WILDLIFE INFOMETRICS INC.

DISCUSSION PAPER

Potential Population Response to Linear Corridor Development in the Chase Caribou Herd Area, North-central British Columbia

R. SCOTT MCNAY[1]

JUNE 25, 2007

[1]Wildlife Infometrics Inc., PO Box 308, Mackenzie, BC, V0J 2C0, wild_info@wildlifeinfometrics.com

Prepared for Fiera Biological Consulting., contract #

CITATION: McNay, R.S. 2007. Potential population response to linear corridor development in the Chase caribou herd area, north-central British Columbia. Wildlife Infometrics Report 237. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

ABSTRACT

Herds of woodland caribou in north-central British Columbia are within the Southern Mountains Ecological Area where populations are considered threatened of becoming locally extirpated. Consistent with expectations from recovery planning efforts, I assessed the likely impact of proposed linear access development within one of these herd areas locally known as the Chase herd. Current access through this herd area to the northern communities of Tsay Keh and Fort Ware is facilitated by a route along the western side of the Williston Reservoir known as the Factor Ross route. Alternative access routes were proposed through a protected area known as the Corina-Tomais or further west through an area known as Helicopter Lakes. Population viability analyses predicted that either of the new access routes are likely to increase risk of decline for the Chase herd with little to no difference in effect between the routes. If sub-populations adjacent to the routes suffer a 20% change in survival rates, the entire meta-population was predicted to decline by 100-200 animals and the probability of long-term decline to a threshold population of 300 animals was predicted to be as high as 65%. Improvements to the analysis include additional scenarios to provide comparisons to assumed conditions of natural disturbance as a base case and to projected resource development as a cumulative impacts case. Also, I recommend a sensitivity analysis based on multiple simulations using a range of assumed impacts from linear development.

ACKNOWLEDGEMENTS

I would like to thank Viktor Brumovsky for providing modifications to the seasonal range maps which included projected spatial effects of proposed linear access development.

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INTRODUCTION

Populations of woodland caribou (*Rangifer tarandus caribou*) have declined through most of their range in North America (Chowns and Gates 2004, McLoughlin et al. 2003, Wittmer et al. 2005). The decline has led to research and management focused on recovering populations to more stable conditions (Messier et al. 2004). Ultimate factors leading to the mechanisms of decline are thought to be:

(1) reduction in range resulting from timber harvesting (Chowns and Gates 2004, Wittmer et al. 2005), mining, or development of oil and gas resources (Nelleman and Cameron 1996, Bradshaw et al. 1997, James 1999);
(2) displacement from range by humans seeking recreational opportunities (Messier et al. 2004, Seip et al. In Press), agricultural and industrial development (Chowns and Gates 2004, Dyer et al. 2001), or human habitation;
(3) increased direct mortality resulting from excessive hunting (Johnson 1985, Seip and Cichowski 1996) or increased predation (Rettie and Messier 1998, McLoughlin et al. 2003, Wittmer et al. 2005); or
(4) a combinations of these factors.

Because caribou in north-central British Columbia are located within the Southern Mountain National Ecological Area, they are considered threatened of becoming locally extirpated (COSEWIC 2002). Recovery planning areas for these herds have been delineated (Figure 1), a recovery plan developed (McNay et al. Submitted), and recovery actions established. Continued development of natural resources within these areas now requires consistent and regular use of monitoring tools to forecast the potential implications of development on caribou and their range values. Our objective was to assess the potential response of caribou populations to proposed linear development in the Chase herd area. The linear development was proposed as a means to improve access to the northern communities of Tsay Keh and Fort Ware by redirecting current access through alternate and relatively more negotiable routes. However, development of new linear corridors is expected to lead to reduction in forage values, reduced access to forage due to increased human activity, and to increased predation rates due to improved search rates of predators. The manifestation of these changes for caribou in the Chase herd area is expected to be reduction in parturition, recruitment, adult survival, or a combination of these mechanisms of population decline.

