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Macrolichen and bryophyte responses to coarse woody debris characteristics in sub-boreal spruce forest

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ABSTRACT

Coarse woody debris (CWD) forms an important and specific habitat for many species of lichens, liverworts and mosses. We studied the relationships of 88 macrolichen and bryophyte species to CWD characteristics in mature mesic sub-boreal spruce forests in north central British Columbia. CWD characteristics and macrolichen and bryophyte species richness and abundance data were collected. Ordination, regression tree analysis and indicator species analysis were used to establish relationships between selected CWD variables and macrolichen and bryophyte species assemblages, overall species richness and individual species presence and abundance. Decay class and height from ground were the two CWD characteristics that most influenced macrolichen and bryophyte communities. Species composition varied along a continuum of assemblages from a dominance of arboreal lichens on decay class 1 (less decayed) CWD, to *Cladonia*, *Dicranum* and *Brachythecium* species and a diversity of liverworts on decay class 3, to feathermosses and *Plagiomnium* and *Peltigera* species on decay class 4 (more decayed) CWD. The height from ground of a log influenced the growth of liverwort and moss species with restricted growth on logs over about 10 cm above the ground. Log species, bark cover and diameter showed more limited influence on community composition in this study. Species were not greatly influenced by aspect (northern versus southern log aspect); however, macrolichen and moss species were more common on the upper sides of logs and several liverwort species were restricted to the lower sides of CWD (upper versus lower sides of logs). These results provide insight into the relationships between CWD characteristics and macrolichen and bryophyte communities, provide a basis for examining forest management impacts on lichen and bryophyte composition and highlight the importance of maintaining a diversity of CWD on the landscape.

1. Introduction

Coarse woody debris (CWD) in forests creates an important habitat for many lichens and bryophytes (mosses and liverworts) as well as other species including fungi and insects (Harmon et al., 1986; Arsenault, 2002; Jonsson et al., 2005). Some species of lichen and bryophyte are strongly dependant on CWD substrates and liverworts in particular are more often found on CWD than on other substrates in forests (Anderson and Hytteborn, 1991; Lesica et al., 1991). CWD is a specialised substrate which retains moisture, providing a more stable microclimate environment than soil, and which is elevated, relieving species of the competitive influence of species on the forest floor (Mills and Macdonald, 2004). CWD is also an ever evolving substrate whose characteristics, including amount of wood decay, bark cover, proximity to ground and microclimatic conditions, change through a continuum over time. The changes in these interrelated characteristics influence the composition of lichen and bryophyte communities on CWD and result in shifting communities (e.g., Söderström, 1988, 1993). Some species of liverwort and moss may find preferred conditions for establishment and growth on particular decay classes (Anderson and Hytteborn, 1991; Crites and Dale, 1998; Rambo, 2001). The tree species of the CWD may affect lichen and bryophyte species diversity and broadleaf CWD in particular may influence bryophytes differently than conifer CWD (Anderson and Hytteborn, 1991; McAlister, 1997). The availability of CWD substrates in a variety of states of decay, diameters, species etc. may influence the community composition of species of lichens and bryophytes at the forest floor.

The role of CWD in maintaining lichen and bryophyte communities in sub-boreal spruce forests in central British Columbia is of interest, particularly in reference to the implications of maintaining suitable and sufficient sources of CWD in managed

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and disturbed stands. The sub-boreal spruce forest landscape is changing rapidly due to the combined impacts of logging and a massive mountain pine beetle (MPB; *Dendroctonus ponderosae* Hopkins) outbreak. To minimize impacts to sensitive lichens and bryophytes associated with CWD it is important to understand the influence of stand-level (e.g., tree species composition) and log-level attributes (e.g., diameter of CWD), which can be altered by forest management. This study aimed to examine how a variety of CWD attributes influence the species richness and abundance of macrolichen and bryophyte species. The purpose was twofold: (1) to isolate key log attributes which have a large influence on lichen and bryophyte species richness and abundance and (2) to determine which log attributes to control for when examining the influence of landscape-level attributes on lichen and bryophyte richness and abundance.

2. Methods

2.1. Study area

The study was conducted in north central British Columbia near Prince George, BC extending from about 53°N to 53.5°N latitude and 123°W to 124.5°W longitude (Fig. 1). Sample plots were located in the sub-boreal spruce (SBS) biogeoclimatic zone within the dry warm (SBSdw) and moist cold subzones (SBSmc) (Meidinger et al., 1991). The climate is characterized by long snowy winters and short warm summers with moderate precipitation. Mean annual precipitation (MAP) is 495 mm for the SBSdw and 506 mm for the SBSmc in the area and mean annual temperatures are 2.6°C and 0.6 respectively (DeLong et al., 1993). The relatively slight difference in MAP supported pooling of data across sites.

