Title: **The response of caribou terrestrial forage lichens to forest harvesting and mountain pine beetles in the East Ootsa and Entiako areas**

FSP No.: M08-5226

Description: The Tweedsmuir-Entiako caribou population summers in the North Tweedsmuir Park area, and winters in the Entiako and East Ootsa areas. During winter, caribou select mature lodgepole pine forests where terrestrial lichens are abundant, and forage primarily by cratering through the snow to obtain terrestrial lichens.

The Committee on the Status of Endangered Wildlife in Canada has recently listed all caribou in the Southern Mountains National Ecological Area (SMNEA), which includes the Tweedsmuir-Entiako population, as Threatened. The Recovery Strategy for Northern Caribou in the SMNEA in BC identifies research on the effects of mountain pine beetles (MPB) on Northern Caribou as a priority. One of the greatest threats currently facing most Northern Caribou populations in BC and Alberta is the impact of the extensive MPB epidemic. Since this scale of MPB attack has been unprecedented on caribou ranges in recent history, until this project was initiated in 2001, there was no information available on the effects of MPB on caribou, making it difficult to develop management prescriptions that minimize impacts to caribou. Because the Tweedsmuir-Entiako caribou population is the first caribou population to experience the current MPB epidemic, information collected on the Tweedsmuir-Entiako population will benefit all Northern Caribou populations in BC and Alberta.

The current MPB epidemic was detected in the East Ootsa and North Tweedsmuir Park areas in the mid 1990's. By the late 1990's, MPB numbers reached epidemic levels on both summer and winter ranges. By 2006, most mature lodgepole pine stands in the Tweedsmuir-Entiako caribou winter range have been attacked by MPB and are in the "grey attack" phase of the epidemic.

Three of the most critical questions that need to be answered regarding effects of MPB on caribou are:
· How will caribou winter habitat be affected by MPB attack? (i.e. how will terrestrial lichens respond? will snow accumulation increase due to a loss of canopy and/or will eventual blowdown lead to impeded movements?)
· How will caribou habitat use and winter range use be affected by extensive MPB attack? (i.e. will caribou avoid using MPB-attacked habitats for traveling or foraging during winter and migration and/or will they alter foraging strategies in beetle killed areas?)
· How will caribou population dynamics be affected by extensive MPB attack? (i.e. will mortality rates and causes, and/or population growth change following the MPB epidemic).

This project addresses the first question on the effects of MPB on caribou habitat. The project was initiated in 2001 in

the East Ootsa and Entiako areas to monitor various vegetation responses to MPB attack and MPB management logging, with an emphasis on terrestrial caribou forage lichens. The project also assesses stand structure, changes in coarse woody debris as an indicator of movement barriers, and regeneration.

In 2001, 79 permanent research plots were established in stands with red attack and in harvested areas in 4 different biogeoclimatic subzones and 7 different site series to address whether ecological conditions affected response of understory vegetation. Basic site information for each 200 m2 circular plot (7.98 m radius) was collected including UTM location, elevation, slope, aspect, stand age, dbh and canopy closure; percent cover of each shrub, herb, bryophyte and lichen species was also estimated. An oblique photograph of the plot was taken from the south side. Stand density was recorded by tree species and size, and by status of MPB attack for lodgepole pine trees. Coarse and fine woody debris was also measured to assess potential obstruction to wildlife mobility. Terrestrial lichen cover was documented by photographing permanently marked lichen colonies (approximately 10 per permanent plot; total photoplots: 771) and fisheye photographs were taken at plot centre to assess light penetration and canopy openness. In 2002, growth rate trials were established for terrestrial lichens, red-stemmed feathermoss and kinnikinnick. All permanent plots were re-measured in 2003 and 2005. In 2005, all trees >7.49 cm dbh were individually tagged for subsequent identification and regeneration <1.3 m in height was divided into 3 categories (0-10 cm; 10-30 cm; 30-130cm).

