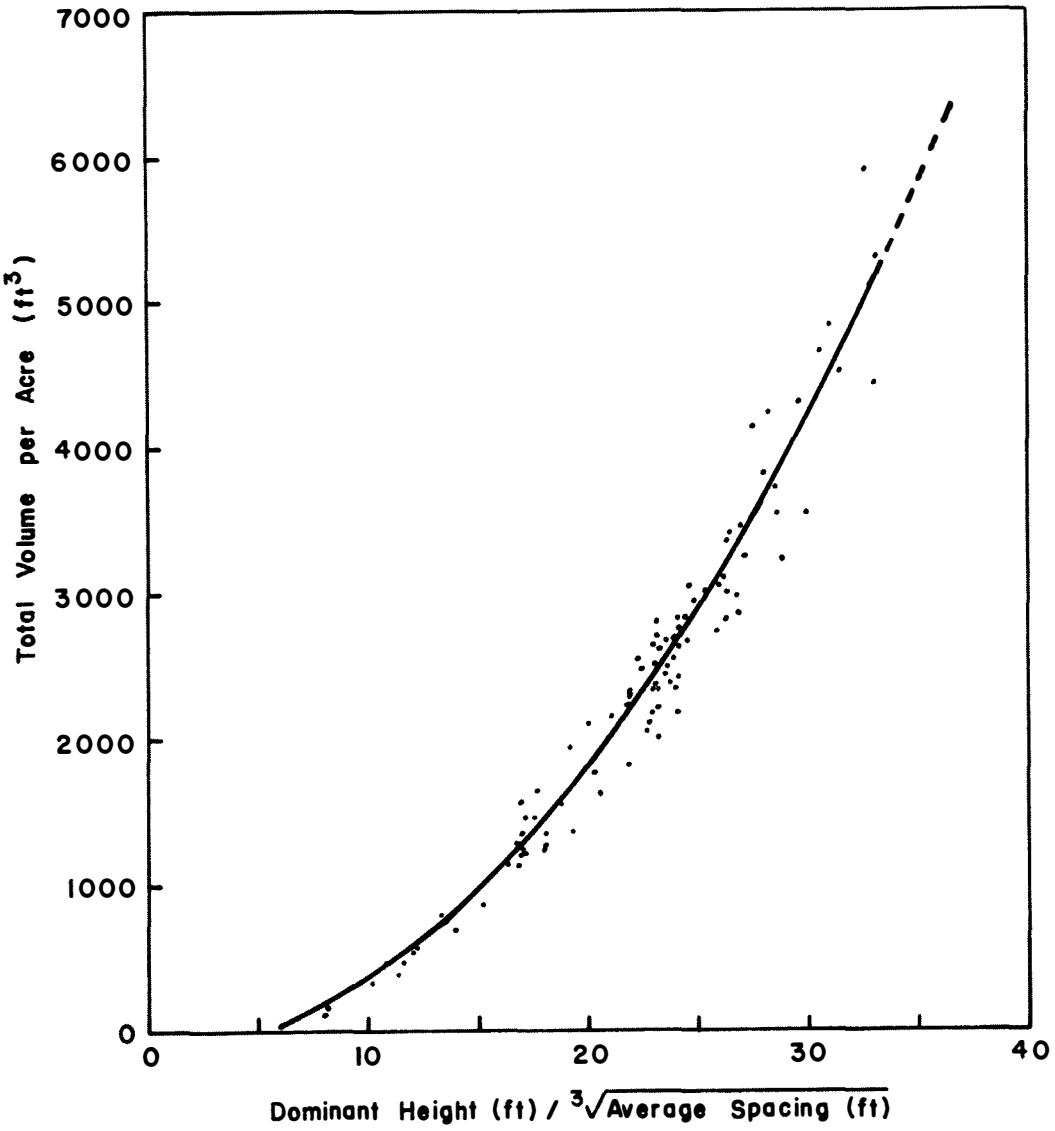

Figure 4. Relationship of total volume per acre to spacing and dominant height, for planted white spruce.

volumes to be expected from given combinations of height and stocking, but the table is in no sense predictive because it does not indicate when a plantation will reach a particular height or what the average spacing will then be.

