Forest Research Branch

PRELIMINARY YIELD TABLES FOR BLACK SPRUCE MANITOBA-SASKATCHEWAN

by

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Sommaire en français

DEPARTMENT OF FORESTRY PUBLICATION NO. 1064

1964

Published under the authority of

The Honourable Maurice Sauvé, P.C., M.P.
Minister of Forestry
Ottawa, 1964

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964

Catalogue No. Fo 47-1064

ABSTRACT

Yield tables, prepared from 167 single-examination plots, are presented for four physiographically defined sites. The sites are described as to soil parent material, soil profile development, lesser vegetation and height of dominant trees.

The paper describes a modified intercept-per cent method of preparing yield tables, and shows that intercept-per cent varies with stand age as well as with site.

The tables provide number of trees, basal area, average diameter and volume in cubic feet for the merchantable portion of a stand by ten-year age classes. Merchantable volume at 100 years is 2,200 cubic feet on site A, 1,923 cubic feet on site B, 1,523 cubic feet on site F and 1,289 cubic feet on site D.

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ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance and cooperation of the Manitoba Paper Company Limited, the Manitoba Forest Service, and the Saskatchewan Forestry Branch, whose permanent sample plot records and other data were used extensively in the preparation of this paper.

Preliminary Yield Tables for Black Spruce Manitoba-Saskatchewan[1]

by

J. S. Jameson[2]

INTRODUCTION

Yield tables are of two basic types—normal and empirical—both of which are usually prepared with data from single examinations of plots. Normal yield tables attempt to show the average yield obtainable from fully stocked stands on a given site and in a given cover type (Bedell and MacLean 1952) on which all growing space is effectively occupied (Anon. 1958a). They may also indicate a theoretical optimum number of stems per acre at which yield may be maximized. Empirical yield tables, often derived from inventory data, attempt to show the average yield obtainable from average stocked stands on a given site and in a given cover type (Bedell and MacLean 1952; Kabzems and Kirby 1956; Anon. 1958a) on which all growing space may or may not be effectively occupied. Although the tables prepared in this study are considered to be empirical the data do not represent average stand conditions; they were obtained from stands that were nearly fully stocked.

Whether yield tables are normal or empirical, they must be adjusted to actual stand conditions for the purpose of predicting growth and yield; Chapman and Meyer (1949) imply that normal yield tables can be more accurately adjusted to actual stand conditions than can empirical yield tables. Some tables in their use for the prediction of yield, require the assumption that the ratio of yield table values to actual stand values remains constant with age; others provide that the ratio will change with age. With empirical yield tables of the type referred to by Chapman and Meyer, a constant ratio of yield table values to stand values must be maintained with changing age since no normality, or standard of stocking, to which stands presumably progress, has been established. With the variable-density tables referred to by Spurr (1952) the problem of progression to normality is minimized.

In this paper, a set of black spruce[3] yield tables prepared from single examinations of 167 plots and arranged on a physiographic site basis (Hills 1950, 1952) is presented. The tables are empirical in the sense that they were constructed from plots representing stands that were less than fully stocked. They are also preliminary tables which may be adjusted at remeasurement. Certain modifications of normal yield table methods have been developed. Use of the tables requires the assumption that a ratio of yield table values to actual stand values remains constant with changing age.

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[3]For list of scientific names of tree species, see Appendix I.

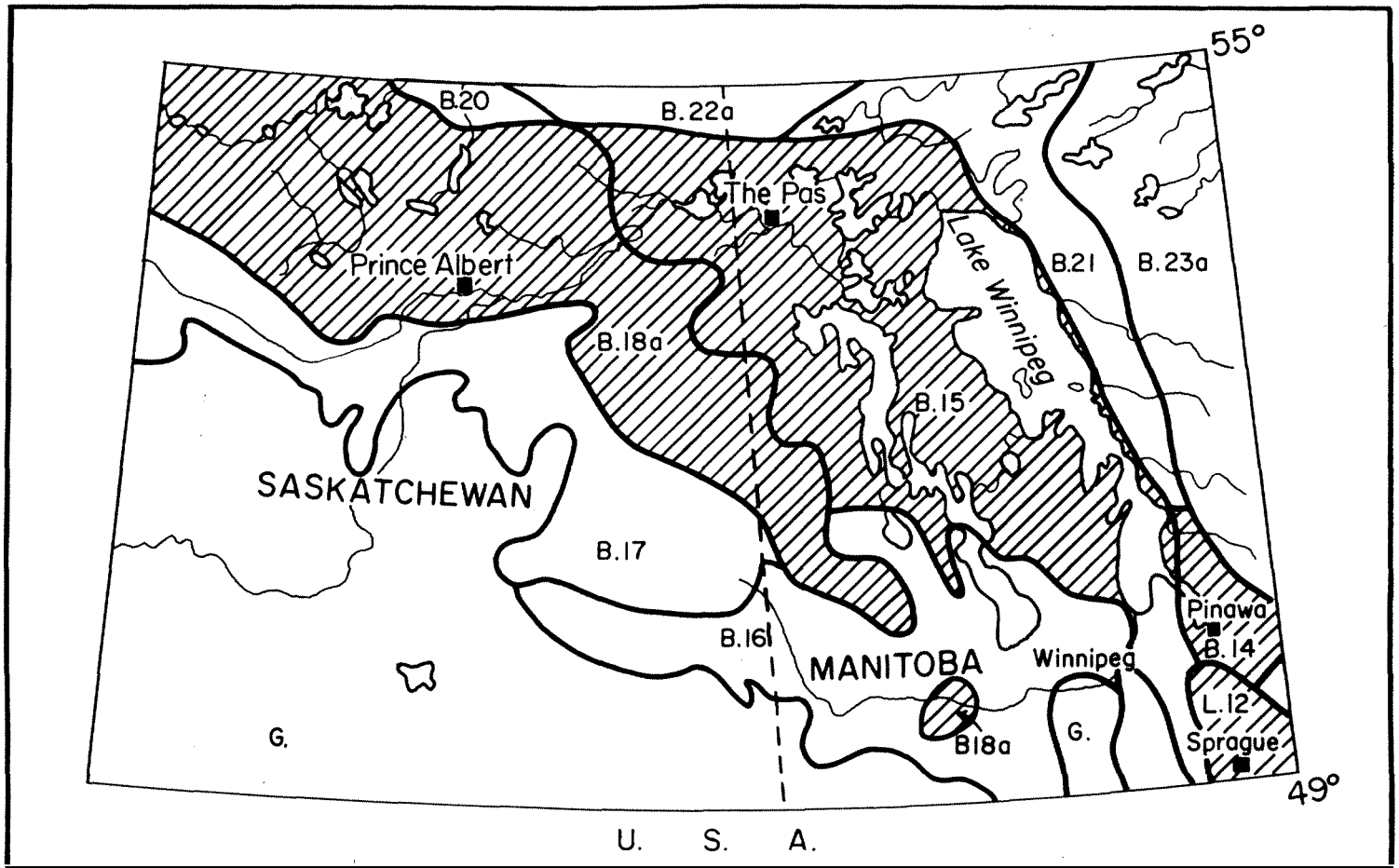

Figure 1. Portion of Manitoba and Saskatchewan showing location of Forest Section with yield tables applicable in shaded area.

DESCRIPTION OF FOREST SECTIONS

The yield tables specifically apply to the B.14 (Lower English River); B.15 (Manitoba Lowlands); L.12 (Rainy River), and B.18a (Mixedwood) Forest Sections of Manitoba and Saskatchewan as described by Rowe (1959), and shown in Figure 1.

In the B.14 Forest Section, mixed trembling aspen and white spruce provide the chief forest cover on well drained sites, with black spruce occurring on the shallow bogs. On the flat poorly drained land, characteristic of the B.15 Forest Section, the prevailing vegetation consists of black spruce and tamarack. In the B.18a Forest Section, the characteristic forest cover is also trembling aspen and white spruce. However, black spruce occurs, often mixed with jack pine, on the plateau-like tops of higher hills; and in pure stands on the lower, wetter positions. In the L.12 Forest Section, jack pine occupies the majority of the drier sites, but low relief and poor drainage throughout the Section has favoured the development of extensive swamps with black spruce, tamarack and eastern white cedar, particularly in the western portion over sedimentary rocks.

The climate of the four sections is continental with a great annual range in temperatures and with only moderate precipitation. Climatic data for these four sections can be briefly summarized in the following: mean January minimum temperature −14° to −18°F.; mean July maximum temperature 75° to 78°F.; mean annual temperature 31° to 34°F.; mean annual precipitation 15.4 to 20.3 inches; mean growing season precipitation 9.6 to 12.8 inches; and mean length of growing season 157 to 165 days (Anon. 1958a, Rowe 1959).

