GROWTH RATES OF *LOBARIA* spp. ALONG EDGES OF FOREST HARVESTING BLOCKS WITH DIFFERENT LEVELS OF RETENTION

Final Report

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Prepared for TRC Cedar Ltd. by

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INTRODUCTION

One of the most important factors influencing the growth of retained canopy lichens in managed forests is their response to canopy microclimate, particularly edge effects that extend into the surrounding forest from block margins. This is a special concern in wet Interior Cedar-Hemlock (ICH) stands of the upper Fraser River Valley (Prince George and Headwaters Forest Districts), where a unique assemblage of canopy lichens can be found. This lichen community, especially the cyanolichens, has been the focus of international conservation biology concern, in response to issues of habitat fragmentation and modification. (Goward and Arsenault 2000).

Clearcutting results in “hard” edges, characterized by an abrupt transition from a closed canopy to open conditions, and creating major changes in boundary layer climate in the surrounding forest stand. These microclimate changes can adversely affect canopy communities. Recent changes in forest harvesting practices, such as greater leave tree retention within harvest blocks, result in “soft” edges that may reduce boundary-layer climate effects on adjacent stands. These changes in forest harvesting practices may have important implications for the conservation biology of canopy lichens, particularly when considered at a landscape level, where even small reductions in the ratio of “edge” to “interior” forest habitat could have large influences on canopy lichen retention.

The purpose of this project is to examine the effects of variable retention and clearcutting harvest techniques on canopy lichens by comparing growth rates of *Lobaria* spp. along transects that extend back from both “hard” and “soft” block boundaries into the adjacent old-growth forest. It is jointly funded by TRC Cedar Ltd. of McBride, B.C. and the Sustainable Forest Management Network.

This report covers the establishment of the project in fall 2003, the first reweighing of the lichens in fall 2004, the addition of small *L. pulmonaria* thalli and *L. retigera* thalli in fall 2004, and the reweighing of the lichens in fall 2005. These new samples should strengthen the interpretation of experimental results by including a second species (*L. retigera*) and a different thallus size class (*L. pulmonaria*). This inclusion of new samples in fall 2004 was done without additional cost to TRC.

STUDY AREAS

The study blocks are located in the very wet cool subzone of the ICH Zone (ICHvk) in the upper Fraser River Valley between Prince George and McBride, B.C. Study blocks were selected according to the following criteria:

- Summer road access (and likely to remain accessible for several years);
- Unharvested stand along south- to west-facing block edge must be Age Class 8 or 9 (i.e. > 140 years old), cedar-leading, mesic or wetter, and without evidence of recent major damage by hemlock looper;
• South- to west-facing block edge must not coincide with any change in topography or forest cover type;
• No steep slopes, streams, or draws along south- to west-facing block edge;
• The south- to west-facing block edge must not show signs of major post-harvest vegetation response, such as windthrow of edge trees or regrowth of deciduous trees; and
• The stand should show evidence of prior conditions favourable for cyanolichen growth (e.g. remnant lichen populations).

In addition, variable retention blocks had to have enough retained trees adjacent to the south- to west-facing edge to provide some buffering from major wind effects.

Table 1 summarizes the attributes of the blocks that were selected for study.

<table>
<thead>
<tr>
<th>Site</th>
<th>Block ID</th>
<th>Location</th>
<th>Type of harvest</th>
<th>Forest cover type of SW-facing edge</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A59671</td>
<td>Km 3 on Hungary Creek Road</td>
<td>clearcut</td>
<td>CS(H)841</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A57901</td>
<td>Km 5 on Hungary Creek Road</td>
<td>clearcut</td>
<td>CS(BH)941</td>
<td>Study area south of reserve</td>
</tr>
<tr>
<td>3</td>
<td>A57901</td>
<td>Km 5 on Hungary Creek Road</td>
<td>clearcut</td>
<td>C(S)941</td>
<td>Study area north of reserve</td>
</tr>
<tr>
<td>4</td>
<td>A61216</td>
<td>Connector Road</td>
<td>variable retention</td>
<td>CBH(SE)941</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>A61216</td>
<td>328 Road, off Camel Road</td>
<td>variable retention</td>
<td>CBSH831</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>A61216</td>
<td>Dome Creek Dump Road</td>
<td>variable retention</td>
<td>SH(BC)841</td>
<td></td>
</tr>
</tbody>
</table>