Preliminary data from 2003 and 2005 suggest that kinnikinnick is proliferating on MPB killed sites and affecting terrestrial lichen abundance. Change in terrestrial lichen abundance during the MPB epidemic appears to be mediated indirectly through changes in other ground vegetation rather than directly through changes in canopy condition. It is unclear whether this response by kinnikinnick is only an initial and short-term response to changes in stand structure and site resources, or whether the enhanced kinnikinnick response will persist. Although the focus of this project is on disturbances created by MPB and forest harvesting, a wildfire burned 6 permanent plots in 2004, providing some additional information on the initial effects of fire disturbance.

In 2007, we propose to re-measure all 79 research plots to assess changes in terrestrial forage lichen abundance and competing vegetation, stand structure, regeneration, canopy openness, coarse woody debris and growth rates; and, to assess whether the dramatic increase in kinnikinnick abundance has continued since 2005. Information from this project will provide terrestrial lichen abundance, stand structure, regeneration and coarse woody debris information 6 years following attack and will be critical for developing forest management strategies on caribou winter ranges that

are experiencing MPB epidemics.

Two other projects are also assessing the effects of MPB on terrestrial forage lichens: “Response of woodland caribou to partial retention logging of woodland caribou ranges attacked by mountain pine beetle” (FSP M07-5049) is being conducted on the Kennedy-Siding caribou population and includes an assessment of changes in terrestrial lichen abundance; and, “Effects of a mountain pine beetle epidemic on forest floor vegetation dynamics and regeneration in the Itcha-Ilgachuz caribou winter range in the Quesnel TSA” (FSP Y07-1328). Project Y07-1328 was initiated in 2005, while project M07-5049 was initiated in 2006. Both those projects are still in the green and red attack stages of the MPB epidemic. Because this project in the Entiako and East Ootsa area is in the grey stage of the MPB, it provides information on the responses of terrestrial lichens and other forest floor vegetation to a later stage of the MPB epidemic than the other two projects. All 3 projects are complimentary since terrestrial lichens may respond differently in different ecological situations (i.e. different biogeoclimatic subzones) due to potential differences in competing vegetation and their responses.

Project Objective: Current Year Objectives:
(1)To re-measure terrestrial lichen abundance, competing vegetation abundance, stand structure, regeneration and coarse woody debris on 79 permanent plots in the East Ootsa and Entiako areas.
(2)To assess changes in forest floor vegetation dynamics, stand structure, regeneration and coarse woody debris accumulation since the last re-measurement in 2005, and since the study began in 2001.

Long Term Objectives:
(1)To assess the short term and long term response of terrestrial caribou forage lichens and competing vegetation to the mountain pine beetle epidemic.
(2)To assess the timing and extent of coarse woody debris accumulation, as an indicator of movement barriers for caribou, following a mountain pine beetle epidemic.
(3)To assess changes in stand structure, composition, and regeneration in caribou winter habitat following a mountain pine beetle epidemic.

The objective for the 2007/08 Forest Sciences Program funding portion of the project is:
(1)To conduct the fieldwork portion of the project.

Data analysis, report writing and some fieldwork preparation will be funded by the project partners.

Experimental Design and Methods:

Methods for this project will follow methods used during the first 5 years (2001-2005) of the study. For photoplots, a 75 cm x 75 cm frame will be positioned at each photoplot using the two permanently placed pigtail stakes. The frame defines the boundary of the photoplot and provides a scale reference for analysis. Each photoplot will be photographed using a 35mm camera with a 28 mm lens mounted on a tripod and boom and positioned approximately 1.2 m directly over the frame. A small erasable board with the subzone, site series, site number, photoplot number and date written on it will be placed within the field of view. Photographs will be taken using 200 ASA film and scanned to high resolution digital jpeg files to be used for image analysis. Lichen colony percent cover within each frame will be analyzed using the software program Gap Light Analyzer (Canham 1988). This program was originally designed to determine canopy closure and the amount of light that canopies transmit; however, it can also be used to determine percent cover of objects within photographs. All digital and print format images relating to this project will be catalogued and archived. A visual estimate of terrestrial lichen cover and the cover of the dominant competitors (kinnikinnick, feathermoss, crowberry and twin-flower) will also be recorded for each photoplot. A stepwise approach will be used to develop multiple regression models of terrestrial lichen in relation to stand characteristics and forest floor vegetation cover.

