EXTENSION NOTE

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NELSON FOREST REGION

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How Light Conditions Affect Tree Seedling Performance in the Interior Cedar-Hemlock Subzone: Preliminary Results—EP 1191

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■ **Preliminary study results indicate that the pattern of height growth of all ten tree species is similar to the pattern of ambient light levels found across the light gradient. However, seedling survival appears to be fairly consistent across the light gradient except at very low levels of light (<20% above canopy light).**

INTRODUCTION

In 1994, the Forest Sciences Section of the Nelson Forest Region initiated a study to see how ambient light conditions affect the survival and growth of tree seedlings. The study examined the performance of seedlings across a gradient of light conditions, ranging from "low" light conditions under an undisturbed canopy, to "high" light conditions (full sun) in a clearcut.

With funding from Forest Renewal BC, the study was developed in response to increasing interest in the use of partial cutting systems, and to the lack of information available about the development of various tree species, relative to other species, in non-clearcut environments.

The study is now in its fifth growing season. This Extension Note describes the design, implementation, and three-year results of the study.

OBJECTIVES

The specific objectives of the study are to:

1. Characterize the micro-environments along the gradient in terms of light conditions, soil moisture and temperature, and air temperature.
2. Measure and compare the growth of ten tree species across the gradient.
3. Quantify the natural regeneration across the gradient.

In the longer term, the trial will allow researchers to monitor competitive interactions and stand development, and to investigate morphological adaptations of seedlings to different light conditions and the contributing physiological processes.

SITE DESCRIPTION

The study site is a level area located on the Burton Forest Service Road, about 50 km south of Nakusp, British Columbia. It is in the Columbia-Shuswap variant of the Interior Cedar-Hemlock moist warm biogeoclimatic subzone (ICHmw2), on a circum mesic site. The mature stand consists of 53% Douglas-fir, 25% cedar, 15% larch, and 5% pine and birch. The dominant height is 35 m, and density is 650 stems/ha.

The site was conventionally harvested during the winter of 1994/95 by a hand faller and a line skidder. The trial consists of two small clearcuts (.75 ha), each measuring 50-m wide by 150-m long (east-west axis).

STUDY DESIGN

The trial was designed according to a similar design prepared by Ashton et al (1994) which showed that the range of light durations created by strip cutting is similar to those found under various levels of partial canopy.

East-west oriented cutblocks with a width of approximately 1.5 times the height of the surrounding canopy have been shown to provide a gradient of light micro-environments similar to those that could be found across a range of partial cuts (Smith and Ashton 1993). The east-west orientation of the cuts, and the position of the sun from the south, create a north-to-south gradient of light exposure with more light being received on the north edge of each block.

Measuring the Micro-Environments

Originally, seven measurement locations, expected to have distinct micro-environments, were established in each block. The measurement locations were placed relative to the south edge of the cutblock at the following intervals: 67, 52, 46, 25, 1, –5, and –17 m. Although seedlings along the entire gradient have also been measured, only the results from the seven micro-environments are presented in this Extension Note.

Following harvesting, three micro-climate monitoring stations (Figure 1) were installed on each block, and sensors were connected to the seven measurement locations (Figure 2). This arrangement monitors key environmental parameters, i.e., soil moisture, soil temperature, air temperature, and relative humidity. Precipitation and wind speed are measured in the middle of each block.

Fisheye photographs were taken in order to characterize ambient light conditions (Comeau and Thomas 1998). A computer program called GLI-C was then used to analyze the images and estimate the light conditions. GLI-C provides estimates of the global light index (GLI), which is a measure or total light available (both direct and diffuse) during the growing season.

Several methods of measuring light conditions have been tested at the study site, including quantum sensors and hemispherical photographs. The data are being used to characterize light conditions in the study, as well as to test the accuracy of two light models (TRAYCI and LITE)[1] currently being developed in the province.

Measuring Seedling Survival and Growth

In the spring of 1995, the two patch cuts were planted with random rows of western larch, Douglas-fir, Engelmann spruce, western redcedar, western hemlock, white pine, ponderosa pine, lodgepole pine, subalpine fir, and paper birch. Figure 2 shows the planting layout for each patch cut.

In each block, the seedlings were planted in 42 rows, oriented north-south: three groups of single-species rows of ten species, three groups of three rows of mixed Douglas-fir and birch (one-to-one mix), and one group of three rows of pure Douglas-fir.

