Home

Scientia Silvica
Extension Series, Number 41, 2000

Western Larch Site Index in Relation to Ecological Measures of Site Quality

Introduction

A silviculturist needs to know how productivity of all tree species under management varies with the ecological determinants of site quality, *i.e.*, the environmental factors that directly affect the growth of plants - light, heat, soil moisture, soil nutrients, and soil aeration. A good understanding of this variation is necessary for making biologically viable, species- and site specific silvicultural decisions. Productivity of a given species is usually measured by site index (top tree height at 50 years at breast height age). Quantified relationships between site index of a given species and ecological measures of site quality provide predictive models for estimating site index for all sites on which the species may grow.

Western larch (*Larix occidentalis* Nutt.) is an important tree species in southern central and eastern British Columbia. It grows mainly in the IDF, ICH, and MS zones on moderately dry through very moist sites and on poor through very rich sites. In view of this relatively wide ecological amplitude, a large variation in productivity could be expected. In the study summarized here, relationships between larch site index and selected ecological measures of site quality were examined, and a site index model using these measures as predictors was developed.

Study stands and Procedure

The study area encompassed the entire native range of larch in BC. The stands selected for the study had regenerated naturally after a major disturbance, typically wildfires, and were deliberately selected across the widest range of climatic (biogeoclimatic subzones), soil moisture, and soil nutrient conditions. The stands were unmanaged, uniformly and fully stocked, even-aged (ranging from 40 to 160 yrs at @ bh), and without signs of obvious damage or suppression.

A 0.04 ha plot was established in each of the 315 study stands, the three largest diameter trees were cut and sectioned, and site index was determined from stem analysis data. An average height curve was computed for each species from sampled site trees for each study plot using Richard's three-parameter equation and linear interpolation technique; the actual site index for each plot was then calculated as the average true height of site trees using the fitted equation. Allocation of stands into biogeoclimatic subzones was done according to biogeoclimatic maps. Soil moisture regime (SMR) and soil nutrient regime (SNR) were estimated using a combination of topographic and soil morphological properties as well as understory vegetation.

Descriptive statistics were used to examine the relationship between site index and inferred climatic, soil moisture, and soil nutrient regimes. Inferential statistics were used to evaluate the strength of these relationships and site index predictions, and the model was cross-validated using independant data. To detect the strongest climatic influence on height growth, only stands on zonal sites were examined. This study is the first to examine the effect of SNR and SMR interaction on larch site index.

Results and Discussion

Regional climate did influence site index of larch on zonal sites, with significant differences ($\alpha = 0.05$) occurring between two subzone groups: low-precipitation IDF subzones and high-precipitation ICH and MS subzones. However, when comparing the zonal sites with equivalent soil moisture, no significant differences in site index were detected on very dry, moderately dry, and slightly dry sites between study subzones. Thus, it was concluded that precipitation, not temperature, limits growth of larch in the study area. Consequently, subzone was not considered a useful predictor of larch site index.

Larch site index significantly increased from water-deficient to moist sites and decreased from moist to wet sites. On water-deficient sites, it increased from very poor to very rich sites; estimates of both actual SMR and SNR had both significant and consistent positive effects on site index on these sites. On sites where water was not deficient, the influence of SNR appeared to be marginal.

A cross-validated prediction model based on field-estimated actual SMR and SNR accounted for 84% of the variation in western larch site index:

$$SI = 7.9 + 0.0(ED) + 4.8(VD) + 8.4(MD) + 10.8(SD) + 12.5(F) + 14.1(M) + 7.3(VM) + 7.4(W) + 0.0(VP) + 1.1(P) + 3.4(MD) + 4.5(R) + 4.7(VR)$$

Adjusted $R^2 = 0.84$ SEE = 1.5 MSE = 2.1

where: ED - excessively dry, VD - very dry, MD - moderately dry, SD - slightly dry, F - fresh, M - moist, VM - very moist, W - wet, VP - very poor, P - poor, MD - medium, R - rich, VR - very rich, SEE - standard error of the estimate, MSE - mean square error.