DESCRIPTION OF SITES

Black spruce is generally considered a wet-site species, but it is capable of growing on a wide range of sites. In the area under study it occurred over the entire range of sites from the driest to the wettest, but on the dry, coarse sandy or gravelly sites and on the dry shallow till over bedrock sites its occurrence on a stand basis was too infrequent to provide data for yield tables. At the other end of the moisture scale, black spruce occupied the very wet bog sites. Although individual black spruce of merchantable size occasionally occurred, density of stocking and size class of the main stand were usually such that these sites could be classed as non-productive.

Four sites, which represent four segments of the major portion of the site continuum for black spruce, were therefore established for the black spruce stands in the area under study. These sites, based on Hills' (1950, 1952) classification are distinguishable by plant communities, soil features and height of dominant trees. Brief descriptions of them are given below, and more detailed soil profile and lesser vegetation descriptions are presented in Appendices II and III.

Site A (Site Index 53 feet at 100 years)

Soils on this site are moderately fresh to moderately moist loam to clay-loam tills on undulating to moderately rolling topography.

The soil profile type is either the orthic grey wooded[4] with a leached A_e and a blocky structured B_t horizon, or the bisequa grey wooded, in which there is a podzol profile developed on a grey wooded profile.

[4]Soil profile nomenclature throughout text is taken from the Proceedings of the Fourth National Meeting of the National Soil Survey Committee of Canada. Guelph, Ontario, February 1960.

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The typical forest cover consists of a mixture of trembling aspen and white spruce. Black spruce often occurs in pure stands, particularly after fires. It is on this site that black spruce attains its best development. Under well-stocked black spruce stands the lesser vegetation consists principally of the feather mosses; namely, *Calliergonella schreberi* (BSG.), Grout, *Hylocomium splendens* (Hedw.) BSG., and *Hypnum crista-castrensis* L. Hedw. In the tall and medium shrub layer probably the most characteristic species is *Vaccinium myrtilloides* Michx.

Site A is of common occurrence throughout the B.18a Forest Section.

Site B (Site Index 50 feet at 100 years)

Soils on Site B are moist to very moist fine sand to clay of till or lacustrine origin on level to gently undulating topography.

There is an organic cap 4 to 12 inches in depth. On fine sandy material, there is a well-defined A_e horizon and a water table at about five feet. On loam to clay textures, there is a seasonally saturated gley horizon perched on a blocky structured B_{tg} horizon, and either an A_h or a weakly developed A_{ej} horizon. These soils could be classified as orthic podzols, gleyed grey wooded, orthic gleysols, peaty gleysols, or low humic eluviated gleysols.

As on Site A, trembling aspen and white spruce predominate in pure and mixed stands. Pure black spruce stands occur, and under well-stocked stands of this type the lesser vegetation is dominated by the feather mosses. In the medium herb and tall shrub layers respectively, *Petasites palmatus* (Ait.) A. Gray, and *Ledum groenlandicum* Oeder are strongly represented.

Site D (Site Index 45 feet at 100 years)

Soils on Site D are wet, poorly drained sand or clay flats of till or lacustrine origin, overlaid by an organic cap 12 to 30 inches in depth. The organic cap consists of a fibrous or sphagnum peat overlying a mucky peat near the mineral soil surface. The underlying mineral soil is saturated, very dark grey or blue-grey in colour, with a massive or single grained structure. Sphagnum hummocks and mucky depressions are characteristic.

The typical forest cover is black spruce in well stocked stands. White spruce, balsam poplar and tamarack may occasionally occur in mixture. In the L.12 Forest Section white cedar may also occur.

Lesser vegetation is dominated by *Sphagnum* spp. in the moss layer and *Ledum groenlandicum* in the shrub layer. *Calliergonella schreberi* and *Hylocomium splendens* regularly occur but are somewhat less dominant. *Carex* spp. and *Mnium* spp. frequently occur in the water-filled depressions characteristic of the microtopography of the site.

Site F (Site Index 48 feet at 100 years)

Soils are moist and very moist on coarse to medium sands laid down as beaches or terraces. Topography is level to very gently undulating.

There is an organic cap 4 to 12 inches in depth, an A_e horizon, which may be mottled, a mottled dark brown B_{fg} horizon and a permanent water table at five feet. These soils may be classified as gleyed podzols, peaty podzols, peaty gleysols or peaty eluviated gleysols.

The forest cover may be either pure black spruce, pure jack pine, or a mixture of the two, depending upon history and seed source.

Under black spruce, the lesser vegetation is characterized by *Calliergonella schreberi*, *Hylocomium splendens* and *Sphagnum* spp. in the moss layer. *Ledum groenlandicum* is dominant in the tall shrub layer and *Rubus pubescens* Raf. and *Mitella nuda* L. in the low herb layer.

FIELD METHODS

More than 200 one-fifth-acre permanent sample plots, established by federal and provincial governments and by industry, in black spruce stands throughout the Manitoba-Saskatchewan District were examined, and of these 167 were accepted. Plots were rejected because of uneven-aged stand structure, or because of site variation within the sample plot. Very dense stands and open stands were not sampled.

On each plot the following data were obtained:

1. Diameter tally by species and one-inch classes of all trees over 0.5 inch.
2. Diameter, height, age at stump-height and crown class of 3 trees of each species selected systematically.
3. Diameter, height and age at stump-height of five selected dominants or codominants of each species.
4. Soil profile description, and geological origin of soil; slope, aspect, and position on slope.
5. List of lesser vegetation by cover-abundance and sociability.
6. Other pertinent information including origin of stand, and disturbance, if any.

Each plot was assigned to a site on the basis of the soil profile development and ground cover pattern.

YIELD TABLE PREPARATION

Local tables of total[5] and merchantable[6] volume in cubic feet, by site and 30-year age classes, were prepared for black spruce, jack pine, larch, white spruce, trembling aspen and white birch from standard volume tables (Anon. 1948; Brown and Gevorkiantz 1934; Jameson 1961).

Height/age curves were drawn by sites, using the heights and ages of dominant and codominant black spruce trees selected on each plot (Figure 2).

For each plot, per acre summaries by species, of number of trees, basal area, total volume[5] in cubic feet for the entire stand (one inch D.B.H. and up) and merchantable volume[6] in cubic feet for the merchantable stand (four inches and up) were prepared. Values were calculated for average basal area of the entire stand and merchantable stand. Merchantable volume/density ratios (volume of trees four inches and up divided by their basal area) for all species were calculated, and ratios of merchantable volume of each species to merchantable volume of all species determined.

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[5]Total volume includes stump and top.
[6]Merchantable volume excludes stump and top. For white spruce, stump height is 1.5 feet; for other species stump height is one foot. For all species top diameter is three inches.

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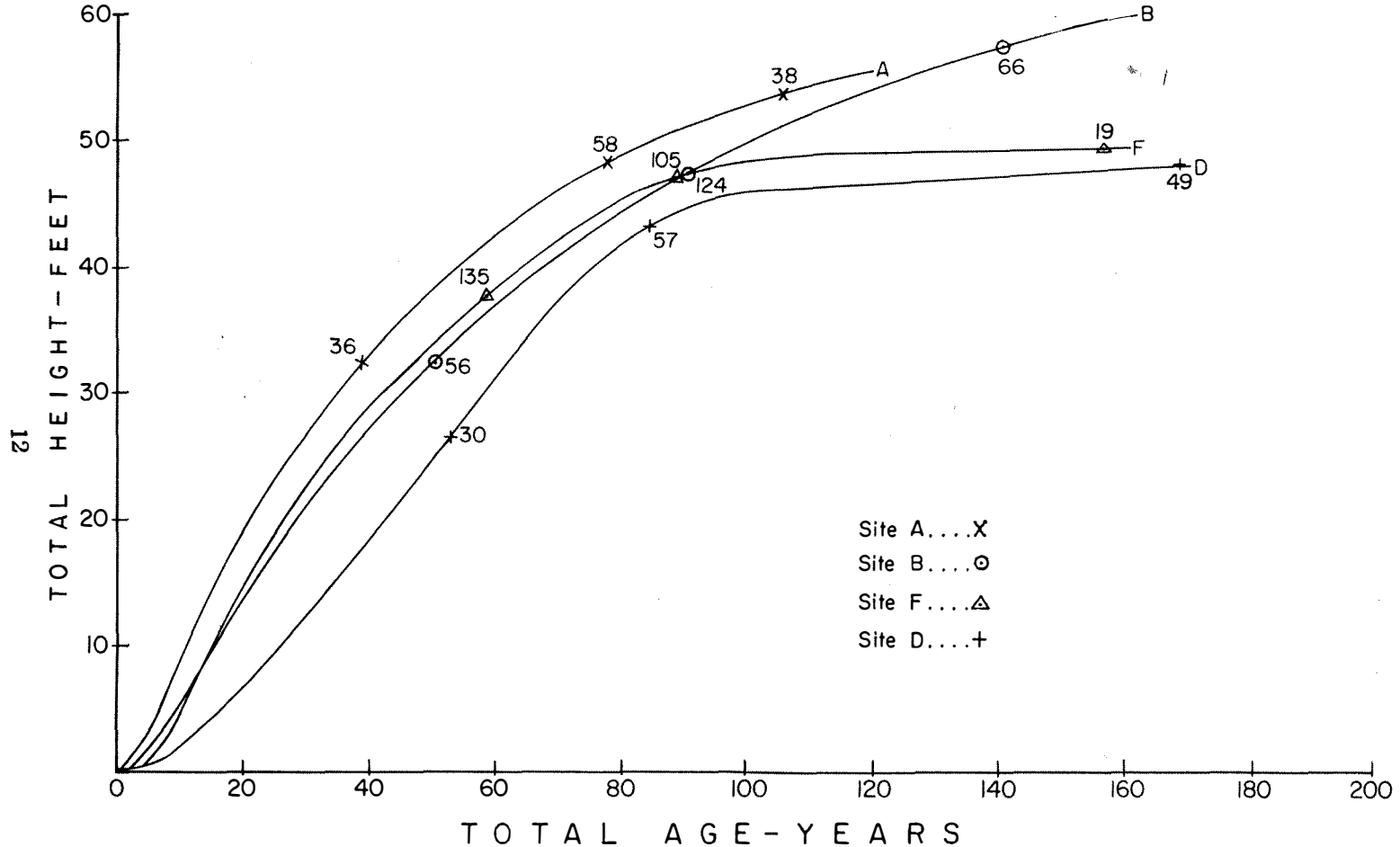

