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YIELD ESTIMATES FOR PEATLAND BLACK SPRUCE IN NORTHEASTERN ONTARIO

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CATEGORY: Growth and yield
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INTRODUCTION

Approximately 50% of Ontario's black spruce (*Picea mariana* [Mill.] B.S.P.) stands occur on peatlands (Ketcheson and Jeglum 1972); these sites predominate in the Clay Belt of northeastern Ontario. Although normal yield tables for black spruce (and other boreal species) were prepared by Plonski (1974), they were based on provincewide data encompassing the full range of sites on which black spruce is the dominant species.

Productivity on peatlands may be significantly less than on better drained sites due to excess moisture, poor aeration, and inadequate nutrient availability (McEwen 1969, Payandeh 1973). Recognizing a need for more specific growth and yield information for this important landscape type, the Canadian Forest Service – Ontario developed a set of preliminary yield functions and tables for peatland black spruce in Ontario (Payandeh 1990). This technical note captures the highlights of that publication and facilitates use of the information it contains.

METHODS

In the early 1970s, 425 permanent growth plots were located in peatland black spruce stands in the Cochrane area (Fig. 1). The stands that were sampled covered a wide range of ages, densities, site indices, and other stand characteristics (*see* Table 1). Most of the plots were established in Forest Ecosystem Classification (FEC) Operating Groups (OGs) 11, 12, and 13; however, some were located in OGs 8, 9, and 14 (Jones et al. 1983). One-third of the plots were established near drainage ditches and about 70% of these were subsequently fertilized (*see* Frontline Technical Note 64).

Detailed mensurational data were collected on both an individual tree and stand basis. In addition, site characteristics were classified to provide a framework within which to develop empirical yield models for predicting both tree and stand volumes. Classes of site variables were aggregated into a small number of meaningful categories. In analyzing the data, both linear and nonlinear models were employed. While both model types produced equations with reasonably "good fit" (i.e., high R^2 values), the nonlinear models were chosen because of their flexibility and their ability to describe stand development over time.

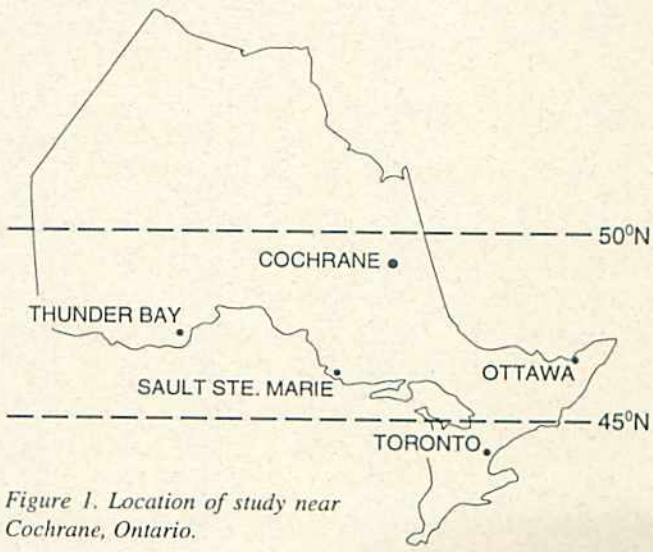

Figure 1. Location of study near Cochrane, Ontario.

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Table 1. Statistical summary of permanent growth plots of peatland black spruce in northeastern Ontario.

Stand characteristics	Minimum	Maximum	Mean	Coefficient of variation (%)
Diameter (cm)	2.88	26.54	12.16	39.91
Height (m)	2.84	17.96	9.14	29.62
Site index (m)	1.59	15.38	5.26	46.01
Age (years)	32	200	105	33.73
Density (trees/ha)	210	20,390	2,841	81.53
Total basal area (m^2/ha)	2.30	78.05	24.37	48.91
Merchantable basal area (m^2/ha)	0.00	64.28	18.39	71.92
Total volume (m^3/ha)	5.16	423.52	111.33	62.45
Merchantable volume (m^3/ha)	0.00	392.33	80.54	84.86

Table 2. Summary of nonlinear regression equations expressing peatland black spruce stand yield characteristics as a function of site index and stand age.