Yield Tables

Prediction has been attempted in Tables 3 to 6, which present total and merchantable volumes by 5-year age classes. Heights at given ages were determined from the site index curves, and numbers of trees from the survival/height curves. Mean d.b.h. to the nearest hundredth of an inch was estimated

TABLE 2. STAND VOLUMES FOR WHITE SPRUCE PLANTATIONS

Dominant height (ft)	Volume (ft^3/ac)	Average current spacing (ft)					
		4	5	6	7	8	10
20	Total	634	527	451	393	348	280
	Merch	-	95	112	125	115	98
30	Total	1594	1356	1185	1057	955	804
	Merch	1004	895	841	803	764	659
40	Total	2932	2510	2208	1980	1800	1534
	Merch	2231	1983	1833	1703	1584	1365
50	Total	4648	3990	3520	3164	2884	2469
	Merch	3765	3312	3062	2784	2567	2222
60	Total		5795	5119	4608	4206	3608
	Merch		4868	4453	4055	3743	3247
70	Total			7007	6312	5765	4953
	Merch			6096	5555	5131	4458
80	Total				8277	7563	6503
	Merch				7284	6731	5853

from the SH regression. Basal areas per acre were derived by multiplying numbers of trees by the basal area equivalent to mean d.b.h. (D.b.h. values were subsequently rounded to the nearest tenth of an inch for presentation in the tables.) Total volumes were calculated from the HS regression. Merchantable volumes were derived as previously described. Tabular values based on extrapolations of basic height or spacing data can be inferred from the broken lines in Figure 2.

The following conclusions may be drawn from the tables:

(a) Except for merchantable volumes at age 20 and site classes 50 and 60, closer spacings contain greater standing volumes at all ages than do wider spacings; the relative difference decreases with age.

(b) Merchantable volume as a proportion of total volume increases with age, and is greater at wider than at closer spacings.

(c) Current annual volume increment culminates sooner at closer spacings.

These tables represent probably the highest stocking that can reasonably be expected for a given planted spacing, and as such can be regarded as showing the maximum yields for which a forest manager might aim, although perhaps seldom achieve on a large scale.

TABLE 3. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 50)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
20	19.8	4 x 4	2717	2.4	87	619	56
		5 x 5	1742	2.7	70	514	87
		6 x 6	1210	3.0	59	439	110
		7 x 7	889	3.3	52	383	123
		8 x 8	681	3.5	46	338	112
		10 x 10	436	4.1	39	272	95
25	25.9	4 x 4	2607	2.8	112	1136	534
		5 x 5	1722	3.2	93	973	516
		6 x 6	1210	3.5	80	850	510
		7 x 7	889	3.8	71	753	497
		8 x 8	681	4.2	65	677	481
		10 x 10	436	4.8	55	565	412
30	32.2	4 x 4	2430	3.2	138	1784	1213
		5 x 5	1643	3.6	118	1548	1084
		6 x 6	1195	4.0	105	1379	1020
		7 x 7	889	4.4	94	1237	977
		8 x 8	681	4.8	86	1121	930
		10 x 10	436	5.5	73	948	806
35	38.3	4 x 4	2205	3.7	164	2489	1917
		5 x 5	1540	4.1	143	2192	1710
		6 x 6	1136	4.5	128	1970	1615
		7 x 7	878	4.9	117	1797	1527
		8 x 8	681	5.4	107	1640	1427
		10 x 10	436	6.2	92	1396	1242