Figure 2. Dominant height/age relationship . . . black spruce.

Mean age at stump-height for each plot was determined from the borings of dominant and codominant trees. To determine total plot age from age at stump height, correction factors (calculated by averaging the ages of a large number of free-growing stems one foot in height) were applied. They are as follows:

Site	Years	Number of Observations
A and B	4	190
D	7	196
F	6	112

Preparation of Guide Curves

In North America, the generally accepted method of constructing normal yield tables is to use site classes based on site index and to derive curves for each site class from guide curves constructed by using all the data pooled. When, as in this study, sites are defined ecologically or physiographically, curves should be constructed independently for each site because of the differences in the shape of the growth curves (Spurr 1952). However, data were inadequate for independent site-curve construction for all sites and it was necessary to develop a procedure to suit this particular situation. This was done by modifying the procedures outlined by Chapman and Meyer (1949) for preparing normal yield tables and by adopting some of the features of the procedures followed by Bedell and MacLean (1952) and MacLean and Bedell (1955).

All plot data for total basal area, number of trees and average basal area were pooled without regard to site. These data were sorted by ten-year age classes and the mean values for trees 1 inch and up and for trees 4 inches and up were determined for each decade. Curves of total basal area, number of trees and average basal area over age were drawn and balanced. The two sets of three curves were made to cross check at each decade as the product of average basal area and number of trees must equal total basal area. These are guide curves and are similar to those described by Chapman and Meyer (1949) for preparing normal yield tables.

Total basal area, number of trees and average basal area were read from the guide curves at each decade, and tables showing these values were prepared for trees 1 inch and up and for trees 4 inches and up. These tables and guide curves formed the basis for the final yield tables.

Yield Table Values for Basal Area and Number of Trees by Sites

An outline of the methods used to obtain total basal area, number of trees and average basal area from the guide curves for each site follows. Plot data were sorted by site and ten-year age classes and means determined for total basal area and number of trees per acre, and for age. Mean basal area per tree for each ten-year age class was obtained from the mean of total basal area divided by mean of number of trees. From the guide curves, values for total basal area, number of trees and average basal area were read at ages corresponding with the mean age of the sample for each age class on each site condition. The ratio of the mean value for each site and age to its corresponding guide curve value was calculated and expressed in per cent

$$\left(\text{e.g. } N\% = \frac{N}{Nc} \times 100\right).$$

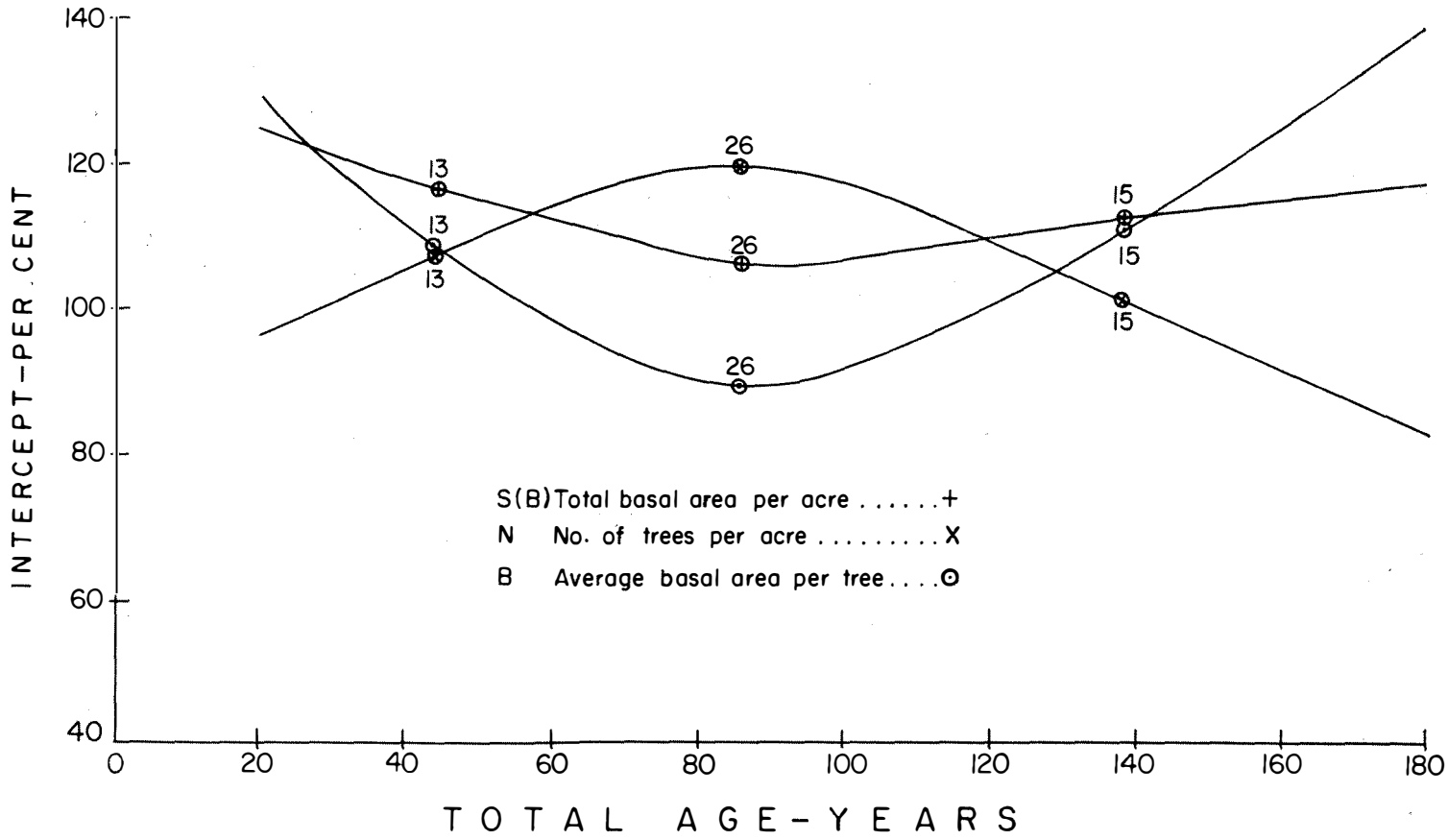

Figure 3. Intercept percent/age . . . Site B.

TABLE 1. EXAMPLE OF CALCULATION OF NUMBER OF TREES, TOTAL BASAL AREA AND AVERAGE BASAL AREA PER ACRE FROM GUIDE CURVES

Guide curve				Site B						
				Intercept—percent			Calculated			
Age	No. of trees	Basal area	Average basal area	No. of trees	Basal area	Average basal area	No. of trees	Basal area	Average basal area	No. of trees x Av. basal area
		(sq. ft.)	(sq. ft.)							
20	1,400	7.0	.005	—	—	—	—	—	—	—
30	2,420	31.0	.013	101.0	121.2	119.1	2,444	37.6	.015	36.6
40	3,100	61.5	.020	105.5	117.9	111.6	3,270	72.5	.022	72.0
60	2,915	105.0	.036	113.9	112.0	98.6	3,320	117.6	.036	119.5
80	2,470	136.0	.055	119.0	106.9	89.5	2,939	145.4	.049	144.0
100	2,030	150.0	.074	117.0	106.8	91.2	2,375	160.2	.067	159.0
120	1,650	152.0	.092	109.8	109.5	100.2	1,812	166.4	.092	166.6
140	1,275	139.5	.109	100.9	112.6	111.9	1,286	157.1	.122	156.8
160	1,030	116.0	.112	91.9	114.5	124.8	947	132.8	.140	132.4
180	940	89.5	.095	82.9	116.0	139.0	779	103.8	.132	103.0

These percentages were plotted over mean age, and curves—termed intercept-per cent curves (after Chapman and Meyer 1949)—for total basal area, number of trees and average basal area were drawn, balanced and cross checked for each of the sites. Figure 3 is a set of intercept-per cent curves for site B.