Yield characteristic	Regression equation	R^2	SEE
Stand height (m)	$H = 15.24\ S^{0.84}/(1 + e^{(6.16 - 0.972 \ln(A) - 0.009 \ln(S))})$	0.90	0.79
Density (trees/ha)	$N = 1395.7 + 2839\ S^{-2.82}(1 + e^{(8.9 - 1.86 \ln(A) + 1.95 \ln(S))})$	0.52	9.63
Total basal area (m^2/ha)	$BA_t = 40.9\ S^{-0.15}/(1 + e^{(18.78 - 3.16 \ln(A) - 3.4 \ln(S))})$	0.46	5.48
Merchantable basal area (m^2/ha)	$BA_m = 1.08\ BA_t^{0.98}/(1 + e^{(40.16 - 7.08 \ln(A) - 5.61 \ln(S))})$	0.93	3.16
Total volume (m^3/ha)	$V_t = 22.24\ S^{-0.053} BA_t^{0.97}/(1 + e^{(8.03 - 1.08 \ln(A) - 1.19 \ln(S))})$	0.98	7.96
Merchantable volume (m^3/ha)	$V_m = 0.83\ V_t^{1.02}/(1 + e^{(43.05 - 7.56 \ln(A) - 6.14 \ln(S))})$	0.98	8.94

N = stand density (trees/ha)
S = site index (height in m at age 50)
BA_m = merchantable basal area (m^2/ha)
V_m = merchantable volume (m^3/ha)
A = age (years)
BA_t = total basal area (m^2/ha)
V_t = total volume (m^3/ha)

Tables 3, 4, and 5 show preliminary estimates of yield generated from the equations in Table 2, for site indices 3, 6, and 9 m, respectively. For example, given a site index of 6 m and a stand age of 70 years, Table 4 provides the following stand image: density = 3034 trees/ha; dbh = 9.45 cm; height = 8.12 m; basal area (trees ≥ 10 cm dbh) = 10.93 m^2/ha; and volume (trees ≥ 10 cm dbh) = 38.98 m^3/ha.

Table 3. Preliminary estimates of yield per hectare for peatland black spruce stands in northeastern Ontario (site index 3 m).

Stand age (yrs)	Density (trees/ha)	DBH (cm)	Height (m)	Basal area (m^2/ha) of trees >1.5 cm dbh	Basal area (m^2/ha) of trees ≥10 cm dbh	Volume (m^3/ha) of trees >1.5 cm dbh	Volume (m^3/ha) of trees ≥10 cm dbh
20	31,959	0.23	1.45	0.13	0.00	0.09	0.00
30	15,841	0.61	2.12	0.47	0.00	0.49	0.00
40	9,908	1.21	2.75	1.14	0.00	1.52	0.00
50	7,060	2.00	3.36	2.23	0.00	3.59	0.00
60	5,468	2.97	3.94	3.78	0.03	7.09	0.03
70	4,485	5.04	4.50	5.76	0.13	12.29	0.16
80	3,834	5.18	5.05	8.08	0.44	19.26	0.67
90	3,379	6.32	5.57	10.61	1.23	27.88	2.28
100	3,049	7.43	6.08	13.21	2.86	37.87	6.22
110	2,802	8.46	6.56	15.76	5.54	48.84	13.92
120	2,611	9.41	7.04	18.14	9.10	60.41	25.84
130	2,460	10.25	7.50	20.32	13.00	72.23	40.84
140	2,340	11.00	7.94	22.26	16.71	84.04	56.97
150	2,242	11.66	8.37	23.95	19.91	95.65	72.68

Table 4. Preliminary estimates of yield per hectare for peatland black spruce stands in northeastern Ontario (site index 6 m).

