Title: Enhancing the resiliency of the Tweedsmuir-Entiako caribou to the current Mountain Pine Beetle outbreak

FSP No.: Y08-1259

Project Description: The range of the Tweedsmuir-Entiako caribou (rangifer tarandus caribou) population coincides with an area that is experiencing an unprecedented mountain pine beetle (Dendroctonus ponderosae; MPB) outbreak in central British Columbia (Eng et al. 2005, Cichowski and Banner 1993). This caribou herd belongs to the west-central metapopulation, which is part of the declining Southern Mountain population of woodland caribou and have been designated as threatened (NCTAC 2004, COSEWIC 2005). The caribou rely on mature forest to provide winter range. Areas of mature forest provide their preferred food, terrestrial lichens, and it provides security cover from predators, mainly wolves and bears (Seip and Cichowski 1996, Cichowski and McLean 2005). In addition, large contiguous areas of mature forest allow caribou to shift their use of the landscape, within and between years, making their location and movement less predictable to predators. Changes in forest structure, resulting from the current MPB outbreak, could alter habitat availability and cause a shift in the predator-prey dynamics in the caribou's winter range. Moose and deer potentially benefit from an increase in young seral forest, and with an expanded prey base the number of wolves may increase. This increase in the density of wolves can compromise the viability of local caribou populations (Wittmer et al. 2005).

There is a pressing need for forest managers to determine appropriate strategies to enhance, as best as possible, the adaptive capacity of the Tweedsmuir-Entiako caribou to the current MPB outbreak. Information is required on what areas are appropriate for forest salvaging activities and road building and which are not, and on where stand tending can lead to an accelerated recruitment of good caribou habitat (Bunnell et al. 2004). However, there are numerous uncertainties associated with this issue. For example, there are uncertainties about the post MPB structural composition of caribou habitat, including the length of time for MPB killed stands to fall down, the potential shift in sub-canopy vegetation from lichen mats to other cover types (Williston and Cichowski 2004), and at what point do these stands no longer provide adequate caribou habitat and how fast do they recover (Coates et al. 2006). Compositionally, there are shifts in forest pattern and age structure that may suit other ungulates, risking a shift in predator-prey dynamics that may compromise the viability the caribou population (Bunnell et al. 2004), but it is unclear how this dynamic may unfold.

The goal of this project is to evaluate current woodland caribou habitat, how it is being modified by the current MPB outbreak, and which forest management strategies have potential to enhance the resilience of the Tweedsmuir-Entiako caribou population; all in the context of landscape change, ecological and wildlife response uncertainties, and current knowledge gaps. The approach will use collaborative modeling; influence diagrams (McNay et al. 2006), and scenario analysis techniques (Peterson et al. 2003) to capture existing research and opinions on caribou and habitat ecology. Scenario analysis and assessment is a systematic way of gaining insights into complex and uncertain futures (Peterson et al. 2003). The results of this project will be applied by engaging resource managers in the Nadina and Vanderhoof Forest Districts, including forest licensees, Morice-Lakes Innovative Practices Agreement (IFPA) participants, the government ministries of Environment, Forests and the Integrated Land Management Bureau, and First Nations. Input from resource managers and First Nations will be solicited through workshops to describe the project and to develop

forest management scenarios. Project results will be applied in the development of Recovery Action Plans for the northern caribou in the SMNEA. As well, the Nadina Forest District will use the caribou, moose and deer seasonal habitat maps generated from the project to inform operational forestry activities as part of the Forest Stewardship Planning process.

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Project Objective:

1) Construct a Tweedsmuir-Entiako caribou range base line

The pre-MPB landscape condition of the Tweedsmuir-Entiako caribou herd will be re-constructed using historic inventory data and satellite imagery and compared with current landscape condition to document landscape change to-date. The limited Tweedsmuir Park data will be enhanced with interpreted satellite imagery and terrain models.

2) Synthesize literature and expert knowledge on caribou's response to disturbance:

Influence diagrams will be used to capture the seasonal caribou, moose, deer and wolf information provided by workshops, and to describe the likely state of seasonal habitat given observed environmental condition. Influence

diagrams will also be used to capture descriptions of the risks to caribou, including predation, natural and human disturbance. These diagrams will be formalized into Bayesian Belief Networks (BBNs) to capture the environmental correlates, disturbance factors and response conditions.

3) Scenario analysis of future landscape condition:
Explore potential future caribou habitat conditions by modeling MPB, wildfire, and timber harvesting and salvaging events.