From the three intercept curves, the curved percentages were read at even decades for each site. Each percentage was applied to the total basal area, number of trees and average basal area, read from the guide curves at each decade, to obtain total basal area, number of trees and average basal area for each site. Table 1 shows the procedure followed with respect to site B. Multiplication of the actual average basal area by number of trees in this table will reveal that they cross check within reasonable limits. Data for the other sites were obtained in the same way.

These values were plotted and smooth curves of total basal area, and number of trees were drawn over age for each site; the values read at each decade are those in the yield tables (Tables 2 to 5).

The same procedure was followed for the merchantable stand as was for the entire stand. Basal area, number of trees and average basal area for the merchantable stand are presented by site and ten-year age classes in Tables 2 to 5. Average diameter of the merchantable stand in the tables is the diameter of the tree of average basal area.

Yield Table Values for Merchantable Volume

Several methods of determining merchantable volume per acre by site and age class were tried. For example, merchantable volume for each site was initially derived in the same manner as basal area and number of stems per acre, but this and other methods were abandoned in favour of one found useful by MacLean and Bedell (1955) in Ontario. They used volume/density ratio in their yield studies to express volume per unit basal area by site and age; volume per acre could then be easily calculated for any stand density. The authors found that this ratio was strongly correlated with age for the sites described[7]. A method making use of volume/density ratio was developed for this yield study and found satisfactory. The procedures are outlined in the following paragraphs.

Volume/density ratios calculated for each plot were sorted by site and ten-year age classes. Means were determined, data plotted and smooth curves of volume/density ratio over age were drawn. The volume/density ratio over age curve for site B is shown in Figure 4. From these curves, the curved ratios were read at ten-year intervals (Table 6). As with MacLean and Bedell's data, there was good correlation with age for all sites.

Merchantable volume of all trees 4 inches and up for each site and age class was obtained by multiplying the curved volume/density ratio of Table 6 by the previously determined merchantable basal area. These values were plotted and smooth curves drawn. Tables 2 to 5 present the total merchantable volume of all trees 4 inches and up by site and age class as read from the curves.

The ratio of species merchantable volume to merchantable volume of all species obtained on each plot was plotted over age and curves showing this relationship for each site were prepared. Percentages were read from the curves for each site and age. Merchantable volume for each species was calculated by multiplying the total merchantable cubic foot volume by the appropriate percentages at each decade.

[7]Personal communication with D. W. MacLean.

TABLE 2. YIELD TABLE—SITE A

Age	Trees 1 inch and up		Trees 1-3 inches		Merchantable stand—trees 4 inches and up								
	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	Average basal area (sq. ft.)	Average diameter (inches)	Volume per acre (cu. ft.)*				
									Black spruce	Jack pine	Other softwood	Hard-woods	Total
10	—	—	—	—	—	—	—	—	—	—	—	—	—
20	1615	11.0	1615	11.0	—	—	—	—	—	—	—	—	—
30	2800	45.0	2705	34.5	95	10.5	.109	4.5	69	26	0	18	113
40	3255	85.5	2990	55.0	265	30.5	.113	4.6	236	71	4	46	357
50	3135	115.0	2670	60.0	465	55.0	.118	4.7	496	119	14	70	699
60	2840	135.0	2185	55.5	655	79.5	.122	4.7	822	151	32	76	1081
70	2545	149.0	1740	47.0	805	102.0	.127	4.8	1167	160	58	73	1459
80	2265	161.0	1365	41.5	900	119.5	.133	4.9	1503	142	71	53	1769
90	1995	165.5	1050	33.0	945	132.5	.140	5.1	1804	122	61	40	2027
100	1755	166.5	800	25.5	955	141.0	.149	5.2	2046	88	44	22	2200
110	1545	165.0	650	23.0	895	142.0	.159	5.4	2169	45	22	22	2259
120	1370	160.0	560	23.0	810	137.0	.168	5.6	2184	0	0	22	2206

No allowance for cull.

Rotation age—black spruce 98 years, all species 89 years.
Basis: 27 yield plots,

*Merchantable volume in cubic feet above a one-foot stump to a three-inch top.

TABLE 3. YIELD TABLE—SITE B

Age	Trees 1 inch and up		Trees 1-3 inches		Merchantable stand—trees 4 inches and up									
									Volume per acre (cu. ft.)					
	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	Average basal area (sq. ft.)	Average diameter (inches)	Black* spruce	White** spruce	Jack* pine	Tama-* rack	Hard-* woods	Total
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	2445	37.0	2400	33.0	45	4.0	.090	4.1	24	0	2	7	1	34
40	3260	72.5	3025	58.5	135	14.0	.096	4.2	100	4	7	19	7	137
50	3400	99.0	3145	72.5	255	26.5	.102	4.3	221	18	12	26	18	295
60	3320	117.0	2930	75.0	390	42.0	.108	4.4	394	41	15	31	31	512
70	3145	132.0	2615	71.5	530	60.5	.116	4.6	621	79	16	24	47	787
80	2935	145.0	2275	63.0	660	82.0	.124	4.8	928	113	11	23	57	1132
90	2680	153.5	1905	48.5	775	105.0	.134	5.0	1279	152	0	15	76	1522
100	2370	160.5	1495	34.0	875	126.5	.145	5.2	1673	173	—	0	77	1923
110	2080	165.0	1150	21.5	930	143.5	.155	5.3	2041	159	—	—	68	2268
120	1805	166.5	865	12.0	940	154.5	.164	5.5	2368	127	—	—	51	2546
130	1525	164.0	595	7.0	930	157.0	.168	5.6	2618	81	—	—	0	2699
140	1280	157.0	370	4.5	910	152.5	.167	5.5	2654	0	—	—	—	2654

No allowance for cull.

Rotation age—black spruce 129 years; all species 121 years.
Basis: 54 yield plots.

*Merchantable volume in cubic feet above a one-foot stump to a three-inch top.
**Merchantable volume in cubic feet above a 1.5-foot stump to a three-inch top.

TABLE 4. YIELD TABLE—SITE D

Age	Trees 1 inch and up		Trees 1-3 inches		Merchantable stand—trees 4 inches and up						
	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft.)	Average basal area (sq. ft.)	Average diameter (inches)	Volume per acre (cu. ft.)*		
									Black spruce	Tamarack	Total
10	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—
30	2880	22.0	2880	22.0	—	—	—	—	—	—	—
40	3240	45.0	3185	39.5	55	5.5	.099	4.3	28	23	51
50	2955	63.5	2790	47.0	165	16.5	.102	4.3	112	58	170
60	2565	79.0	2255	46.5	310	32.5	.105	4.4	273	91	364
70	2245	92.5	1795	43.0	450	49.5	.109	4.5	497	102	599
80	2000	104.5	1420	38.5	580	66.0	.114	4.6	737	101	838
90	1825	113.0	1145	31.0	680	82.0	.121	4.7	985	97	1082
100	1685	120.0	935	24.5	750	95.5	.129	4.9	1199	90	1289
110	1565	124.0	790	16.5	775	107.5	.139	5.0	1399	74	1473
120	1455	126.2	675	10.7	780	115.5	.148	5.2	1541	64	1605
130	1350	126.2	585	8.2	765	118.0	.154	5.3	1609	67	1676
140	1250	122.5	510	8.0	740	114.5	.156	5.4	1572	66	1638
150	1180	116.5	470	9.5	710	107.0	.150	5.3	1505	46	1551
160	1140	109.0	470	13.0	670	96.0	.143	5.1	1369	42	1411

No allowance for cull.

Rotation age—black spruce 117 years; all species 115 years
Basis: 30 yield plots.

*Merchantable volume in cubic feet above a one-foot stump to a three-inch top.