We were unable to find three variable retention blocks that met all the selection criteria. Rather than abandoning the prepared samples, we decided to place them at a site that did not meet our forest type criteria, but that was otherwise suitable. Site 6 is subxeric rather than mesic, and is hemlock-leading (despite the forest cover label) rather than cedar-leading.
METHODS

2003/2004

In September 2003 we collected a large number of samples of *Lobaria pulmonaria* from a cedar-hemlock stand adjacent to Hungary Creek Road, in the general area of the clearcut study sites. The samples were transported to the University of Northern British Columbia, where they were cleaned and removed from their substrates. Three hundred large thalli (typical in size for the species) and 150 small thalli were transferred to a controlled environment, where they were stabilized and weighed at 25° C and 40% relative humidity.

The samples were transported to the six field sites (Table 1), where they were placed in mesh enclosures. Each enclosure was constructed of an 18 by 29 cm base of rigid plastic mesh (material sold as ceiling panels for fluorescent lights), covered by a rectangle of black plastic mesh (material sold as screen for rain gutters), which was included to simulate the colour of a dark branch. Nylon cords were attached to each corner of the rigid plastic base and tied together above the centre, and the entire assembly was covered with clear polypropylene fish net (mesh size 5 mm), forming a shallow pyramid. A 20-cm length of PVC pipe was hung horizontally below the assembly as a weight.

Sample trees were systematically located along transects laid out at various distances from the edge of the cutblock and in retained trees within variable retention blocks (Table 2). A large *L. pulmonaria* sample was placed in each enclosure. The small *L. pulmonaria* samples were placed only at Sites 1-3, in an SFM-funded pilot project to evaluate methods for measuring growth of small thalli. The mesh enclosures containing the *Lobaria* samples were suspended from the branches of sample trees on the side of the tree facing the cutblock, at a height of 3 to 6 metres above the ground.

<table>
<thead>
<tr>
<th>Site</th>
<th>Retained trees within block</th>
<th>Edge trees (0 m)</th>
<th>7.5 m from edge</th>
<th>15 m from edge</th>
<th>30 m from edge</th>
<th>60 m from edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearcut blocks (“hard” edges)</td>
<td></td>
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<td></td>
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<tr>
<td>1</td>
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<td>10</td>
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<td>2</td>
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<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>3</td>
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<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Variable retention blocks (“soft” edges)</td>
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<tr>
<td>4</td>
<td>10</td>
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<td>6</td>
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<td>10</td>
<td>10</td>
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</tbody>
</table>

Installation of the lichen growth rate enclosures was completed 2 October 2003.
2004/2005

In September/October, the lichens were collected from the field sites, stabilized in the UNBC weighing room, and weighed at 25 °C and 40% relative humidity. They were returned to the enclosures at the field sites by 15 October 2004.

Also in September/October 2004, we expanded the SFM-funded pilot project on small thalli. Using methods described above, we prepared an additional 150 *L. pulmonaria* thalli and added them to the enclosures at Sites 4-6. As well, we prepared 90 samples of another cyanolichen, *L. retigera*, and added them to five enclosures (Numbers 2, 4, 6, 8, and 10) along the 0m, 15m, and 60m transects at each site. All the lichens were attached to the plastic mesh with black braided fishing line (Figure 1).

2005/2006

In September 2005, the lichens were collected from the field sites, weighed at UNBC as before, and returned to the field sites by 30 September.

RESULTS AND DISCUSSION

First-year results are shown in Figure 2. Ten samples that lost biomass (typically due to fragmentation) and 1 sample with an unrealistically high growth rate (probably the result of a recording error) were excluded from this preliminary analysis. Results are shown as annual relative growth (ARG):

\[
\text{ARG} = \frac{(\text{biomass}_{2004} - \text{biomass}_{2003})}{\text{biomass}_{2003}} \times 100,
\]

or, increase in biomass during one year as a percentage of the initial biomass. Thus, if the annual relative growth of a lichen sample was 10, the lichen was 10% heavier in fall 2004 than in fall 2003.

