Plonski's (metric) yield tables formulated

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Abstract

A four-parameter sigmoidal growth model was employed to express various characteristics of interest in Plonski's metric yield tables as functions of stand age and site index. Except in a few cases, excellent fits were obtained. The resulting equations will facilitate direct computer use of Plonski's metric yield tables.

Résumé

Un modèle de croissance sigmoïdale à quatre paramètres a été utilisé pour exprimer diverses caractéristiques intéressantes des tables métriques de rendement de Plonski, en fonction de l'âge du peuplement et de la qualité du site. À l'exception de quelques cas, une adéquation excellente ont été obtenue. Les équations qui en résultent faciliteront l'utilisation directe par l'ordinateur des tables métriques de rendement de Plonski.

Introduction

Plonski (1956, 1960, 1974) constructed normal yield tables for the major forest types in Ontario: black spruce (*Picea mariana* [Mill.] B.S.P.), jack pine (*Pinus banksiana* Lamb.), aspen (*Populus tremuloides* Michx.), white birch (*Betula papyrifera* Marsh.), red pine (*Pinus resinosa* Ait.), white pine (*Pinus strobus* L.), and tolerant hardwoods. Plonski (1956) gave a detailed account of the construction and use of his tables.

Despite their shortcomings, normal yield tables have been used extensively in forest-management and economic-evaluation research and as a basis for management-planning inventories. This is particularly true of Plonski's yield tables in Ontario. However, these tables were constructed on the basis of balanced and harmonized curves; i.e., no equations were given for them. Thus, to utilize the tables, it is necessary to look up or interpolate values for given variables individually from the appropriate tables or graphs. Payandeh (1973) formulated Plonski's Imperial yield tables by means of stepwise multiple linear regression analysis. The purpose of this note is to present similar information for Plonski's metric yield tables so as to facilitate computer processing and to expedite interpolation between table values.

Methods

For each species, values for various characteristics of interest, such as stand age, height, basal area, diameter, number of trees, gross total volume, etc., were read directly from the appropriate tables. A four-parameter nonlinear model was used to express each stand characteristic of interest as a function of stand age and site index:

$$Y = B_1 S^{B_2} (1 - e^{B_3 A})^{B_4} + E$$

where: Y = a characteristic of interest such as stand height, average diameter, basal area, number of trees, total gross volume, etc.

S = site index (m) at index age 50 years,

A = stand age (years),

e = base of natural logarithms

B_1, B_2, B_3, B_4 = model parameters to be estimated,

E = error term of the model

Results

The estimated parameters of the above model for the various characteristics of interest for the seven species are summarized in (Table 1). With a few exceptions (the R^2 values for basal area per hectare for all species except for aspen and white birch, and the number of trees per hectare for aspen were between 0.92 and 0.96), these equations provide very good approximations ($R^2 \geq 0.98$) of the tabular values.

References

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Table 1. Estimated parameters for various characteristics of interest for the seven species in Plonski's (metric) yield tables

Characteristic of interest	B ₁	B ₂	B ₃	B ₄
<i>Black spruce</i>				
Height (m)	4.294	0.670	-0.021	1.762
DBH (cm)	4.926	0.604	-0.019	1.632
No. trees/ha	6100.858	-0.695	-0.009	-1.208
BA (m ²)	18.009	0.369	-0.033	2.452
Gross vol. (m ³), main stand	51.472	0.830	-0.027	3.413
Gross vol. (m ³), total production	53.025	0.925	-0.024	3.196
Gross merch. vol. (m ³)	12.895	1.377	-0.030	8.050
Merch. vol. (m ³) to 7-cm DBH	31.082	1.004	-0.032	5.976
<i>Jack pine</i>				
Height	1.393	0.980	-0.039	1.794
DBH (cm)	1.347	1.003	-0.037	2.274
No. trees/ha	17415.646	-1.259	-0.021	-2.490
BA (m ²)	5.050	0.596	-0.071	1.511
Gross vol. (m ³), main stand	4.555	1.437	-0.045	2.455
Gross vol. (m ³), total production	7.065	1.429	-0.039	2.767
Gross merch. vol. (m ³)	1.984	1.690	-0.062	8.070
Merch. vol. (m ³) to 7-cm DBH	2.563	1.611	-0.068	8.015
<i>Aspen</i>				
Height	1.719	0.928	-0.033	1.516
DBH (cm)	2.181	0.984	-0.013	1.184
No. trees/ha	48549.530	-1.383	-0.039	-2.88
BA (m ²)	6.856	0.556	-0.035	1.35
Gross vol. (m ³), main stand	7.655	1.323	-0.042	3.422
Gross vol. (m ³), total production	6.962	1.446	-0.038	3.453
Gross merch. vol. (m ³)	5.043	1.412	-0.057	8.127
Merch. vol. (m ³) to 7-cm DBH	5.647	1.408	-0.047	4.606
<i>White birch</i>				
Height	1.035	1.068	-0.051	2.752
DBH (cm)	0.418	1.414	-0.035	2.447
No. trees/ha	54382.856	-1.568	-0.025	-2.459
BA (m ²)	1.987	0.919	-0.066	3.746
Gross vol. (m ³), main stand	2.476	1.604	-0.059	5.293
Gross vol. (m ³), total production	2.811	1.646	-0.053	5.106
Gross merch. vol. (m ³)	0.137	2.534	-0.067	12.352
Merch. vol. (m ³) to 7-cm DBH	0.535	2.109	-0.070	12.424
<i>Tolerant hardwoods</i>				
Height	2.780	0.801	-0.030	1.914
BA (m ²)	6.231	0.646	-0.038	3.135
Gross vol. (m ³), main stand	20.129	1.103	-0.020	2.401
Gross merch. vol. (m ³)	11.719	1.191	-0.027	4.165
<i>White pine</i>				
Height (m)	4.881	0.698	-0.024	2.257
BA (m ²)	20.470	0.272	-0.047	1.441
Gross vol. (m ³), main stand	58.978	0.851	-0.024	2.445
Gross merch. vol. (m ³)	34.780	1.010	-0.028	4.000
<i>Red pine</i>				
Height	1.472	0.999	-0.027	1.332
BA (m ²)	18.008	0.317	-0.052	2.097
Gross vol. (m ³), main stand	16.496	1.182	-0.034	2.285
Gross merch. vol. (m ³)	6.348	1.473	-0.038	3.547