TABLE 5. YIELD TABLE—SITE F

Age	Trees 1 inch and up		Trees 1–3 inches		Merchantable stand—trees 4 inches and up								
									Volume per acre (cu. ft.)*				
	No. of trees	Basal area (sq. ft.)	No. of trees	Basal area (sq. ft)	No. of trees	Basal area (sq. ft.)	Average basal area (sq. ft.)	Average diameter (inches)	Black** spruce	Jack pine	Tamarack	Hard woods	Total
10	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—
30	2900	48.0	2800	37.0	100	10.0	.101	4.3	45	16	18	4	83
40	3535	88.0	3270	60.0	265	28.0	.104	4.4	155	38	48	13	254
50	3285	113.0	2850	67.0	435	46.0	.107	4.4	319	52	75	24	470
60	2860	123.0	2290	61.0	570	62.0	.111	4.5	525	49	91	35	700
70	2435	127.0	1780	51.0	655	76.0	.116	4.6	754	38	104	47	943
80	2060	128.0	1355	41.5	705	86.5	.123	4.8	978	23	92	58	1151
90	1730	127.0	1000	31.0	730	96.0	.133	4.9	1197	14	82	68	1361
100	1485	124.5	745	20.0	740	104.5	.142	5.1	1386	0	61	76	1523
110	1295	121.0	575	10.0	720	111.0	.155	5.3	1524	—	49	66	1639
120	1135	116.0	455	2.5	680	113.5	.167	5.5	1608	—	34	68	1710
130	980	111.0	350	0.5	630	110.5	.175	5.7	1623	—	0	68	1691
140	860	106.0	280	2.0	580	104.0	.177	5.7	1551	—	—	48	1599

No allowance for cull.

Rotation age—black spruce 105 years; all species 99 years.
Basis—56 yield plots.

*Merchantable volume in cubic feet above a one-foot stump to a three-inch top.
**Includes a small amount of white spruce.

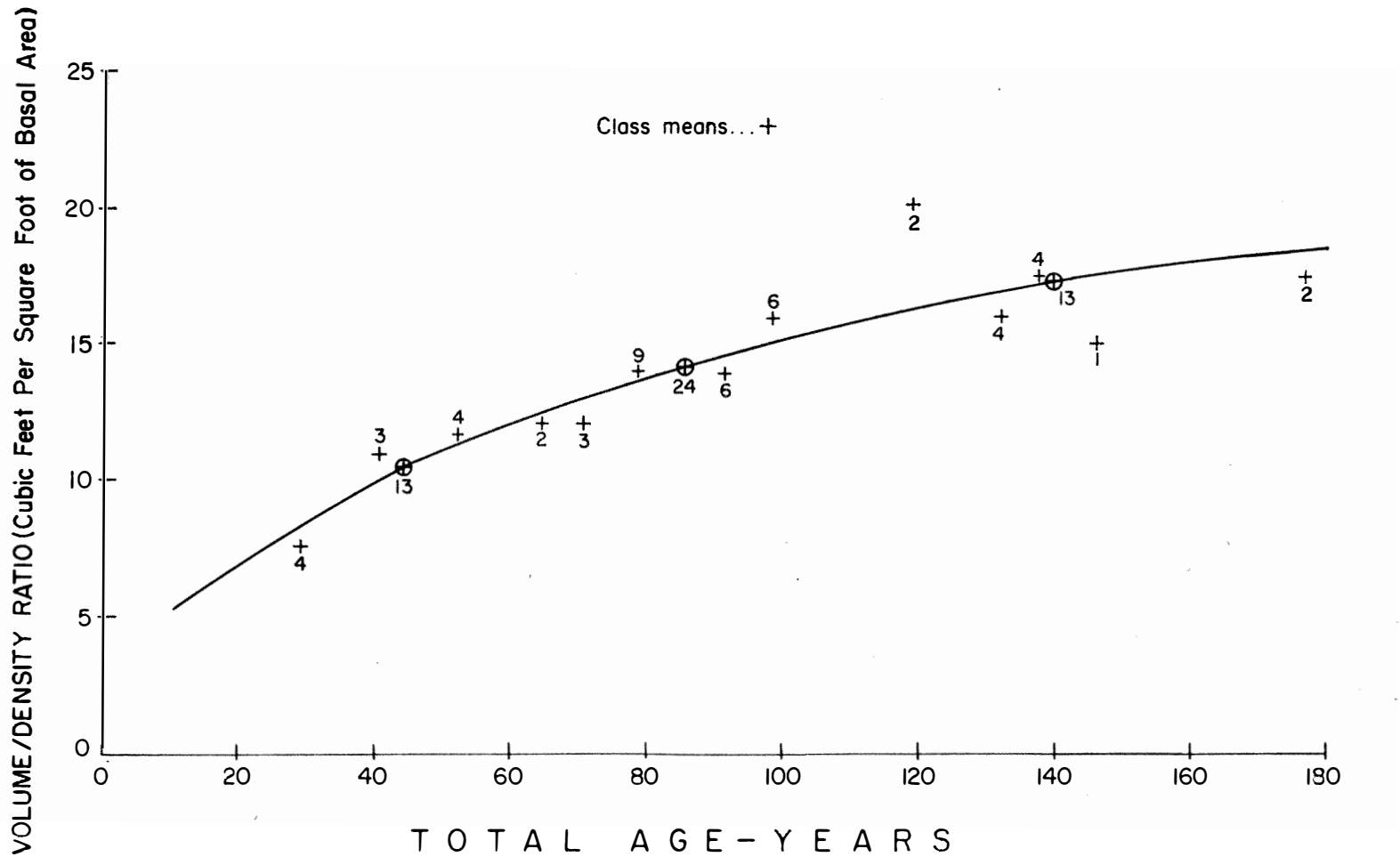

Figure 4. Volume/density ratio over age . . . Site B.

RATIO BY SITES
TABLE 6. MERCHANTABLE VOLUME/DENSITY

Age	Site A	Site B	Site F	Site D
20	9.7	6.8	—	—
30	10.7	8.3	7.9	7.9
40	11.7	9.8	9.1	9.2
60	13.6	12.2	11.3	11.2
80	14.8	13.8	13.3	12.7
100	15.6	15.2	14.6	13.5
120	16.1	16.5	15.1	13.9
140		17.4	15.4	14.3
160				14.7

Yield Variability

Minimum and maximum basal areas for each age class were plotted over age by sites, and curves drawn to establish approximate lower and upper limits. At the estimated rotation age for each site, minimum and maximum basal areas were read from the curves as follows: Site A at 98 years—minimum 136 square feet and maximum 188 square feet; Site B at 129 years—minimum 136 square feet and maximum 183 square feet; Site D at 117 years—minimum 91 square feet and maximum 150 square feet, and Site F at 105 years—minimum 110 square feet and maximum 142 square feet. The variability in basal area may be attributed to site variations within the range of each physiographic site and to variations in density of stocking due to historic influences. However, the variability attributed to each is difficult to assess.

APPLICATION

The yield tables presented here can be used directly to estimate present volumes from basal areas and to predict future yields of black spruce stands if the site, age and density of the stands are known.

These procedures are illustrated in the following example for a black spruce stand 60 years of age on Site B, with a density of 40.0 square feet per acre of merchantable trees. In the yield tables, the per acre values for basal area and merchantable volume are 42.0 square feet and 512 cubic feet. Present volume (PV) in the example is determined as follows:

$$PV = \frac{40.0}{42.0} \times 512 = 488 \text{ cubic feet per acre}$$

The yield table shows that 394 cubic feet of the 512 cubic feet is black spruce. Volume per acre of black spruce is therefore

$$\frac{394}{512} \times 488 = 376 \text{ cubic feet.}$$

In predicting future yields, basal area changes are assumed to follow trends similar to those in the yield tables, and no allowance is made for the "trend towards normality". The predicted volume at 130 years in the yield table is 2,699 cubic feet of which 2,618 cubic feet is black spruce. The predicted volume in the example, therefore, is

$$\frac{40.0}{42.0} \times 2{,}699 = 2{,}570 \text{ cubic feet,}$$

$$\text{of which } \frac{2{,}618}{2{,}699} \times 2{,}570 = 2{,}493 \text{ cubic feet is black spruce.}$$

DISCUSSION

These yield tables are prepared for physiographically or ecologically defined sites, which is an advantage, as it is believed that the rate of stand development varies with site. The tables are therefore at variance with most normal yield tables in which site index is used to classify site and in which the stands are shown to develop in a similar manner but at different levels for all sites. For example, in most such tables, maximum basal area is usually attained at a similar age on all sites, whereas it was attained at a different age for each of the sites described in these tables. This difference in the rate of stand development with site is the main reason for preparing tables in the manner described herein.

Differences in the rate of stand development may be readily observed in the set of dominant height/age curves in Figure 2. These curves show variation in rate of height growth with site. They are not in the neatly arranged order so characteristic of the mathematically defined height/age curves of most normal yield tables. Figure 2 also shows that the ranking of these curves by site changes from young to older age classes. Thus, the assumption, made in most normal yield tables in which site is defined by site index, that the site quality class of a stand remains constant throughout a rotation, may be incorrect.