Table 3 shows the proportion of the specimens, by location, that gained biomass during the second year of the study. Only a few of the *L. pulmonaria* specimens lost biomass, and the incidence of biomass loss was unrelated to location. The incidence of biomass loss in *L. retigera* was much higher, and appeared to be related to location. All 14 *L. retigera* samples located along the hard edges lost biomass, but only one sample located along the soft edges lost biomass.
Growth rates during 2004/05 are shown in Figure 4.

Overall, the small thalli of *L. pulmonaria* grew faster (means of 22.1% in 2003/04 and 29.6% in 2004/05) than the large thalli (means of 17.2% in 2003/04 and 17.5% in 2004/05. The results to date suggest that increased exposure has had a positive effect on the growth of *L. pulmonaria*, although the lower growth rate of the large thalli at the edge of the clearcuts during both years may indicate that extreme exposure has had a negative impact. The highest growth rates were observed in the samples located in the residual trees and along the edges of variable retention blocks, and 7.5 meters from the edge of the clearcuts.

*L. retigera* had the lowest growth rate (mean of 9.3%), and the number of specimens that failed to grow suggests that the species is quite sensitive to exposure and possibly also to transplantation effects. The first-year results suggest that the residual trees in the variable retention blocks may have mitigated the adverse effects of increased exposure, but the small sample sizes make interpretation difficult.

**CLIMATE MONITORING**

A previously installed set of canopy climatology instrumentation at Hungary Ck. was activated in fall 2003 for use under this project, looking at light, temperature, and moisture availability in replicate *Lobaria* thalli at the 10 m height within the canopy. These measurements were designed to provide background information against which regional changes in lichen growth rates could be evaluated. We accessed this site in spring 2004 to download the accumulated data files. Unfortunately, a leak in the datalogger enclosure system resulted in flooding of circuit boards on the datalogger. As a consequence we have had to deactivate the climate station at this site.

For the purposes of this study we are now using previously collected canopy data from this site (obtained under SFM funding) to obtain a correlation between climate data from the adjacent Northern Wetbelt Silvicultural Systems (NWSS) monitoring station at
Lunate Ck (a continuing project) and our own short term canopy climate data set. This allows us to meet our original project goals, of assessing the impact of regional climate trends on lichen growth using the NWSS installation project data.

The correlation between mean daily duration of thallus hydration (the major predictor of lichen growth rates) and rainfall accumulation (during the previous 48 hours) was highly significant ($R^2=0.81$), as indicated in Figure 4. We used this data to provide a prediction of potential duration of thallus hydration in the 2003 summer season (Fig. 5), and can apply this regression to future seasons data upon submission to peer-reviewed journals.

**PLANS FOR 2006/07**

In summer 2006 we will collect additional field data (e.g., basal area measurements, fisheye photographs of the canopy), which will be used to characterize the study sites and the environments of the lichen samples.

In September/October 2006 the samples from all six sites will be brought to the laboratory at UNBC, stabilized at 25 C and 24% relative humidity, and weighed. The data will be entered and analyzed, and a report will be submitted by 31 March 2007.

The value of the data will be enhanced by continuing the project until the response pattern of the lichens stabilizes. We are currently proposing to use joint TRC/FSP funding, subject to annual review by respective agencies, to meet this objective. In September 2006, we intend to retire the *L. pulmonaria* samples, and to increase the sample size of *L. retigera*.

Other plans for 2006/07 include a field tour and a publication.

**REFERENCE**

Figure 1. Large *L. pulmonaria* sample (top), *L. retigera* sample (lower left), and small *L. pulmonaria* sample (lower right) ready for placement in enclosure.
Figure 2. Annual relative growth (mean ± SE) from fall 2003 to fall 2004 of large and small Lobaria pulmonaria thalli in forests adjacent to clearcuts ("hard" edges) and variable retention block ("soft" edges). "R" indicates residual trees in variable retention blocks.
Figure 3. Annual relative growth (mean ± SE) from fall 2004 to fall 2005 of large and small *L. pulmonaria* thalli and of *L. retigera* thalli in forests adjacent to clearcuts (“hard” edges) and variable retention block (“soft” edges). “R” indicates residual trees in variable retention blocks.
Figure 4. Correlation between measured duration of lichen thallus hydration (*Lobaria pulmonaria*) and rainfall totals at Lunate Creek.

Figure 5. Predicted duration of lichen thallus hydration (*Lobaria pulmonaria*) from NWSS rain gauge data at Lunate Creek (summer 2003).