Scientia Silvica

Extension Series, Number 40, 2001

Influence of Salal on Height Growth of Coastal Douglas-fir

Introduction

The influence of salal on tree growth has attained considerable attention in coastal British Columbia. Field observations, surveys, and studies in the CWH zone have indicated poor growth performance of crop tree species in salal-dominated plantations and natural immature and old-growth stands. Where sites have been burned and planted, tree growth has improved; similar effects have been observed for naturally regenerated stands. Immature stands that developed after wind disturbance or harvesting feature rapid growth and nearly complete absence of salal. As studies have shown that ericaceous plants negatively impact tree growth, the salal on potential harvest sites has been considered undesirable.

This study examined (1) the possible influence of salal on the stand, soil nutrient status and site index, and (2) the relations between site index, salal, plant communities, and site in disturbed, immature, coastal Douglas-fir ecosystems. We compared vegetation and environmental characteristics of 101 ecosystems, and examined differences in foliar and soil nutrient characteristics and site index between stands with high and low salal cover through analysis of variance (ANOVA) and regression analysis.

Study Stands and Methods

All study stands were located within the very dry and dry maritime subzones of the CWH zone on eastern Vancouver Island and the adjacent mainland across a wide range of elevations, aspects, and soil conditions. The stands were located in even-aged immature Douglas-fir stands with a relatively wide age range (18 to 69 yrs) and stocking (400 to 900 stems ha^{-1}), and without a history of damage. All stands had similar management history: slashburning, planting to Douglas-fir, and pre-commercial thinning.

In each stand, a 20 x 20 m plot was located to represent an individual ecosystem with relatively uniform vegetation and soil. Vegetation and environment of each plot were described, and the relative soil moisture regime (SMR) and soil nutrient regime (SNR) were estimated in the field. The relative SMRs were converted to actual SMRs using actual evapotranspiration and water balance.

In each plot, the five largest diameter trees of the study species were measured for age at 1.3 m and top height. Site index was taken from height growth tables. On each plot the current year's foliage from the upper crown of 15 dominant trees was sampled and analyzed for total nitrogen. Samples of forest floor and the top 30 cm of mineral soil were taken at each plot, air-dried, and analyzed for a number of nitrogen-related properties.

Results and Discussion

In order to examine the possible effects of salal on the stand, and soil nutrient status and site index, it was necessary to consider only groups of plots with the same site conditions in order to eliminate variation due to external influences on tree growth. Based on a comparison of the site characteristics for each vegetation unit (Table 1), we used plots from the Oregon grape unit (where salal had a 60% cover) and the Moss unit (where salal had 15% cover) as these two units had similar soil properties. We selected from each unit 15 plots such that each plot had the same regional climate (biogeoclimatic subzone), moderately dry SMR, and poor SNR. All these plots are considered to have similar site quality and vegetation potential.

Table 1. Means and standard deviations (in parentheses) of selected stand and soil characteristics of the study stands stratified according to vegetation units. SMR categories: VD – very dry, SD – slightly dry, F – fresh, M – moist; SNR categories: VP – very poor, P – poor, M – medium, R – rich, VR – very rich.

Vegetation unit Characteristic	(1) Lichen n = 13	(2) Salal n = 26	(3) Oregon grape n = 26	(4) Sword fern n = 30	(5) Salmonberry n = 6
Douglas-fir site index (m)	21 (2.3)	28 (3.3)	28 (3.5)	33 (2.3)	34 (2.9)
Mean cover of salal (%)	85	60	15	7.5	0.7
SMR	VD	MD – SD	MD – F	SD – F	M
SNR	VP - P	VP – M	VP – M	P – R	R - VR

The major difference between the two sets of plots was salal cover. Data from these 30 plots were then used to test two hypotheses: (1) salal competes successfully against Douglas-fir for both available soil water and nutrients, and (2) there is a strong relationship between the salal cover and Douglas-fir site index on these moderately dry and poor sites.

In the absence of significant differences in soil moisture and nutrient characteristics, it might be expected that there were no significant differences between high- and low-cover salal sites in the foliar nutrient levels in the Douglas-fir trees. This was actually found when the foliar nutrient levels were compared (p <0.05; Table 2). There were also no significant differences in Douglas-fir site index. When the results of these comparisons are taken into account, it appears that, on environmentally-equivalent sites, high salal cover did not adversely affect Douglas-fir height growth.

Table 2. Mean foliar nutrient concentrations (by dry weight) of the Douglas-fir trees in 15 environmentally equivalent plots in each of the Salal and Oregon grape vegetation units. Standard deviations are in parentheses.