A limitation of yield tables prepared in the manner described for ecologically defined sites is that the true variability of yield within the site units cannot be adequately defined from the samples because of their non-random placement and because the site units represent somewhat subjective segments of the range of black spruce habitats. However since the plots were established prior to stratification by site units, it is believed that the average yield values are probably unbiased and sample the range of site variability reasonably well. In practice, the average yields will be applied to extensive areas, and they should not be used to predict growth of small areas, such as individual plots, that may vary greatly from the average conditions of the site unit to which they belong.

These tables are based on single examination data, and this is a disadvantage since no consideration can be given to changes in stocking, density and/or species composition, which normally occur with age. On remeasurement of the plots, when changes in density and species composition during the remeasurement period have been determined, the techniques being developed in Ontario, which provide for these changes in yield tables, may be usefully applied here.

The intercept per cent curves used in determining the three parameters—basal area, number of trees and average basal area—are similar to those employed in preparing normal yield tables, except that the percentages are related to stand

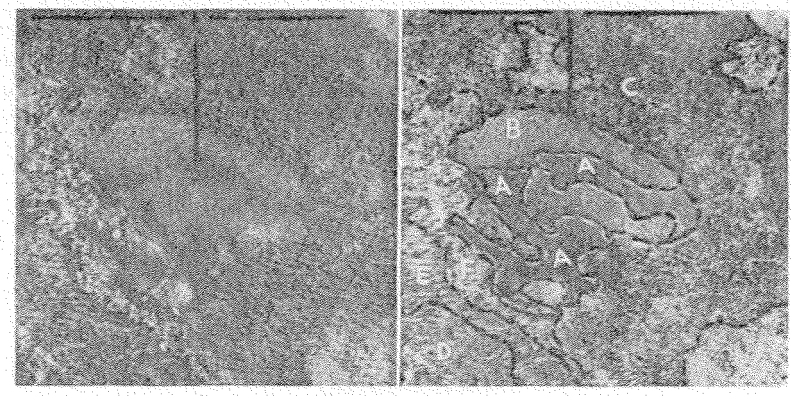

Figure 5. Black spruce, larch and jack pine stands, southeastern Manitoba (Scale 1:15,840)

A: F site—Black spruce stand.
Age: 56 years. Basal area: 133 sq. ft. (120–144 sq. ft.).
Merch. volume: bS—530 cu. ft. tL—41 cu. ft. jP—175 cu. ft.
No. of trees: 1″ + 3175, 4″ + 585.
Basis: 4 plots.

B: F site—Black spruce (larch) stand.
Age: 56 years. Basal area: 140 sq. ft. (121–153 sq. ft.).
Merch. volume: bS—365 cu. ft. tL—175 cu. ft. jP—35 cu. ft.
No. of trees: 1″ + 3650, 4″ + 525.
Basis: 6 plots.

C: F site—Black spruce stand.
Age: 170 years (overmature). Basal area: 67 sq. ft. (56–76 sq. ft.).
Merch. volume: bS—935 cu. ft. tL—10 cu. ft.
No. of trees: 1″ + 640, 4″ + 390.
Basis: 3 plots.

D: Dry site—jack pine stand.

E: Moist site—jack pine stand.

F: Moist site—aspen-black spruce-white spruce stand.

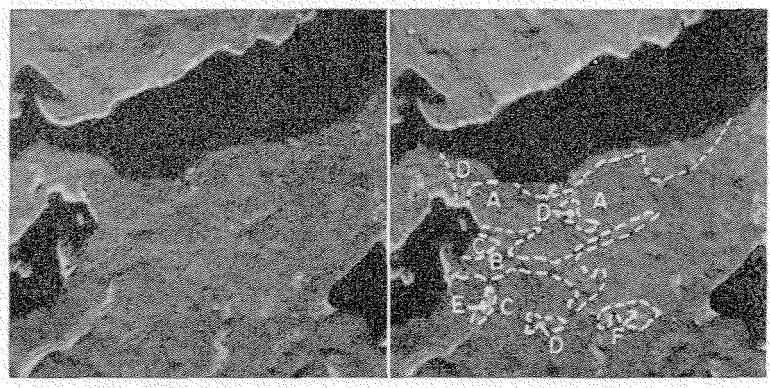

Figure 6. Black spruce stand—Little Bear Lake, Saskatchewan (Scale 1:15,840)

A: A site—Black spruce stand.
Age: 101 years. Basal area: 132 sq. ft.
Merch. Volume: bS—1115 cu. ft. jP—80 cu. ft.
No. of trees: 1″ + 2265, 4″ + 800.
Basis: 2 plots.

B: B site—Black spruce stand.
Age: 141 years. Basal area: 178 sq. ft.
Merch. volume: bS—3225 cu. ft.
No. of trees: 1″ + 975, 4″ + 840.
Basis: 2 plots.

C: A site—Black spruce stand.

D: B site—Black spruce stand.

E: A site—Largely white birch.

F: D site and wet meadow—Black spruce, larch and shrubs.

age rather than to site index. This procedure is considered reasonable, since the rate of stand development is not constant on all sites but varies with site. Thus, a ratio of site values to mean values for basal area, which, as shown herein, increases or decreases with age, would seem to be more accurate than one which remains constant with age and varies only with site index. The use of basal area (calculated from the intercept-per cent curves) together with the volume/density ratio to determine volume per acre for each site, is also considered reasonable, since the former is one of the three factors cross checked for all age classes on each site and the latter is correlated with age for each site.

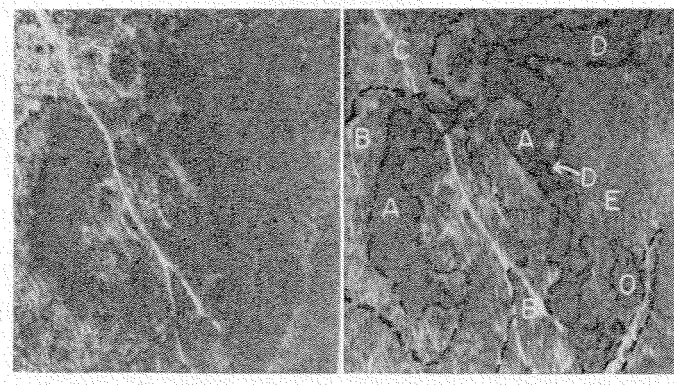

Figure 7. Black spruce and mixedwood stands, Eldridge Lake, near reserve, Saskatchewan (Scale 1:15,840)

A: B site—Black spruce stand.
Age: 131 years. Basal area: 162 sq. ft. (108–202 sq. ft.)
Merch. volume: bS—2240 cu. ft. wS—50 cu. ft.
No. of trees: 1" + 1685. 4" + 930.
Basis: 5 plots
B: Moist site—Cut-over white spruce-aspen stand.
C: Fresh site—Cut-over white spruce-aspen stand.
D: D site—Black spruce stand.
E: D site—Black spruce (larch) stand.

The sites described herein can be readily identified on the ground and on air photographs, and may be easily mapped. The preparation of maps based on these sites and yield tables will permit the identification of areas of highest productivity where a more intensive silviculture may be profitably applied. Figures 5, 6 and 7 are stereo pairs of air photographs of several stands in this district at a scale of 1:15,840. On the photographs, sites and stands have been mapped and identified. For the black spruce stands, estimates of yield in basal area and merchantable cubic foot volume by site and age are provided.

In conclusion, it would appear that the techniques used could be employed in preparing tables for other species in even-aged stands or other physiographically or ecologically defined sites in this and other areas, with a minimum plot data.

SUMMARY

Empirical yield tables were prepared for even-aged black spruce stands on four physiographically defined sites for four forest sections (Rowe 1959) of Manitoba and Saskatchewan. The sites were sampled by 167 one-fifth-acre sample plots. The site classification was adapted from Hills (1950, 1952) and the site descriptions include soil, vegetational and topographical features.

The paper describes in detail the method used in preparing the tables; it includes a modification of the basic method used in preparing normal yield tables. Figures and tables provide a step-by-step outline.

Dominant height/age curves, given for each site, illustrate the differences between sites in rate of height growth. These curves and the yield tables also illustrate that assuming a uniform rate of stand development on all sites in mathematically defined normal yield tables may be unrealistic.

SOMMAIRE

L'auteur a dressé des tables empiriques de rendement au sujet de quatre peuplements équiennes d'épinette noire répartis en quatre sections forestières (Rowe, 1959) du Manitoba et de la Saskatchewan, délimitées d'après leur physiographie. Les sections furent réparties en 167 placeaux d'un cinquiéme d'acre. La classification a été faite selon la méthode adoptée par Hills (1950 et 1952) et la description des types forestiers comprend des données sur la nature du sol, la végétation et la topographie.