TABLE 3. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 50) (Continued)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
40	43.3	4 x 4	1997	4.1	184	3104	2514
		5 x 5	1420	4.6	162	2760	2291
		6 x 6	1080	5.0	147	2507	2156
		7 x 7	846	5.4	136	2301	2002
		8 x 8	678	5.8	126	2128	1873
		10 x 10	436	6.7	107	1821	1639
45	47.0	4 x 4	1830	4.4	198	3572	2929
		5 x 5	1325	4.9	176	3198	2718
		6 x 6	1025	5.4	161	2923	2543
		7 x 7	820	5.8	149	2704	2380
		8 x 8	665	6.2	139	2516	2239
		10 x 10	436	7.1	119	2168	1951
50	50.0	4 x 4	1680	4.8	208	3942	3272
		5 x 5	1250	5.2	187	3560	3097
		6 x 6	980	5.7	172	3273	2880
		7 x 7	790	6.1	160	3037	2703
		8 x 8	650	6.5	149	2840	2556
		10 x 10	436	7.4	128	2470	2223

TABLE 4. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 60)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
20	24.0	4 x 4	2650	2.7	105	964	337
		5 x 5	1735	3.0	86	818	352
		6 x 6	1210	3.3	74	710	362
		7 x 7	889	3.7	65	627	364
		8 x 8	681	4.0	59	562	348
		10 x 10	436	4.6	50	466	308
25	31.3	4 x 4	2460	3.2	135	1683	1111
		5 x 5	1657	3.6	114	1459	992
		6 x 6	1198	3.9	101	1298	948
		7 x 7	889	4.3	91	1162	895
		8 x 8	681	4.7	82	1052	863
		10 x 10	436	5.4	71	888	746
30	38.8	4 x 4	2188	3.7	166	2551	1964
		5 x 5	1526	4.2	145	2248	1776
		6 x 6	1134	4.6	130	2023	1679
		7 x 7	876	5.0	119	1847	1588
		8 x 8	681	5.4	109	1687	1485
		10 x 10	436	6.3	93	1436	1278
35	45.8	4 x 4	1883	4.3	193	3419	2804
		5 x 5	1353	4.8	171	3052	2564
		6 x 6	1043	5.2	157	2788	2426
		7 x 7	830	5.7	145	2573	2264
		8 x 8	672	6.1	135	2390	2127
		10 x 10	436	7.0	115	2052	1847

TABLE 4. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 60) (Continued)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
40	51.8	4 x 4	1600	5.0	214	4164	3498
		5 x 5	1202	5.4	193	3778	3287
		6 x 6	954	5.9	179	3487	3069
		7 x 7	775	6.3	166	3248	2891
		8 x 8	640	6.7	155	3038	2734
		10 x 10	436	7.5	134	2660	2394
45	56.0	4 x 4	1415	5.4	227	4685	3982
		5 x 5	1100	5.9	207	4303	3744
		6 x 6	880	6.3	192	3982	3504
		7 x 7	730	6.7	179	3741	3329
		8 x 8	615	7.1	169	3524	3172
		10 x 10	436	7.9	147	3129	2816
50	60.0	4 x 4	1245	5.9	238	5166	4494
		5 x 5	985	6.4	219	4775	4202
		6 x 6	805	6.8	203	4454	3964
		7 x 7	680	7.2	191	4206	3743
		8 x 8	590	7.5	181	4006	3605
		10 x 10	436	8.2	159	3610	3249

TABLE 5. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 70)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
20	28.3	4 x 4	2542	3.0	122	1369	780
		5 x 5	1697	3.3	103	1180	708
		6 x 6	1208	3.7	90	1040	686
		7 x 7	889	4.1	80	925	657
		8 x 8	681	4.4	72	835	635
		10 x 10	436	5.1	62	701	554
25	36.9	4 x 4	2265	3.6	158	2322	1742
		5 x 5	1567	4.0	137	2041	1572
		6 x 6	1150	4.4	123	1828	1481
		7 x 7	885	4.8	112	1662	1413
		8 x 8	681	5.2	102	1513	1316
		10 x 10	436	6.1	87	1287	1145
30	45.6	4 x 4	1890	4.3	192	3392	2781
		5 x 5	1353	4.8	171	3024	2540
		6 x 6	1047	5.2	156	2766	2406
		7 x 7	830	5.6	144	2549	2243
		8 x 8	672	6.0	134	2368	2108
		10 x 10	436	6.9	115	2033	1830
35	53.0	4 x 4	1545	5.1	217	4304	3658
		5 x 5	1175	5.6	198	3930	3419
		6 x 6	930	6.0	182	3628	3193
		7 x 7	765	6.4	170	3388	3015
		8 x 8	635	6.8	159	3179	2861
		10 x 10	436	7.6	138	2790	2511