Nutrient element	Salal plots (n = 15)	Oregon grape plots (n = 15)
Mass of 100 needles (mg)	472 (79)	492 (71)
Nitrogen (%)	1.17 (0.078)	1.17 ((0.116)
Phosphorus (%)	0.209 0.036)	0.199 (0.042)
Calcium (%)	0.397 (0.067)	0.414 (0.047)
Magnesium (%)	0.130 (0.022)	0.129 (0.014)
Potassium (%)	0.689 (0.080)	0.687 (0.070)
Sulphate-sulphur (ppm)	325 (135)	312 (133)
Zinc (ppm)	19.4 (3.87)	20.5 (2.47)
Manganese (ppm)	547 (327)	499 (257)
Boron (ppm)	19.5 (8.82)	21.9 (5.87)
Active iron (ppm)	42.0 (11.5)	39.0 (12.9)

Salal understory can account for a large fraction of stand water consumption, especially towards the latter part of the dry period in late July and August. Because Douglas-fir develops terminal buds approximately at the onset of this drought, subsequent soil water deficits, possibly exacerbated by salal water consumption, are not likely to have a significant influence on height growth, *vis-à-vis* site index. This could explain the failure of this study to find significant differences in Douglas-fir site index between the high and low salal cover sites.

The frequency and mean cover of salal decreased from up to 100% in the salal unit to as low as 0.6% in the Lichen and Salmonberry units. If salal exerted a profound influence on forest productivity, then a significant relationship would be expected between its cover and site index. To test this hypothesis, we examined the relationship between Douglas-fir site index and salal cover across all 101 study plots. A simple linear regression of site index on salal cover produced the following equation:

[1] SI = 32.44 - 0.71(mid-point percent salal cover) $R^2 = 0.23$, SEE= 4.45 m

where SI = site index (m @ 1.3m age 50) and SEE = standard error of the estimate.

Although statistically significant (p <0.01), the equation explained only a small amount of the variation in Douglas-fir site index across a wide range of sites. This regression appears to reflect the relationship between salal and humus form quality, in that salal cover generally decreased as the humus from changed from Mor to Moder to Mull progressively from Lichen through Salmonberry units.

Multiple linear regression of site index on vegetation unit produced the following equation (where VU1 through VU4 are dummy variables):

$$[2]\ SI = 34.3 - 13.2(VU1) - 5.8(VU2) - 6.45(VU3) - 0.87(VU4) \qquad R^2 = 0.67,\ SEE = 2.94\ m$$

Equation [2] explained a greater amount of the variation in Douglas-fir site index than equation [1] as it quantified the relationships between site quality (as reflected by plant communities) and forest productivity. Climate, SMR, and SNR are used to differentiate among environmentally equivalent sites. In order to determine whether these variables have stronger relationships than plant communities, the relationship between site index, SMR and SNR was examined. Climate was not included as study plots were distributed within the same regional climate. Multiple linear regression produced the following equation:

$$[3]\ SI = 35.5 - 7.5(VD) - 1.72(MD) + 3.33(F) - 9.10(VP) - 5.03(M) - 1.75(R) \qquad R^2 = 0.86,\ SEE = 1.99\ m$$

where VD - very dry, MD - moderately dry, and F - fresh are dummy variables for SMRs; VP - very poor, M - medium, and R - rich are dummy variables for SNRs.

Thus, variables representing the SMRs and SNRs were better predictors of site index than plant species or plant community variables. This suggests that SMR and SNR are site factors that directly affect plant growth and offer a simple means of characterizing site quality and explaining forest productivity. Although understory vegetation may provide a good indication of site quality and can influence forest floor formation and decomposition rate through above- and below-ground litter production, such vegetation is usually an expression, rather than a determinant, of site quality.

Conclusions

There were (i) few significant differences in soil and foliar chemical properties between the high and low salal-cover ecosystems having similar climate, SMR, and SNR, and (ii) poor relationships between Douglas-fir site index and salal cover. Much stronger relationships were obtained using variables representing vegetation units or SMR and SNR. Our results imply that salal may not significantly affect height growth in immature Douglas-fir stands on moderately dry and nutrient poor sites in dry cool mesothermal climates of southern coastal BC.

Reference

Klinka, K., R.E. Carter, M.C. Feller, and Q. Wang. 1989. Relations between site index, salal, plant communities, and sites in coastal Douglas-fir ecosystems. Northwest Science 63: 19-28.

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

Editor: Karel Klinka (klinka@interchange.ubc.ca)
Research: R.E. Carter (ReidCarter@NBFinacial.com), Q. Wang (charlw@mail.sy.ln.cn), M.C. Feller (feller@interchange.ubc.ca), and K. Klinka
Production and design: Christine Chourmouzis (chourmou@interchange.ubc.ca)
Financial support: Canadian Forestry Services and BC Ministry of Forests under the Canada-British Columbia Forest Resource Development Agreement, Extension, Demonstration, and Research, and Development Sub-program (1985-1990).
For more information contact: R.E. Carter

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