There is a 20-m unplanted buffer on both the east and west sides of each block. The rows are 90-m long, extending from 20 m inside the forest on the north side to 20 m inside the forest on the south side of each block. Spacing is 3 m between seedlings within each row, and 2.6 m spacing between rows (Figure 2).

Germination and Natural Regeneration

A trial was initiated in the second year of the study to test germination success of four species: Douglas-fir, western larch, western redcedar, and paper birch. Heavy predation by rodents and poor seed viability led to abandonment of this trial. However, a new study aimed at assessing the patterns of natural regeneration across the gradient has been initiated.

PRELIMINARY RESULTS

Micro-Environments

It has become clear that light conditions and soil moisture content vary considerably across the gradient, and efforts to characterize these factors is being expanded.

Actual light levels, i.e., the global light index (GLI), corresponded to expected levels. Initial measurements of total light are shown in Figure 3. Measurement locations that incurred influences of an overhead or adjacent canopy showed the greatest variability in light levels.

Initial studies of photosynthetic potential were completed for seven of the ten tree species planted across the gradient. Results showed, for all species, that seedlings planted more than 20 m into the forest, on either side of the clearcut, have negative photosynthetic potential (Simpson 1999). However, the light environments of the north and south edges (both just inside and just outside the forest) were found to be quite different. This is also resulting in growth differences in the seedlings planted at these locations. The forest edge on the north side of the cutblocks has high light levels, and there is adequate light at 10 m into the forest for the survival and growth (though at a relatively slow rate) of small conifers (Simpson 1999). Low light levels on the south edge limit the survival and growth of conifer species.

Soil moisture also varies across the gradient. Measurements from micro-climate monitoring stations suggest an abrupt decrease in soil moisture when moving from the edge of the opening into the forest. In May 1998, 24 addi-

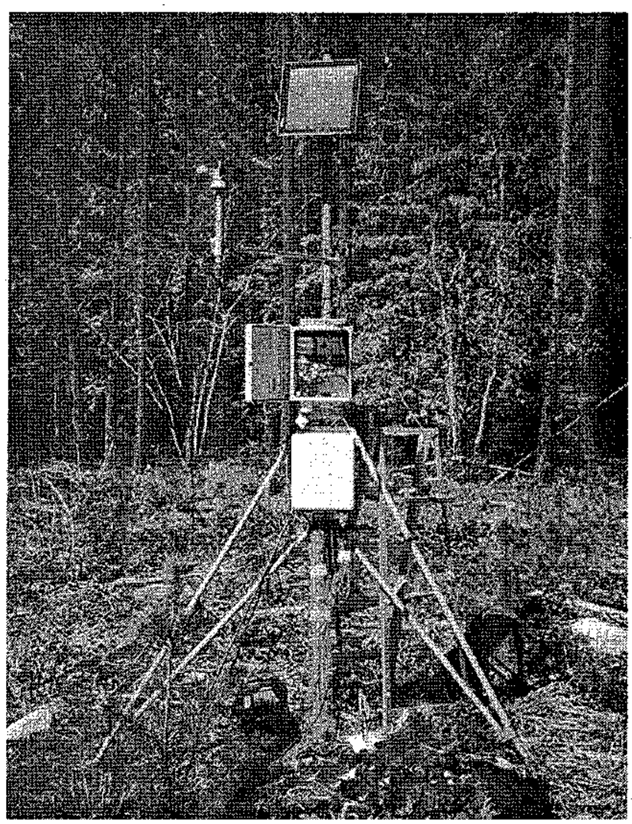

Figure 1. Three micro-climate monitoring stations were installed on each of the two study blocks.

[1] TRAYCI is a spatially explicit light model developed by the University of Freiburg in Germany, and the BCMOF. See Brunner 1998.
LITE is a light interception and transmission estimator developed by the BCMOF. See Comeau et al 1998.

tional soil moisture sensors were installed to help characterize the spatial and temporal patterns of soil moisture at the forest edge. This additional information should help explain some of the observed differences in tree growth and survival.