TABLE 5. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 70) (Continued)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
40	59.7	4 x 4	1260	5.9	237	5137	4469
		5 x 5	996	6.3	218	4742	4173
		6 x 6	810	6.8	202	4417	3931
		7 x 7	683	7.1	190	4167	3709
		8 x 8	594	7.4	180	3973	3576
		10 x 10	436	8.2	158	3573	3216
45	65.1	4 x 4	1055	6.6	249	5765	5073
		5 x 5	857	7.0	230	5375	4784
		6 x 6	720	7.4	216	5064	4507
		7 x 7	620	7.7	203	4817	4335
		8 x 8	556	8.0	194	4643	4179
		10 x 10	427	8.6	173	4238	3814
50	70.0	4 x 4	890	7.3	256	6312	5618
		5 x 5	745	7.7	238	5946	5292
		6 x 6	640	8.0	224	5644	5080
		7 x 7	560	8.3	211	5396	4856
		8 x 8	510	8.5	202	5229	4706
		10 x 10	410	9.0	182	4927	4434

TABLE 6. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 80)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
20	32.2	4 x 4	2430	3.2	138	1784	1213
		5 x 5	1643	3.6	118	1548	1084
		6 x 6	1195	4.0	105	1379	1020
		7 x 7	889	4.4	94	1237	977
		8 x 8	681	4.8	86	1121	930
		10 x 10	436	5.5	73	948	806
25	42.1	4 x 4	2050	4.0	179	2957	2366
		5 x 5	1448	4.5	158	2621	2149
		6 x 6	1095	4.9	143	2374	2018
		7 x 7	855	5.3	131	2176	1893
		8 x 8	681	5.7	121	2009	1768
		10 x 10	436	6.6	104	1714	1543
30	51.8	4 x 4	1600	5.0	214	4164	3498
		5 x 5	1202	5.4	193	3778	3287
		6 x 6	954	5.9	179	3487	3069
		7 x 7	775	6.3	166	3248	2891
		8 x 8	640	6.7	155	3038	2734
		10 x 10	436	7.5	134	2660	2394
35	60.6	4 x 4	1210	6.0	238	5225	4546
		5 x 5	965	6.5	220	4836	4256
		6 x 6	795	6.9	205	4526	4028
		7 x 7	675	7.2	192	4284	3813
		8 x 8	585	7.6	182	4076	3668
		10 x 10	435	8.2	161	3681	3313

TABLE 6. YIELD TABLE FOR UNMANAGED WHITE SPRUCE PLANTATIONS (SITE INDEX CLASS 80) (Continued)

Age from planting (years)	Dominant height (ft)	Planted spacing (ft)	Trees per acre	Mean dbh (inches)	Basal area (ft^2/ac)	Volume	
						Total (ft^3/ac)	Merch (ft^3/ac)
40	68.2	4 x 4	942	7.0	254	6102	5370
		5 x 5	780	7.4	235	5727	5097
		6 x 6	673	7.8	222	5445	4846
		7 x 7	582	8.1	209	5183	4665
		8 x 8	530	8.3	200	5022	4520
		10 x 10	418	8.9	179	4632	4169
45	74.4	4 x 4	760	7.9	258	6772	6027
		5 x 5	655	8.2	242	6448	5803
		6 x 6	576	8.5	229	6164	5548
		7 x 7	515	8.8	217	5939	5345
		8 x 8	473	9.0	208	5769	5192
		10 x 10	397	9.4	190	5441	4897
50	80.0	4 x 4	620	8.7	255	7331	6598
		5 x 5	555	8.9	242	7060	6354
		6 x 6	500	9.2	229	6817	6135
		7 x 7	455	9.4	218	6599	5939
		8 x 8	430	9.5	211	6481	5833
		10 x 10	370	9.8	193	6152	5537

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