STUDY AREAS

The recovery planning areas in north-central BC extend from the town of Mackenzie (N55^{o} 18’ 16”, W123 ^{o} 07’ 56”) in north-central BC throughout the Rocky Mountain foothills on the east side of Williston Reservoir north to the Peace Arm and in the Omineca Mountains on the west side of Williston Reservoir north to the Ingenika River (Figure 1). It also included an area north of the Williston Reservoir and east of Ft. Ware (N57 ^{o} 30’00”, W125 ^{o} 24’00”) through the Rocky Mountains. First Nations reported historic seasonal use of the area by wolves and described an increase in the abundance of wolves and their more persistent presence following the first appearances of moose in the early 1920’s (McKay 1997). Predators of caribou, other than wolves, included grizzly bear (*Ursus arctos* (Linnaeus 1758)), black bear (*Ursus americanus* (Pallas 1780)), and

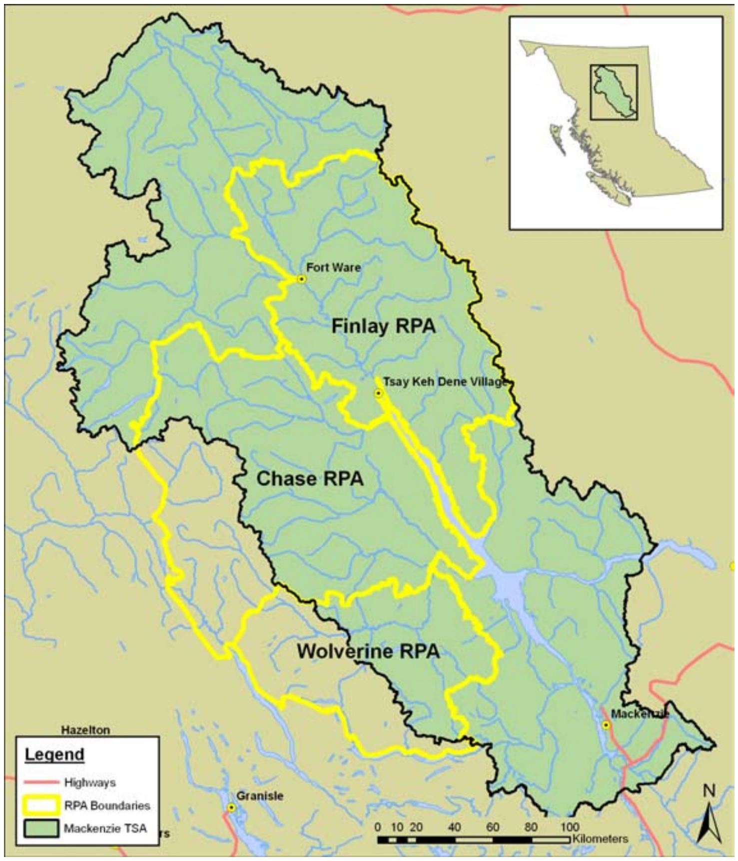

Figure 1. The Wolverine, Chase, and Finlay caribou herd Recovery Planning Areas (RPA) in north-central British Columbia.

wolverines (*Gulo gulo* (Linnaeus 1758)). Golden eagles (*Aquila chrysaetos*) are probable predators of calf caribou. Occasional, rare reports of cougar (*Puma concolor* (Linnaeus 1771)) have been made consistent with the recent increase in deer (*Odocoileus* spp. (Rafinesque, 1832)) and elk (*Cervus elaphus* (Linnaeus, 1758)). Other abundant ungulates in the area include stone sheep (*Ovis dalli stonei* (Nelson, 1884)) and mountain goats (*Oreamnos americanus* (de Blainville, 1816)). Regulated hunting of mature male caribou occurred in the Chase area and the northern half of the Wolverine area for 12 weeks beginning every August 15th. Regulated hunting was discontinued in the Scott area in 2002 and in the southern portion of the Wolverine area prior to 1981 although hunting by Aboriginal people is still permitted.