When predicted values were compared to measured values on the test data set (n = 105), the constructed model (n = 210) proved unbiased in predicting site index. A paired t-test (α = 0.05) showed the regression model predicted a site index that did not differ significantly from the mean site index of the test data set. The mean difference was 0.09 m between the predicted and measured site index (*p* = 0.55). Plotted prediction error values also indicated no bias in site index prediction, and showed that the model estimates of the test data site index were usually within ±3m of the actual measured values. The developed model, using field estimates of SMR and SNR, can be used to provide site index predictions for western larch throughout its range in BC to a satisfactory level of accuracy.

Table 1. Edatopic grid showing the predicted site index values (m @ 50 yr bh) using the SMR-SNR model (n=315), ±95% confidence interval (m), measured mean site index, and SIBEC mean site index values according to actual SMR and SNR. Sample sizes indicated refer only to the measured and predicted site index values.

Actual SMR	Number of plots (n) and site index	SNR: Very poor	Poor	Medium	Rich	Very rich
Excessively dry	n	3	0	0	0	0
	Predicted	8.6±1.7	9.2	11.5	12.7	13.0
	Measured	8.6	ND[3]	ND	ND	ND
	SIBEC[1]	NA[2]	NA	NA	NA	NA
Very dry	n	6	14	8	2	0
	Predicted	13.2±0.6	13.8±0.8	16.1±0.9	17.3±0.7	17.5
	Measured	13.2	14.3	15.4	16.6	ND
	SIBEC	NA	18.0	17.0	18.6	NA
Moderately dry	n	0	45	44	6	0
	Predicted	16.7	17.4±0.5	19.6±0.5	20.8±0.5	21.1
	Measured	ND	17.2	19.9	20.8	ND
	SIBEC	NA	19.6	18.8	20.1	23.7
Slightly dry	n	0	52	58	28	0
	Predicted	19.2	19.9±0.3	22.2±0.5	23.3±0.7	23.6
	Measured	ND	19.9	21.9	23.7	ND
	SIBEC	NA	23.4	23.0	21.0	19.2
Fresh	n	0	0	18	11	5
	Predicted	20.9	21.5	23.8±0.5	25.0±0.6	25.2±1.1
	Measured	ND	ND	21.9	23.7	25.6
	SIBEC	NA	22.9	23.7	21.9	27.0
Moist	n	0	0	1	2	5
	Predicted	22.5	23.1	25.4±1.3	26.6±1.3	26.8±1.1
	Measured	ND	ND	26.5	26.2	26.8
	SIBEC	NA	18.9	24.8	24.1	20.0
Very moist	n	0	0	0	4	1
	Predicted	16.1	16.7	19.0	20.2±1.3	20.4±2.9
	Measured	ND	ND	ND	20.6	18.7
	SIBEC	NA	NA	22.3	22.5	25.2
Wet	n	0	0	0	1	0
	Predicted	16.3	17.0	19.2	20.4±1.6	20.7
	Measured	ND	ND	ND	20.4	ND
	SIBEC	NA	NA	NA	NA	NA

[1]SIBEC (Site Index Estimates by Site Series for Coniferous Tree Species in British Columbia 1997).
[2]NA - SIBEC estimate *not available.*
[3]ND - *no data* were obtained due to the absence or sporadic occurrence of western larch under some edaphic conditions.

Reference

New, D. 1999. Productivity of western larch in relation to categorical measures of climate, soil moisture, and soil nutrients. M.Sc. Thesis. Department of Forest Sciences, University of British Columbia, Vancouver, BC.

Scientia Silvica is published by the Forest Sciences Department, The University of British Columbia, ISSN 1209-952X

Editor: K. Klinka (klinka@interchange.ubc.ca)
Research: D. New (thenews@jetstream.net)
Production and design: C. Chourmouzis (chourmou@interchange.ubc.ca)
Financial support: National Science and Engineering Research Council, Weyerhouser Canada, Ltd., and Cranbrook Forest Industries, Ltd.
For more information contact: David New (thenews@jetstream.net)

Copies available from: www. forestry.ubc.ca/klinka or K. Klinka, 3036-2424 Main Mall, Forest Sciences Department, UBC, Vancouver, BC, V6T 1Z4