COLUMBIA MOUNTAINS INSTITUTE OF APPLIED ECOLOGY

Summaries of Presentations
Managing Forests for Lichens:
The Mountain Caribou Issue

Revelstoke BC
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The following pages contain summaries of the presentations given at the Managing Forests for Lichens: The Mountain Caribou Issue workshop. Co-authors for papers are listed where appropriate. Not all co-authors were present at the workshop. If you would like more information about a speaker's topic please contact the presenter directly at the contact numbers provided.

Workshop Coordinators:

Lauren Waters
L. Waters Ltd, Box 571 Revelstoke BC V0E 2S0
Phone: 250-837-6622 E-mail: lwaters@revelstoke.net

Susan Hall
Parks Canada, Box 350 Revelstoke BC V0E 2S0
Phone: 250-837-7533 E-mail: susan_hall@pch.gc.ca

Del Williams
Revelstoke Community Forest Corporation, Box 3199, Revelstoke BC V0E 2S0
Phone: 250-837-5733 E-mail: rcfc@revelstoke.net

Bruce McLellan
Ministry of Forests, Box 9158 RPO #3, Revelstoke BC V0E 3K0
Phone: 250-837-7767 E-mail: bruce.mclellan@gems9.gov.bc.ca

Columbia Mountains Institute of Applied Ecology
Box 2568 Revelstoke BC V0E 2S0
Phone: 250-837-9311
Fax: 250-837-4223
Email: cmi@revelstoke.net

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Importance of Lichen to Caribou and Other Wildlife - Mountain Caribou Foraging Strategies.

Bruce McLellan, Ministry of Forests, Research Branch, Revelstoke
Box 9158 RPO #3, Revelstoke BC V0E 3K0
Phone: 250-837-7767 E-mail: bruce.mclellan@gems8.gov.bc.ca

Mountain caribou are woodland caribou that live in the wet-belt mountains of British Columbia and use the 2-4 m deep snowpack in winter as a platform to access arboreal lichen. Trailing studies and research on captive animals have indicated that mountain caribou strongly select lichen in the genus *Bryoria* over *Alectoria*. Mountain caribou in the Yellowhead area used higher elevation forests throughout the winter where *Bryoria* is most abundant. In the Columbia Mountains, caribou drop to low elevations during November and December and feed on box wood (*Paxistima myrsinites*), as well as lichen from litter fall and windthrown trees. Managing forests for mountain caribou in the Columbia Mountains will not only require stands of suitable age to have and an abundance of arboreal lichen, but will also have to be of age where litterfall and blowdown occur.

Epiphytic lichens: An Emerging Biodiversity Issue

André Arsenault
Plant Ecologist, Ministry of Forests, Kamloops Forest Region
515 Columbia Street, Kamloops, BC V2C 2T7
Phone: 250-828-4165 E-mail: andre.arsenault@gems8.gov.bc.ca

Trevor Goward
Herbarium, Department of Botany, University of British Columbia, Vancouver BC
Mailing address: Enlichened Consulting Ltd., Edgewood Blue, Box 131, Clearwater, BC V0E 1N0
Phone: 250-674-2553 E-mail: tgoward@mail.wellsgray.net

The trend towards sustainable forestry practices through legislation and certification has led to the need for biological indicators that can assist in providing reliable assessments of sustainability. Epiphytic lichens (i.e., lichens living on the trunks and branches of trees) have been shown to be excellent indicators of environmental change. Recent studies have demonstrated that many epiphytic lichens are associated with old growth forests and are sensitive to forestry practices. Our studies in the interior wet-belt of British Columbia have focused on three main groups of old growth associated lichens: hair lichens, cyanolichens, and stubble lichens (Caliciales). Hair lichens will be discussed elsewhere.