Suit une description détaillée de la méthode utilisée pour préparer les tables; cette méthode comporte notamment une modification apportée à la méthode classique de préparation de tables de rendement normales. Les chiffres et les tables esquissent la classification pas à pas.

Les courbes de hauteur dominante/âge des arbres de chaque type forestier font ressortir les différences de croissance en hauteur entre arbres croissant dans des stations différentes. Ces courbes et les tables de rendement démontrent aussi qu'il serait erroné de présumer que l'indice de croissance des arbres de n'importe quelle station serait uniforme, comme les tables normales de rendement calculé pourraient l'indiquer.

APPENDIX I

Common and Botanical Names of Tree Species Mentioned in Text

Common Name	*Botanical Name*
Aspen, trembling	*Populus tremuloides* Michx.
Birch, white	*Betula papyrifera* Marsh.
Cedar, eastern white	*Thuja occidentalis* L.
Fir, balsam	*Abies balsamea* (L.) Mill.
Pine, jack	*Pinus banksiana* Lamb.
Poplar, balsam	*Populus balsamifera* L.
Spruce, black	*Picea mariana* (Mill.) BSP.
Spruce, white	*P. glauca* (Moench) Voss
Tamarack	*Larix laricina* (Du Roi) K. Koch

APPENDIX II

Site A

The following profile is characteristic of a fresh clay loam stony till on moderately undulating topography. This is a bisequa grey wooded profile.

L :1″. Undecomposed feathermoss and leaf and twig litter.

F :3″. Light to dark brown, partly decomposed matted moss; charcoal and roots present.

Aep :0–3″. 10YR6/2.[6] Light brownish grey; sandy loam to loam; slightly stony; fine platy structure.

Bp :3–7″. 10YR5/6. Yellowish brown; sandy loam; slightly stony; fine platy structure.

Aegw :7–15″. 10YR6/3. Pale brown; loam; slightly stony; coarse platy structure.

Bt :15–22″. 10YR4/4. Dark yellowish brown; (darker on outside of aggregates) heavy clay loam; stony; subangular blocky structure.

BC :22–27″. 10YR4/3. Dark yellowish brown; clay loam; stony; weak subangular blocky structure.

C :27″+. 5Y5/3. Olive; clay loam; stony till pH 7.6.

Site B

The following profile is characteristic of a moist fine sand on level beach deposit. The profile is an orthic podzol.

L :1″. Undecomposed moss, needle and herbaceous litter and twigs.

F :5″. Light brown to black, partly decomposed moss, wood and leaf material; somewhat matted.

Ae :0–2″. 10YR5/2. Greyish brown; fine sand; fine gravelly, medium platy structure.

AB :2–5½″. 10YR4/2. Dark greyish brown; fine sand; fine gravelly, medium weak platy structure.

[6]Munsell Colour Chart

Site B (continued)

Bfg :5½–12½″. 10YR4/3. Dark brown; mottled; fine sand; stonefree; structureless.

BCg :12½–18½″. 5Y5/3. Olive; mottled; fine sand; stonefree; structureless.

Cg :18½″+. 5Y6/3. Pale olive; mottled; fine sand; stonefree; structureless; non-calcareous.

Site D

The following profile is characteristic of a wet poorly drained, shallow peat soil.

L :6″. Undecomposed sphagnum moss.

F :24″. Light brown partly decomposed sphagnum and other moss peat, to very dark brown decomposed moss peat. Roots present to about 12″ below surface.

H :6″. Black muck.

G :0″+. 10YR3/1. Very dark grey; occasionally blue grey or yellow green, coarse sand; stonefree; structureless.

Site F

The following profile is on an almost level, moist, coarse sand of beach origin.

L :½″. Undecomposed moss, occasionally needle and herbaceous litter.

F :4″. Light brown to dark brown partly decomposed moss, and some needles and herbaceous leaves; somewhat matted. Roots present.

H :T–1″. Black well decomposed organic matter.

Ae :0–3″. 10YR5/3–6/2. Greyish brown to light brownish grey; coarse sand; stonefree; structureless.

ABg :3–9½″. 10YR5/4. Yellowish brown; mottled; coarse sand; stonefree; structureless.

Bfg :9½–19″. 10YR4/4. Dark yellowish brown; strongly mottled (2.5YR4/4); coarse sand; stonefree; structureless.

Cg :19″+. 10YR6/3. Pale brown; slightly mottled; coarse sand; stonefree; structureless.

APPENDIX III

Summary of selected species by site and stand age class*

Site	A			B			F			D		
Age class	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+
Number of plots	7	13	6	6	25	18	0	49	6	2	15	12
TALL AND MEDIUM SHRUBS												
Vaccinium myrtilloides Michx.	5 b 2	5 b +1	4 b 1	3 a 1	3 a 1	2 a 1		3 a 1	3 a 1		2 a +1	1 a +
Rosa acicularis Lindl.	4 a 1	4 b 1	4 a 1	5 b 1	4 a 1	5 b 1		5 b 1	2 a 1		2 a 1	
Ledum groenlandicum Oeder	5 c 2	3 b +1	4 b +1	5 c +2	5 c 2	5 c +2		5 c 2	5 c +2	5 e 4	5 c +2	4 c 4
Viburnum edule (Michx.) Raf.	1 a +	3 a 1	3 a +	4 a 1	3 a 1	2 a +		1 a +	2 a +		1 a +	
Alnus rugosa (Du Roi) Spreng. var. americana		1 b +1	1 a +	3 a 1	2 a 1	3 a 1		2 a 1	4 b 1		3 a +1	3 a +1
Lonicera involucrata (Richards.) Banks				3 a 1	3 a 1	1 a +		1 a 1			1 a +	1 a +
L. villosa Michx.				4 b 1	3 a 1	1 a +		4 a 1	2 a 1		3 a 1	2 a +
Ribes hirtellum Michx.	1 a +	1 a +1		3 a 1	2 a +	2 a +		4 a 1	3 a +		3 a 1	1 a +
Salix spp.	1 a +	1 a 1		4 b 1	2 a 1	1 a 1		2 a 1	3 b 1	3 a +	3 a 1	2 a +
Cornus stolonifera Michx.					1 a +	1 a +		4 a +	3 a 1		3 a 1	1 a +
Potentilla fruticosa L.		1 a 1		2 a 1	1 a 1	1 a 1		4 b +1	1 a +		2 a 1	
Rhamnus alnifolia L. Her.				1 a +	1 a +	1 a +		2 a 1	3 a 1		2 a +	1 a +
Vaccinium angustifolium Ait.	1 a +	1 a +				1 a +		2 a 1	3 a 1		2 a +	2 a +
Ribes triste Pall.	1 a +	1 a +		1 a +	2 a 1	2 a +		2 a 1	3 a +		1 a +	
Betula glandulosa Michx.				1 a +	1 a 1	1 a +		1 a +	3 a 1	3 a 1	2 a 1	2 a 1
Salix myrtillifolia Anderss.		1 a +		3 b +1	1 a 1	1 a +		1 a +			1 a +1	
Kalmia polifolia Wang.		1 a +								5 b +1	1 a +	1 a +
Chamaedaphne calyculata (L.) Moench				1 a +				1 a +		5 c 3	1 a +	
TALL HERBS AND GRASSES												
Epilobium angustifolium L.	4 a 1	2 a +	1 a +	5 b 1	4 a 1	3 a 1		3 a 1	3 a +		3 a +	1 a +
Calamagrostis canadensis (Michx.) Beauv.		1 a +		3 b 2	1 a +	2 a 1		2 a 1	2 a +		3 b 1	3 b 1
Aralia nudicaulis L.	2 a +	1 a 1			1 a +	2 a 1		3 a 1	3 a +		2 a +	2 a +
Equisetum fluviatile L.					1 a +				3 a 1		1 a +	1 a 1
Achillea sibirica Lebed.		1 a +		3 a 1	1 a +	1 a +		1 a +			1 a +	
Petasites sagittatus (Pursh) A. Gray				1 a 1	1 a 1	1 a 1		1 a +	3 a 1		2 a 1	2 a 1
MEDIUM SHRUBS AND GRASSES LOW HERBS, GRASSES AND SHRUBS												
Cornus canadensis L.	5 c 2	5 c 2	5 c +1	5 c +1	4 b +1	5 c +1		5 c +1	4 c +1		4 b +1	3 a 1
Vaccinium Vitis-Idaea L. var. *minus* Lodd.	5 c 2	5 b 1	5 b 1	4 b 1	5 b 1	5 b +1		4 b 1	5 c 1	5 b 1	5 c +1	5 c 2
Linnaea borealis L var. *americana* (Forbes) Rehder	3 b 1	4 b 1	3 b 1	4 c +1	5 b 1	5 b 1		5 c 1	5 c 1		4 b 1	2 a 1
Lycopodium annotinum L.	5 b +1	3 b +1	3 a 1		1 a +	1 a +						
Maianthemum canadense Desf.	3 a 1	3 a 1	1 a +	2 a 1	3 a 1	2 a 1		4 b 1	3 a 1		3 a 1	2 a 1
Trientalis borealis Raf.	4 a +	2 a 1	1 a +	1 a +	2 a +	3 a 1		2 a 1	1 a +		2 a +	2 a 1