Seedling Survival and Growth

Average survival (all species combined) was as expected; i.e., lowest inside the forest, and increased towards the north end of the opening (Figure 4). There were also differences in the survival rates of each species relative to planting location. As expected, the more shade-tolerant species (with the exception of subalpine fir) have the highest survival rates for locations under the forest canopy. These species also tended to have fairly high survival rates overall. All species, regardless of shade tolerance, showed statistically significant increases in height growth at the measurement locations that received the most light (Figure 5). A multiple comparison of means test was performed using least square means on the 1998 data (Table 1). The results were unexpected: in some cases shade-tolerant species performed significantly better than shade-intolerant species. Analysis of five-year results is underway, and this information will help guide species selection during partial cutting.

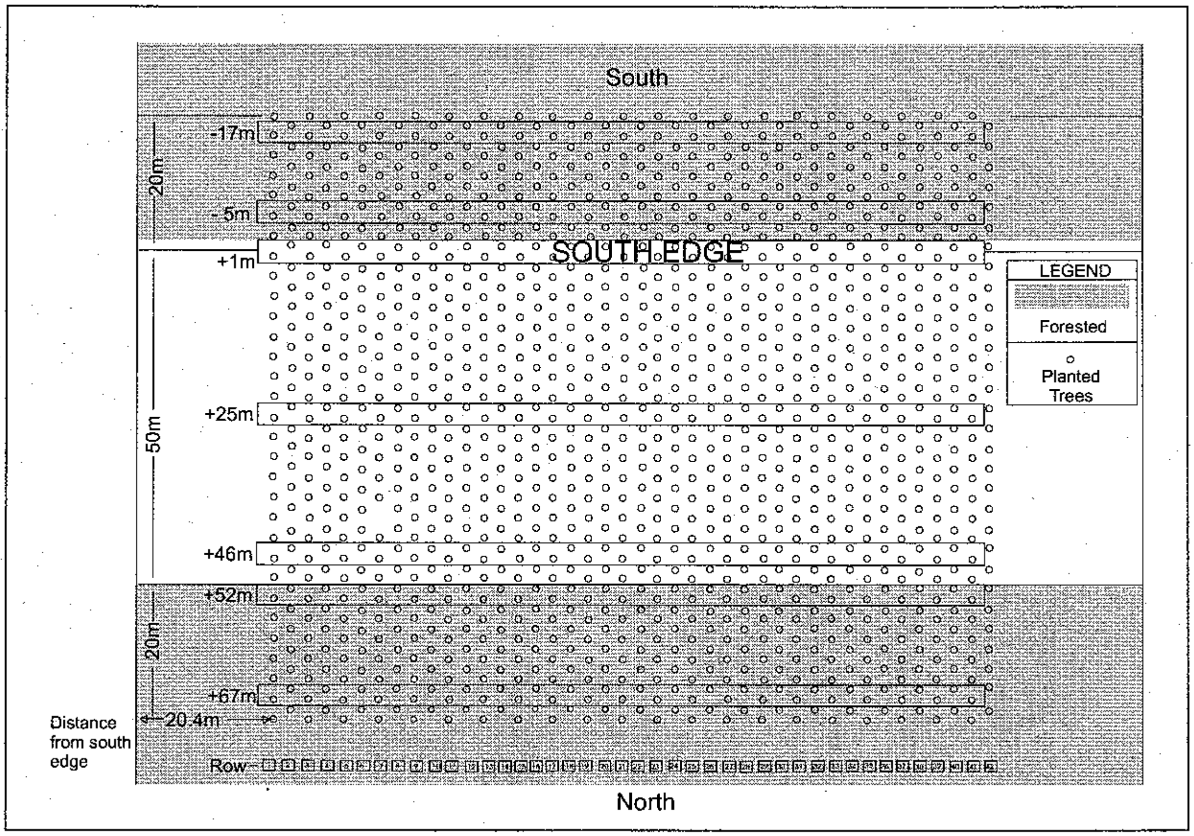

Figure 2. The two 50x150-m cutblocks included in the study were planted with seedlings oriented in north-south rows, and seven measurement locations (labelled at left) were established to monitor environmental conditions and seedling performance.