For the other groups, we have shown that:
1) old growth forests occurring in humid subzones are more critical to cyanolichen diversity than old growth forests in drier subzones;
2) cyanolichen diversity can often be reliably predicted using as few as five environmental variables;

3) stubble lichen diversity is dependent on structural complexity, including such old growth attributes as large leaning trees, and snags and logs of various decay classes; and
4) different groups of old growth dependent lichens respond to disturbance in fundamentally different ways. These findings suggest that no single stand management practice will satisfy the requirements of all old growth dependent lichens. We argue that ecosystem representation in landscape unit planning is essential to the maintenance of lichen diversity at current levels.

Observations on Hair Lichen Dispersal in the ESSF

Trevor Goward
Herbarium, Department of Botany, University of British Columbia, Vancouver BC
Mailing address: Enlichened Consulting Ltd., Edgewood Blue, Box 131, Clearwater, BC V0E 1N0
Phone: 250-674-2553 E-mail: tgoward@mail.wellsgray.net

André Arsenault
Plant Ecologist, British Columbia Forest Service, Kamloops Forest Region 515 Columbia Street, Kamloops, BC V2C 2T7
Phone: 250-828-4165 E-mail: andre.arsenault@gems8.gov.bc.ca

Evidence is given in support of the hypothesis that hair lichens (*Bryoria*) in the ESSF are capable of dispersing over snow to distances of at least two kilometres. It is argued that dispersal is probably not limiting to *Bryoria* distribution in ecosystems subject to prolonged snow cover, especially at upper forested elevations.

New Insights into the Distributional Ecology of Hair Lichens in the ESSF

Trevor Goward
Herbarium, Department of Botany, University of British Columbia, Vancouver BC
Mailing address: Enlichened Consulting Ltd., Edgewood Blue, Box 131, Clearwater, BC V0E 1N0
Phone: 250-674-2553 E-mail: tgoward@mail.wellsgray.net

André Arsenault
Plant Ecologist, British Columbia Forest Service, Kamloops Forest Region 515 Columbia Street, Kamloops, BC V2C 2T7
Phone: 250-828-4165 E-mail: andre.arsenault@gems8.gov.bc.ca

Based on observations in the ESSF, the distributional ecology of "hair lichens" in the genus *Bryoria* is examined. Seven microscale and mesoscale patterns are recognized:
(1) a failure to successfully colonize branches occurring below the upper limit of the winter snowpack;

(2) an occurrence in much lower abundance over the outer, foliated portions of branches than over the inner, defoliated portions of the same branches;
(3) a tendency to periodic die-off in the outer, foliated branches, but not in the inner, defoliated branches;
(4) a development of disproportionately heavier loadings over old, senescent trees than over young, vigorously growing trees of similar size;
(5) an ability to colonize all levels of the forest canopy, including the upper crowns of trees;
(6) an anomalously higher biomass in young stands growing in exposed sites than in young stands growing in sheltered sites; and
(7) a development of considerable biomass in poorly illuminated stands that are nevertheless well ventilated.

It is suggested that the main features of *Bryoria* micro- and mesodistribution are controlled by a pronounced sensitivity to prolonged wetting.

A Management Strategy for Mountain Caribou in the Cariboo Region

Harold M. Armleder
B. C. Ministry of Forests, 200-640 Borland Street, Williams Lake BC, V2G 4T1
Phone: 250-398-4407 E-mail: harold.armleder@gems6.gov.bc.ca

James A. Young
B C Ministry of Environment, Lands and Parks, 400-640 Borland Street, Williams Lake BC, V2G 4T1

John A. Youds
B. C. Ministry of Environment, Lands and Parks, 400-640 Borland Street, Williams Lake BC, V2G 4T1

We describe how research and monitoring were applied, within higher level plan direction, to craft an integrated management strategy for mountain caribou. Nine years of radio-telemetry on 75 animals with over 4000 relocations has defined the range and habitat selection patterns for this population. Timber harvesting trials since 1990 have tested variations of the selection silvicultural system. The Cariboo-Chilcotin Land Use Plan has established the size of the area that can be managed for mountain caribou and defined the level of acceptable impact on the timber resource. These inputs were used to develop an initial strategy that zones caribou habitat and describes management in those zones. Recommendations for forest management systems, access, and predation management are part of the strategy.