4) Identify forest management strategies that will enhance the resilience of the Tweedsmuir-Entiako caribou's population to landscape change:
Strategies will be developed, through scenario analysis, by exploring the factors that enhance or limit the capacity of the caribou herd to adapt to landscape level disturbance, such as, structure of post-disturbance stands, availability of alternative habitat, movement barriers, predator-prey dynamics, and the impact of forestry activities.

Experimental Design and Methods:

1. Tweedsmuir-Entiako Caribou Range Base Line
Spatial information will be organized in a GIS and used to meet the landscape modeling, data distribution and cartographic objectives of the project. Data from Cichowski and MacLean (2005) will be integrated, including caribou telemetry locations, habitat interpretations and lichen mapping. Additional data modeling of topography will be done to capture soil moisture (Fall and Morgan 2000) and to generate terrain curvature and ruggedness indices (Apps et al. 2001).

Satellite imagery will be georectified to the existing spatial data and land cover will be classified. A confusion matrix will be constructed by comparing the classified image with existing forest inventory data and linked project plot data (FIA-FSP M075047) to validate the classified image. Tweedsmuir Park spatial ecological data will be generated based on old (1950s) generalized forest cover data, topographic modeling and the classified imagery.

The historic reconstruction of the GTE will use existing 1973, 1993, 2001 and 2006 Landsat imagery. Additional images will be purchased to create a 5-7 year time sequence of landscape change. Classified imagery will be verified with current and historic ecosystem plot data.

2. Synthesize Existing Information
Team will review existing literature on caribou ecology and response of caribou to natural and human disturbance, with a focus on the Tweedsmuir-Entiako caribou. Based on this information, conceptual models of seasonal moose, deer, wolf, and caribou habitat, and models of threats to caribou populations will be constructed, including models of predator-prey dynamics. Conceptual models will be drafted into influence diagrams and describe the likely state of seasonal caribou habitat given observed environmental condition, the potential status of other ungulates and wolves. The diagrams will define the key environmental correlates, latent variables and response variables.

Empirical data and expert opinion will be gathered through formal workshops with caribou and forest ecologists to refine the influence diagrams. The team will formalize the diagrams into Bayesian Belief Networks (BBNs) to capture the environmental correlates, disturbance factors and response conditions following the methodology of McNay et al. (2006).

Results of caribou habitat and population ecology studies in adjacent areas, such as the Itcha-Ilgachuz and Rainbow mountains (Apps et al. 2001) and

Chase, Scott, Takla and Wolverine herds (McNay et al. 2006) will be used to calibrate and validate components of the models developed for the GTE.

First Nations will be engaged through our traditional knowledge protocol (see First Nations section).

3. Scenario Analysis of Future Landscape Condition

There are two existing landscape projection models, one in the Nadina (Steventon 2006 M07-5006) and one in the Vanderhoof Forest District (DeLong 2006). These two models and the data for Tweedsmuir Park will be integrated into a Tweedsmuir-Entiako Landscape Model (TELM). The area will be represented at a resolution of 1 ha per grid cell, and will incorporate recent timber supply reviews (Morice, Lakes Timber Supply Areas and Vanderhoof Forest District). The landscape models will be implemented using the SELES (Spatially Explicit Landscape Event Simulator) modeling system (Fall and Fall 2001). This software is a flexible tool for building and processing grid-based, spatio-temporal models that has been used for a wide range of related projects, including the provincial MPB projection model (BCMPB, Eng et al. 2005), and other caribou projects in west-central BC (McNay et al. 2006). Using it will facilitate interoperability of our models with those from linked projects. The landscape model will include processes of forest management, stand aging and succession, MPB dynamics (downscaled from BCMPB), road development, and fire. Output from the landscape projection model will be input into the BBN models to conduct caribou analysis of the landscape projections.

A set of scenarios will be designed to evaluate a range of future conditions, such as 1) current management, and 2) management applies no salvage, moderate salvage or aggressive salvage. Models will be verified by aligning current timber management scenarios with timber supply review results, sensitivity analysis of key model parameters, and by having model output reviewed by timber management and forest ecology experts.

4. Enhancing the Resilience of Caribou Population to Landscape Change

Scenario analysis results will be used to gain insights into the factors that enhance or limit the capacity of the caribou herd to adapt to landscape level disturbance, such as, structure of post-disturbance stands, availability of alternative habitat, movement barriers, predator-prey dynamics, and the impact of forestry activities. Strategies will be identified that provide the most robust approach to maintaining caribou habitat when faced with landscape dynamics resulting from a range MPB and fire scenarios and the uncertainty of how caribou will respond to landscape change.

Additional Literature Cited

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