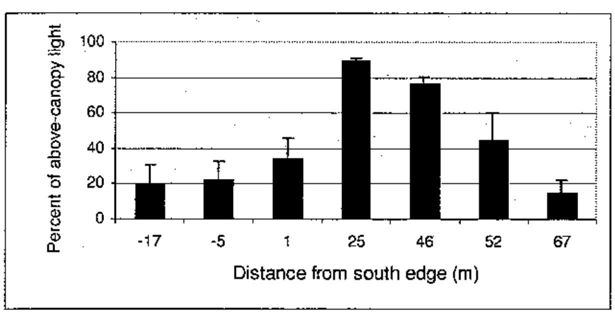

Figure 3. Light levels at each measurement location (see Figure 2 for locations). Mean for both blocks combined.

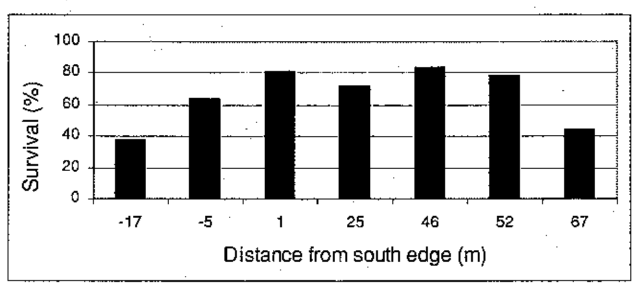

Figure 4. Mean three-year survival rates at each measurement location (see Figure 2 for locations).

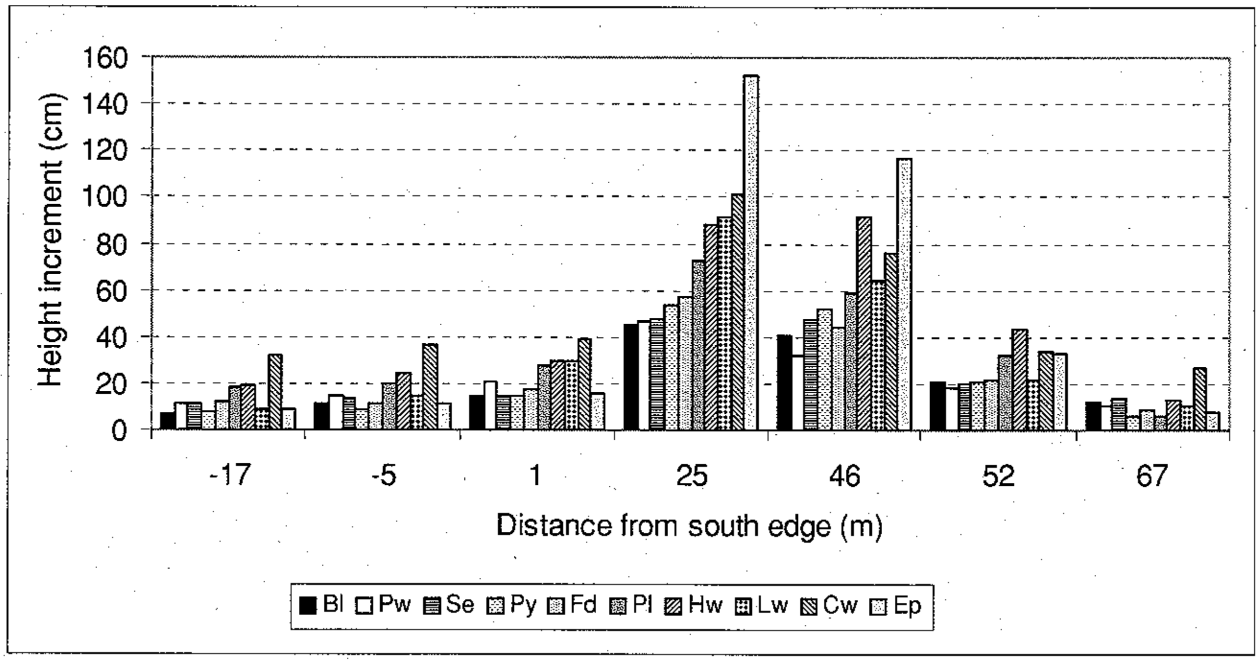

Figure 5. Height increment after three years, for each species at each of the seven locations (see Figure 2 for locations).

Table 1. Results of least-square-means multiple-difference test on mean height 1998. Lines join species that are not significantly different at p=0.05.

	Species									
	Ep	Pl	Hw	Cw	Lw	Py	Fd	Se	Bl	Pw
Least Square Means	1.47	0.94	0.91	0.88	0.86	0.76	0.71	0.62	0.54	0.51

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