Canopy Microclimate and Lichen Function

Darwyn S. Coxson
University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9
Phone: 250-960-6646 E-mail: darwyn@unbc.ca

Jocelyn Campbell
University of Northern British Columbia, 3333 University Way, Prince George BC V2N 4Z9
joc_campbell@hotmail.com

Lichen communities in Engelmann spruce (*Picea engelmanii*) - subalpine fir (*Abies lasiocarpa*) forests (ESSF) of the northern Cariboo Mountains, British Columbia, Canada, show distinct vertical zonation between lichen functional groups. *Alectoria* lichens reach their peak of abundance in the lower canopy, generally below 10 m in height, while *Bryoria* lichens reach peak abundance in the upper canopy, between 15 and 20 m in height. Foliose lichens, though widely distributed on individual branches at all heights, show greatest total loading in the lower canopy. These distribution patterns are accentuated by the physical structuring of these high elevation forests, with trees growing in clumps retaining significantly higher lichen loading on a per branch basis, compared to solitary trees.

The vertical zonation of lichen communities is accompanied by distinct height and aspect related trends in canopy microclimate. Snow-melt events during the winter period account for the majority of lichen wetting. The attenuation of lichen wetting after precipitation events (both snowmelt and rainfall) is typically greatest in lower canopy exposures. The exception to this pattern is seen under midwinter conditions, when solar insolation is insufficient to sustain prolonged snowmelt activity. Differences in lichen wetting duration between upper and lower canopy locations were significant only for south facing aspects during the summer period. For lichens from the *Bryoria* functional group, their peak of abundance in the upper canopy, notwithstanding reduced opportunities for periods of metabolic activity (during wetting episodes), suggests that exclusionary mechanisms preclude colonization and growth in the lower canopy. These may be based on substrate preference or physiological limits. In the later case, intolerance of periods of prolonged wetting would provide a mechanistic basis consistent with observed canopy microclimate gradients.

Partial Cutting in Mountain Caribou habitat in the ESSFwc1/wc4 – Twenty Years Later.

Deb Delong, Ministry of Forests Research Branch, Nelson
518 Lake Street, Nelson BC V1L 4C6
Phone: 250-354-6285 E-mail: debbie.delong@gems6.gov.bc.ca

Results of a recent retrospective look at older partial cuts in the ESSF of southeastern BC will be presented. In the late 1970's and early 1980's several high elevation cut blocks located between Salmo and Creston BC were partially cut in order to salvage Balsam bark

beetle as well as preserve some structure for caribou habitat. Information on the current condition of these stands will be presented and discussed.

ICH Canopy Gaps – Lichen Colonization after 100 Years Regrowth

Shelley Benson
University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9
E-mail: bensonm@unbc.ca

Darwyn S. Coxson
University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9
Phone: 250-960-6646 E-mail: darwyn@unbc.ca

The increasing adoption of selection silvicultural systems in Interior Cedar Hemlock (ICH) forests in British Columbia raises many questions about the long-term viability of arboreal lichen communities within a matrix of modified stand structures. As forests regenerate within present-day partial cuts, their substrate and microclimate conditions provide increasingly favorable conditions for lichen growth and colonization. Nonetheless, we do not know the time period required for the full restoration of lichen community abundance. Most plots where post-harvest monitoring of lichen abundance have been conducted are still within their first decade(s) of measurement (e.g. at Fleet Creek and Date Creek), a small time window against the presumed 150+ years required for a forest to attain old growth characteristics.

Retrospective studies on naturally occurring gaps within the ICH forest may provide an alternative means of examining the future development of lichen colonization within small patches of “second-growth” forest. We have now located a series of 1-2 ha patches of regenerating forest (ca. 110 years old) within old growth ICH forest stands in the Lunate Creek area of the Prince George Forest District. These patches appear to originate from hemlock-looper outbreaks in the past century. Although these areas of “secondary” forest now approach the surrounding canopy in terms of overall height growth, their structural diversity is much simpler than that of the surrounding “old growth” matrix. Measures of lichen abundance show that total biomass loading remains at less than half that of the surrounding forest canopy. We are now replicating these measures in adjacent regeneration patches and hope to extend these measures to include an assessment of species diversity.