Mature forests on upland sites are dominated by hybrid spruce (*Picea glauca* (Moench) Voss *x engelmannii* Parry *ex* Engelm.), lodgepole pine (*Pinus contorta* var. *latifolia* Dougl. *ex* Loud) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) with lesser amounts of trembling aspen (*Populus tremuloides* Michx.), paper birch (*Betula papyrifera* Marsh.) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.). The majority of the lodgepole pine in the main canopy of mature forests is dead due to the impact of the MPB outbreak. In order to reduce the influence of site, all sample plots were located in unmanaged mature (>100 yrs of age), contiguous forest areas with average absolute soil moisture regime (slightly dry and fresh from Pojar et al., 1987) and with <33% of the basal area of the canopy composed of dead lodgepole pine. We used a random procedure to select potential sample polygons from the total available population of polygons identified using existing forest inventory and ecosystem map layers within a GIS. A total of ten polygons were randomly selected three of which were found to be unsuitable in the field based on the above characteristics. Selected stand characteristics are shown in Table 1.

2.2. Plot layout and coarse woody debris transects

At each of the study polygons, three 50 m transects were established forming an equilateral triangle. The first transect followed a random compass bearing with the second and third transects at that bearing plus 120 degrees. Plots were located greater than 50 m from the closest edge of the mature forest polygon.

Each piece of CWD that intercepted the 50 m transect lines was assessed. CWD characteristics and the macrolichen and bryophyte community were both assessed on the first 50 m transect. A minimum transect length of 50 m for assessment of macrolichen and bryophyte species richness was determined based on preliminary species by transect length curves (C. DeLong, unpublished data). CWD characteristics were also assessed on the second and third transects and the information used to describe CWD characteristics for the site (i.e., CWD volume).

CWD was defined as pieces of downed wood ≥7.5 cm diameter, >2 m long and <1.35 m off the ground, at the point of transect interception. CWD did not include stumps, snags or live trees. If a tree trunk and branch of sufficient size both intercepted the transect, each was counted as a separate piece of CWD. CWD decay

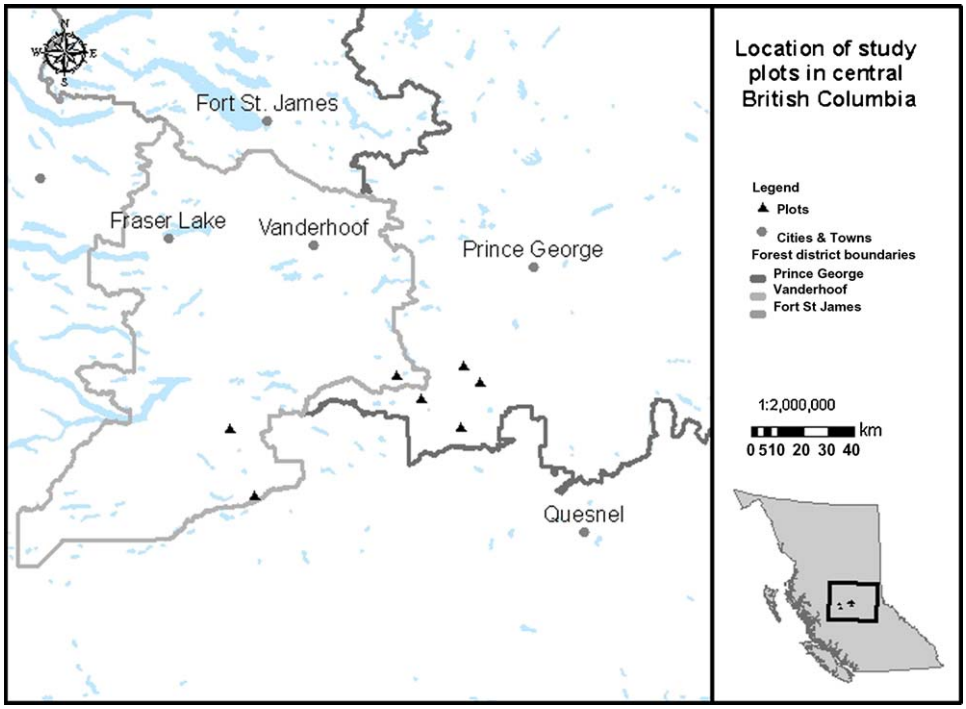

Fig. 1. Location of the study area and samples sites in north central British Columbia near Prince George, BC extending from about 53°N to 53.5°N latitude and 123°W to 124.5°W longitude.