Stand age (yrs)	Density (trees/ha)	DBH (cm)	Height (m)	Basal area (m^2/ha) of trees >1.5 cm dbh	Basal area (m^2/ha) of trees ≥10 cm dbh	Volume (m^3/ha) of trees >1.5 cm dbh	Volume (m^3/ha) of trees ≥10 cm dbh
20	18,067	0.92	2.62	1.21	0.00	1.63	0.00
30	9,248	2.33	3.82	3.95	0.01	7.52	0.01
40	6,002	4.19	4.96	8.27	0.16	19.98	0.27
50	4,443	6.15	6.06	13.20	1.17	38.33	2.70
60	3,572	7.94	7.11	17.70	4.62	59.74	13.73
70	3,034	9.45	8.12	21.29	10.93	81.55	38.98
80	2,678	10.67	9.10	23.96	17.53	102.28	70.79
90	2,429	11.65	10.04	25.88	22.34	121.43	89.97
100	2,249	12.42	10.96	27.25	25.35	138.98	121.46
110	2,113	13.04	11.84	28.24	27.20	155.10	139.68
120	2,009	13.55	12.69	28.96	28.36	169.99	155.08
130	1,926	13.96	13.52	29.48	29.12	183.83	168.56
140	1,860	14.30	14.32	29.88	29.64	196.79	180.68
150	1,807	14.58	15.10	30.18	30.02	208.99	191.75

Table 5. Preliminary estimates of yield per hectare for peatland black spruce stands in northeastern Ontario (site index 9 m).

Stand age (yrs)	Density (trees/ha)	DBH (cm)	Height (m)	Basal area (m^2/ha) of trees >1.5 cm dbh	Basal area (m^2/ha) of trees ≥10 cm dbh	Volume (m^3/ha) of trees >1.5 cm dbh	Volume (m^3/ha) of trees ≥10 cm dbh
20	13,104	1.98	3.70	4.06	0.01	7.77	0.01
30	6,907	4.46	5.39	10.77	0.26	28.91	0.55
40	4,626	6.92	7.01	17.39	2.80	59.17	8.65
50	3,531	8.90	8.55	21.99	10.62	89.86	42.14
60	2,918	10.40	10.04	24.80	19.19	117.36	87.64
70	2,540	11.47	11.47	26.48	24.13	141.46	122.19
80	2,290	12.36	12.85	27.50	26.51	162.76	146.83
90	2,115	13.01	14.18	28.14	27.69	181.90	166.07
100	1,988	13.52	15.47	28.55	28.34	199.32	182.22
110	1,893	13.93	16.71	28.84	28.72	215.36	196.37
120	1,820	14.25	17.91	29.03	28.96	230.02	209.06
130	1,762	14.52	19.08	29.17	29.13	244.16	220.60
140	1,715	14.74	20.21	29.27	29.24	257.22	231.19
150	1,678	14.93	21.30	29.35	29.32	269.52	240.96

Note: The yield tables are in close agreement with work by Evert (1967) and produce growth patterns similar to those developed for northern Minnesota (Perala 1971).

RESULTS AND DISCUSSION

Table 2 provides a summary of nonlinear regression equations expressing peatland black spruce stand yield characteristics as a function of site index and stand age. As an example of the output generated by these equations, Figure 2 shows stand development as a function of age for a typical peatland black spruce stand (site index 5 m).

MANAGEMENT IMPLICATIONS

This set of yield functions and empirical yield tables was developed for black spruce stands in northeastern Ontario. While similar to earlier work by Plonski (1974), this information is specific to peatland black spruce in northeastern Ontario. Thus it represents a refinement of the provincewide normal yield tables previously available. Though the yield information presented is preliminary in nature, foresters should find it useful in managing Ontario's lowland black spruce resource.

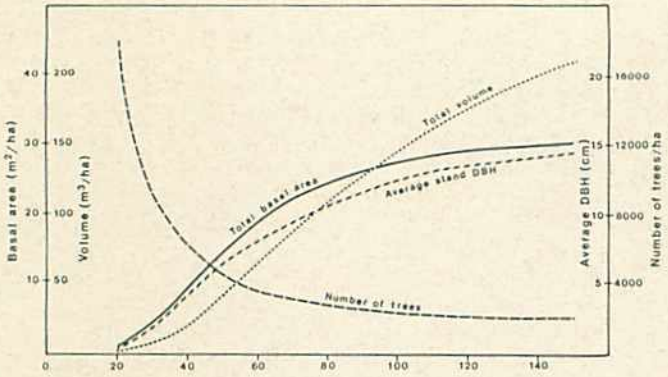

Figure 2. Plot of main yield components against stand age for peatland black spruce in northern Ontario (site index 5 m). Source: Payandeh (1990).

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Bob Haig, a retired former deputy regional director of the Canadian Forest Service – Ontario, prepared this technical note under contract.

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