*For legend see page 31

Summary of selected species by site and stand age class (continued)

Site	A			B			F			D		
Age class	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+
Number of plots	7	13	6	6	25	18	0	49	6	2	15	12
MEDIUM SHRUBS AND GRASSES LOW HERBS, GRASSES AND SHRUBS Cont'd												
Petasites palmatus (Ait.) A. Gray	5 b +1	3 a +1	1 a +	5 c +1	5 b 1	5 b 1		5 b 1	2 a 1		3 a 1	2 a 1
Equisetum sylvaticum L.	5 b +1	3 a +	3 a +	1 a +	2 a 1	1 a 1		1 a 1	1 a 1		1 a 1	1 a 1
Lycopodium complanatum L.	3 a +	1 a +			1 a +	1 a +						
Goodyera repens (L.) R. Br. var. *ophioides* Fern.	2 a +	3 a 1	2 a +		2 a +	1 a +		1 a +	2 a +			
Geocaulon lividum (Richards.) Fern.		1 a +	3 b 1		2 a +	4 b 1			1 a +		1 a +	5 b 1
Lycopodium obscurum L.	3 a 1	1 a +				1 a +						
Grass spp.	3 a 1	2 a +				1 a +						
Rubus pubescens Raf.	1 a 1	1 a 1		3 b 1	3 a 1	4 b 1		5 b +1	4 c +1		5 b +1	3 a 1
Equisetum pratense Ehrh.		1 a +		3 a 1	4 a 1	5 b 2		3 a 1	3 b +1	3 a 1	4 b 2	5 b 2
E. scirpoides Michx.	1 a +	1 a +		3 b 1	4 b 1	3 a 1		4 b +1	3 a 2		3 a +1	2 a 1
Mitella nuda L.	1 a +	1 a 1		3 b 1	4 b 1	3 b +1		5 c +1	5 c +1		4 b +1	4 b 1
Aster ciliolatus Lindl.		1 a +		5 b +1	3 a 1	2 a 1		3 a 1	2 a +		1 a 1	
Galium boreale L.		1 a +		3 a 1	2 a 1	2 a 1		4 b 1	3 a 1		2 a +	
Fragaria virginiana Duchesne	1 a 1	2 a 1		5 b +1	3 a 1	2 a 1		4 b 1	2 a 1		2 a +	
Pyrola secunda L.		2 a +	1 a +	3 a +	3 a +	3 a +		2 a 1	4 b +		3 a 1	2 a 1
Mertensia paniculata (Ait.) G. Don	1 a +	1 a +		3 b 1	3 a 1	3 a 1		1 a +			1 a 1	1 a +
Viola renifolia A. Gray		1 a +		4 b 1	3 a 1	2 a +		3 a 1	3 a +		2 a 1	
Equisetum arvense L.		1 a +	1 a +	2 a 1	3 a 1	2 a 1		1 a 1		3 a 1	1 a +	2 a 1
Carex rostrata Stokes				4 b 1	3 b 1	3 b 1		3 b +1	3 b 2		3 b 2	4 b 2
Gaultheria hispidula (L.) Bigel.	2 a 1	1 a +	1 a 1		1 a 1	4 b 1		2 a 1	2 a 1		3 b 1	4 c +1
Smilacina trifolia (L.) Desf.				1 a +	1 a 1	2 a 1		2 a 1	1 a +	5 c +2	3 b +1	5 b 2
Carex disperma Dew.		1 a +		3 a 1	2 a 1	2 a 1		3 b 1	3 b 1		5 d 2	4 b +1
Rubus acaulis Michx.				3 a 1	1 a 1	2 a 1		1 a +	1 a +		2 a 1	1 a +
Arctostaphylos Uva-ursi (L.) Spreng.		1 a +		3 a 1	1 a +			1 a 1			1 a +	
Campanula rotundifolia L.		1 a +		3 a +	1 a +	1 a +		1 a +				
Vicia americana Muhl.		1 a +		3 a 1	1 a +						1 a +	
Agoseris glauca (Pursh) Raf.				3 a +	1 a +							
Galium trifidum L.		1 a +		3 a +	1 a +	1 a 1		1 a +	1 a +		1 a +	1 a +
Coptis groenlandica (Oeder) Fern.	1 a +	2 a 1	1 a +		1 a +	1 a +		3 b 1	2 a +		3 a 1	1 a +
Galium triflorum Michx.	1 a +	1 a +		1 a 1	1 a +	1 a +		4 a 1	2 a +		3 a 1	1 a +
Vaccinium oxycoccus L.					1 a +	1 a +		2 a 1	3 b 1	5 c 1	3 b 1	3 b 1
Caltha palustris L.					1 a +	1 a +		1 a +	3 a +		3 a 1	2 a 1
Eriophorum spissum Fern.									1 a +	5 c 1		1 a +
Carex spp.					1 a 1	1 a +		1 a 1	1 a 1	5 c 2	2 a +1	1 a +

Summary of selected species by site and stand age class (concluded)

Site	A			B			F			D		
Age class	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+	0–50	51–100	101+
Number of plots	7	13	6	6	25	18	0	49	6	2	15	12
MOSSES AND LICHENS												
Calliergonella schreberi (BSG.) Grout	5 c 3	5 c 3	5 e 3	5 d +2	5 e 3	5 d 3		5 e 3	4 d +2		5 d 3	5 e 4
Dicranum spp.	5 c +1	5 c +1	3 b 1	4 c +1	5 c 2	5 b +1		4 b +1	4 c 1		4 c +1	3 c 2
Hylocomium splendens (Hedw.) BSG.	4 b 2	5 d +2	5 e 3	4 c 2	5 e 3	5 d 3		5 d 2	3 c 3		4 c 2	4 c +2
Hypnum crista-castrensis Hedw.	4 b 1	5 d +2	5 e 3		4 c +2	4 c 2		1 a +	2 a 1		1 a +	2 b +1
Peltigera spp.	4 b 1	3 a 1	5 b 1	3 b 1	5 b 1	5 b 1		3 a 1	3 a 1		3 b 1	2 a 1
Cladonia spp.	5 c 2	3 b 1	3 b +	3 b 1	3 b 1	1 a +		2 a 1	2 a +	3 b 1	2 a 1	2 a 1
Polytrichum juniperinum Hedw.	5 c +1	3 b 1	3 a +	2 a 1	3 b 1	1 a 1		4 c 1	2 a +	3 a 1	4 b +1	3 b 1
Sphagnum spp.	3 a 1	1 a +	1 a 1	2 b 1	3 b 1	4 b 2		5 d +2	3 c +2	5 e 5	5 e 3	5 d 3
Thuidium recognitum (Hedw.) Lindb.	1 a 1			3 c 1	1 a +	1 a +		3 b 1	2 a +		2 b 1	1 a +
Aulacomnium palustre (Web. & Mohr) Schwaegr.	1 a +	1 a +		5 d +2	2 b +1	1 a 1		2 b +1	1 a 1		2 b 2	2 a +
Mnium spp.				1 a 1	1 a +	1 a +		1 a +	3 c +			1 a +
TREE SPECIES (regeneration)												
Picea mariana (Mill.) BSP.								1 a 1	3 a 1			2 a 1
Larix laricina (Du Roi) K. Koch						1 a +		1 a 1	3 a 1		1 a +	2 a 1
Populus tremuloides Michx.		1 a +										
P. balsamifera L.			1 a +	1 a 1	1 a +			2 a +	2 a 1		1 a +	
Abies balsamea (L.) Mill.	1 a +	1 a +			1 a +	1 a +		1 a +	1 a +		1 a +	1 a +

LEGEND

Constancy

5 Constantly present
4 Usually present
3 Often present
2 Occasionally present
1 Rare

The species listed above were selected on the basis of relative dominance—defined by the requirement for any species to have a constancy of 3 (41–60% of plots) in any one of the sites described.

Sociability

a Growing singly.
b Tuft, diameter of group less than half the maximum height of plant.
c Clump, diameter of group is half to twice the maximum height of the plant.
d Patch, diameter of group is 2 to 10 times the maximum height of the plant.
e Large patch, diameter of group is more than ten times the maximum height of the plant.

Cover abundance

5 Covering 76–100% of area
4 Covering 51–75% of area
3 Covering 26–50% of area
+2 Covering 16–25% of area
2 Covering 6–15% of area
+1 Covering 3–5% of area
1 Covering 1–2% of area
\+ Less than 1% or rare,

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