In 2002 three sites within the SBSmc2 submesic (01c) site series were selected in which to conduct a growth rate experiment. At each site, 5 red-stemmed feathermoss and 5 Cladina stems, as well as 5 kinnikinnick shoots were tagged at three microsite conditions: a canopy gap; under a canopy tree; and, in a harvested area. In total, there were 15 tagged shoots per species per microsite type. Each moss and lichen was marked 10 mm from the tip with a black nylon thread and individually numbered with flagging tape attached to the free end of the thread. Growth was determined by measuring the length from the thread to the tip of the longest shoot and subtracting 10 mm. For kinnikinnick, 5 of the longest shoots were marked at each microsite (under the canopy, in a gap and in a cutblock). Each shoot was measured from the branch-tip to the last bud-scar to quantify only the present year's growth. In 2007, we will re-measure the length of each Cladina, red-stemmed feathermoss and kinnikinnick stem.

Each conifer tree within the 400 m2 permanent plot will be counted, identified to species, classified as alive or dead, and classified into the following size classes: > 12.5 cm dbh; 7.5 – 12.49 cm dbh; and, > 1.3 meters in height to 7.49 cm dbh. Four categories of smaller regeneration (> 30 cm - 1.3 meters in height; 10 to 30 cm in height; = 10 cm; Year 1 germinants) will be assessed in 3.99 m2 radius plots originating from plot centre. In addition, lodgepole pine trees will be classified into the following categories: alive; MPB green attack; MPB faded (yellow/orange) attack; MPB red attack; MPB red/grey attack; MPB grey; and, dead (not

due to mountain pine beetle attack). Tree status for trees >7.5 cm dbh will be tracked for each individually marked tree.

For canopy openness, a canopy photograph will be taken at each plot centre using a fisheye lens on a 35 mm camera with 400 ASA film. The camera will be mounted on a tripod 1.2 m above the ground and oriented so that the top of the camera is pointed north. The software program Gap Light Analyzer (Canham 1988) will be used to determine the percent transmission of light through the canopy.

Coarse and fine woody debris measurements are adapted from Trowbridge et al. (1986) and from the Field Manual for Describing Terrestrial Ecosystems (BC MOELP and BC MOF 1998). Bearings for two transects 30 meters in length were selected randomly in 2001 and transects originated at the plot centre. For each transect in MPB plots, the number of pieces will be recorded for the following diameter classes and transect distances: 0-0.5 cm diameter from 0-5 m; 0.6-1.0 cm diameter from 0-10 m; 1.1-3.0 cm diameter from 0-15 m; 3.1-5.0 cm diameter from 0-20 m; 5.1-7.0 cm diameter from 0-25 m; and, >7.0 cm for all 30 m. For all coarse woody debris pieces >7.0 cm in diameter, we will measure the diameter using calipers and record the distance from plot centre, decay class, length class, and mobility class. Decay classes will include: 1 - log hard; bark, branches, and twigs <3cm still present; 2 - log hard to partly decaying, bark and some branches still present; 3 - log hard to partly decaying and round, trace of bark still present; 4 - all of log on ground and sinking, bark absent; 5 - all of log on ground and partly sunken, oval; 5+ - all of log mostly sunken, overgrown by moss, part of forest floor. Length classes will include: 1 - <2 m; 2 - 2-5 m; 3 - 5-10 m; and, 4 - >10 m. Mobility classes will include: 0 - top side of log <10 cm above ground and log mostly part of forest floor; 1 - top side of log 10-40 cm above ground and log mostly branch free; 2 - top side of log or branches 40-100 cm above ground with scattered branches; 3 - top side of log or branches 40-100 cm above ground with dense branches, or top side of log >100 cm above ground (log mostly branch free); and, 4 - top side of log or branches >100 cm above ground with dense branches or with branches reaching down to the ground if log is raised off the ground.

BC MOELP and BC MOF. 1998. Field Manual for Describing Terrestrial Ecosystems. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 25.

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