Remnant Structure: Necessary but Not Sufficient to Conserve Epiphytic Lichens

Karen Price
RR2 S23b C1, Burns Lake BC, V0J 1E0
Phone: 250-695-6631 E-mail: kprice@futurenet.bc.ca

Forest management changes stand age and structure in ways that impact epiphytic lichen establishment and growth. Epiphytic lichens potentially serve as indicators of forest structure

and function and play ecological roles as food for plants (as nitrogen fixers) and animals (including caribou) and as habitat for invertebrates. Epiphytic lichens thus relate to biodiversity at both coarse-filter (i.e. ecosystem health) and fine-filter (i.e. species, e.g. caribou) levels. This presentation summarises results from two studies designed to look at the relationship between stand age and structure and epiphytic lichen communities in the Coastal Western Hemlock zone of western Vancouver Island.

The first study compares forest structure and lichen communities between second growth forest stands initiated by natural (blowdown) and anthropogenic (clearcut) disturbances. We located three blowdown and three clearcut stands aged from 60-80 years and dominated by western hemlock. In each stand, we sampled stand structure within three 20 x 20 m plots and along a triangular 90 m transect, and sampled fallen epiphytic lichens from the litter layer in seven or nine 2 m radius plots. Blowdown sites had more large trees, more large snags, more canopy gaps and more variation in tree density than clearcut sites. The more structurally complex blowdown sites were home to more species and to a higher abundance of epiphytic lichen.

The second study investigates the effects of stand age and tree species on epiphytic lichen abundance and composition (proportion of alectorioid lichens and cyanolichens). We sampled lichens from the litter layer in six young (< 70 years), nine young-mature (70-120 years), seven old-mature (160-200 years) and 40 old growth (300+ years) stands of three species compositions (*Tsuga heterophyla* and *Picea sitchensis*, *T. heterophyla* and *Thuja plicata*, *T. heterophyla* and *Abies amabilis*) in four watersheds. The paucity of mature stands severely constrained study design. Thirty-two stands were paired (16 mature – old growth pairs) for location and tree species to further examine the effects of stand age. Epiphytic lichen abundance, and the proportion of alectorioid lichens, increased with stand age, at least up to 120 years: young-mature stands contained about one-third of the lichen biomass of their old growth partners ($33 \pm 10\%$); old-mature stands contained similar amounts to their partners ($124 \pm 43\%$). Abundance and composition also varied with tree species and location. Relatively high elevation fir forests (> 400 m) had a high abundance of lichen dominated by cyanolichens; low elevation forests (< 200 m) had a high abundance dominated by alectorioids; mid elevation forests (300-400 m) had less lichen. It is important to note that the mature stands studied were all small (~0.5 ha), contained remnant structure and were surrounded by old growth. Hence, our results likely overestimate the level of lichen abundance that would exist in mature stands following standard forestry practices.

We draw management implications by combining the results from the two studies. From the first study, we found that, at the same age, naturally-disturbed stands have more structure and more lichens, suggesting that leaving structural remnants may be useful in conserving epiphytic lichens. However, from the second study, we found that stands younger than 120 years with structural remnants and surrounded by old growth housed much less lichen and a different species composition than nearby old growth stands, suggesting that, in parts of the Coastal Western Hemlock zone, structural retention is insufficient to conserve epiphytic lichens with standard harvest rotation length. We conclude that long rotations, in combination with structural rotation, will be a necessary part of management for epiphytic lichens, caribou and biodiversity.

Overview of Proposed Requirements for Mountain Caribou in the Revelstoke Area; Minster's Advisory Committee's Land-Use Plan

Kurt Huettmeyer, Ministry of Forests, Revelstoke
Box 9158 RPO #3, Revelstoke BC VOE 3K0
Phone: 250-837-7609 E-mail: kurt.huettmeyer@gems2.gov.bc.ca

The overview begins with a background on early caribou management assumptions in the area. Guideline intent and general management approach preceed the operational guidelines themselves. Although slight differences between ICH and ESSF guidelines exist, the 40% retention of older forests is discussed as well as the resultant silviculture system applications. The importance of access management is raised.

Integrating Mountain Caribou Requirements And Forest Management In The Interior Wet-Belt Near Revelstoke, British Columbia -- Lichen Retrospective and Dispersal Studies

Harold J. Quesnel
Ecotessera Consultants Ltd., R.R. #1 S18, C89, Nelson, BC V1L 5P4
Phone: 250-825-4204 E-mail: hquesnel@netidea.com

Lauren Waters
L. Waters Ltd. Box 571, Revelstoke, BC V0E 2S0
Phone 250-837-6622 E-mail: lwaters@junction.net

Alternative harvesting systems in old-growth habitat are being evaluated in the Revelstoke area. Integrating mountain caribou (*Rangifer tarandus caribou*) and timber management is important in the Revelstoke area because a significant proportion of the annual allowable cut will be harvested from old growth stands critical for the early winter and spring range of caribou. Many of these stands are in the Interior Cedar Hemlock zone (ICH). Alternative silviculture systems that maintain caribou habitat while allowing access to merchantable timber will be preferred in caribou habitat.

As part of the evaluation of alternative harvesting systems, dispersal and establishment of lichens, a critical forage for mountain caribou, is being evaluated. Establishment of two lichen genera, *Alectoria* spp. and *Bryoria* spp., was assessed as a function of distance from mature timber on 15 - 17-year-old plantations of interior Douglas-fir (*Pseudotsuga menziesii*). The plantations are located at Sheill Road and Goldstream River. Mature to over-mature forests near the tree plantations are dominated by *Alectoria* spp. with minor amounts of *Bryoria* spp. Significant inverse relationships exist between biomass of lichen established on young Douglas-fir and distance from mature timber. Most lichen establishment occurred within 75 m of mature timber and the proportion of *Bryoria* spp. established significantly

increases with distance from the mature timber. Lichen establishment was significantly less on Western Red Cedar (*Thuja plicata*) than on other tree species.

Dispersal of *Alectoria* spp. and *Bryoria* spp. lichens was assessed using litterfall traps in the Keystone area during 1997 and 1998. Dispersal rates of *Alectoria* spp. and total lichens within the patch cuts (1.0-1.78 ha) were significantly less in 1998 than in 1997. Dispersal of both lichen genera was significantly greater in traps located within mature timber, compared with traps located 0-20 m, 20-40 m, and 40+ m from the mature timber. Lichen dispersal within these patches occurs at a relatively uniform rate. Lichen establishment and dispersal rates were observed to be higher at or near residual trees or wildlife tree reserves.

Effects of Partial Cutting on *Alectoria* and *Bryoria*

Susan Stevenson
Silvifauna Research, 101Burden Street, Prince George BC V2M 2G6
Phone 250-564-5695 E-mail: sksteven@pgweb.com

If partial cutting is to be an effective means of maintaining winter habitat for mountain caribou, the resulting stand must support adequate quantities of available forage lichens. Partial cutting affects the lichens in several ways. By making the stand more open, partial cutting alters the canopy microclimate. The changed microclimate can affect the physiological activity, the growth rates, and the fragmentation rates of the lichens in the canopy. Fragmentation reduces standing crop, but is also a mechanism by which lichen fragments disperse to colonize regenerating trees, and by which lichens become available to caribou as litterfall. High levels of timber removal can result in windthrow in the residual stand and excessive fragmentation of the lichens, depleting the standing crop. For these reasons, a maximum removal of 30% of the timber volume is recommended for caribou habitat.

A research group based at the University of Northern British Columbia is currently investigating the effects of the size and pattern of selection harvest openings on distribution and abundance, physiological functioning, growth and fragmentation, and litterfall rates of *Alectoria sarmentosa* and *Bryoria* spp.