The Chase Recovery Planning Area is 1,733,039 ha situated in steep mountainous terrain ranging in elevation from 671 to 2466m, and has three major watersheds including the Ingenika, Osilinka, and Mesilinka Rivers. It is roughly bounded in the north by the most northerly portion of the Finlay River, in the west by Thutade, Sustut and Driftwood rivers, in the south by Ominicetla Creek, back end of Osilinka River, headwater of Wasi and Flegezand creeks, and in the east by the Williston Reservoir. At low- to mid-elevations, the area is dominated by the BWBSdk1 and SBSmk2 subzone variants, and at mid- to high-elevations the ESSFmv3 subzone variant predominates. The Alpine Tundra (At) prevails above the tree line (Meidinger and Pojar 1991).

METHODS

I conducted population viability simulations using RAMAS®GIS (Applied Biomathematics, Setauket, New York) to assess the potential implications of range reduction and fragmentation as a result of linear development. Spatially explicit, seasonal range maps, available from recovery planning (McNay et al. 2006), were held static at year 2000 conditions to represent the current access scenario (hereafter Factor Ross). I simulated the effect of two proposed linear developments at 1-ha resolution in hypothetical management scenarios by eliminating range values in a 500-m corridor around the proposed road locations (hereafter Corina-Tomias or Helicopter Lakes). Seasonal range values in all scenarios were combined into a single habitat suitability index model expressed as (McNay et al. Submitted):

$$AHVW = \left(\sum_{RT=1}^{4} -0.53 + 0.04RV + 0.79RT - 0.35RT^{2} + 0.04RT^{3} \right) / 4 \text{ ; where}$$

AHVW was the average habitat value weight, RT was the range type (i.e., pine-lichen winter range, post-rut range, high-elevation winter range, or calving and summer range) and RV was the range value (i.e., high, medium, or low) adjusted for seasonal (i.e., winter or summer) predation risk where both the range value and predation risk were estimated using a series of seasonal range Bayesian Belief Networks (McNay et al. 2006).

Linear development was assumed to affect adjacent patches/populations by factoring survival rates in those populations by 0.8. I estimated all populations stochastically using average and standard deviations of stage-specific survival rates predicted using logistic regression (McNay and Voller Submitted). Probabilistic catastrophe was introduced based on the frequency of years when adult survival was <0.85, the proportional effect on survival being based on the average rates from below normal years. All other vital rates and other model parameters were held constant as follows:

- I set patch/population parameters to mimic herd spatial structure based on our experience with the local herds (i.e., threshold habitat suitability for reproductive success was 0.015 and neighborhood distance was 10 cells);
- Carrying capacity (K) within patches/populations was equal to $0.25 * AHVW$ and the maximum growth rate for a population was $0.1 * AHVW + 1.0$ (where AHVW was the average habitat value weight);
- Initial abundance for each patch/population was set at 20 and allocated to stages (adult, juvenile, calf) based on an approximate stable age distribution;
- Dispersal and correlation among meta-populations was considered to be negative exponential functions of the form $\sigma_{ij} = a * \exp\left(\frac{-D_{ij}^{c}}{b} \right)$, where a = 1.0, c = 0.9, b was = 12 for correlation and 2 for dispersal, maximum dispersal = 20 kms, and all life stages were allowed to disperse among patches/populations;
- A ceiling-type density dependence was based on the abundance of all stages and allowed to affect all vital rates;
- 95% of the adult females and 50% of the male adults contributed to polygynous breeding – calves and yearlings did not contribute to breeding – resulting in 86% parturition and an equal sex ratio of calves; and

- I conducted 60 replications of simulations lasting for 300 years at annual time steps.

Scenario results were compared using total population size and extinction risk where the latter was expressed as: a) the probability of decline to a threshold population size of 300 animals and b) the probability of a 60% decline in population size.

RESULTS

Habitat suitability and population parameters for the Chase herd area resulted in the identification of 52 habitat patches or subpopulations (Figure 2) with a total carrying capacity of 799 animals. Lambda for the meta-population was estimated to be 1.092. Based on our assumptions about the effects of linear corridors, the Corina-Tomais route was expected to impact habitat and survival rates for populations 6, 9, 12, 13, 21, 22, and 30. The Helicopter Lakes route was expected to affect populations 11, 13, 15, 19, and 20. The carrying capacities affected were similar at 212 and 210 for the Corina-

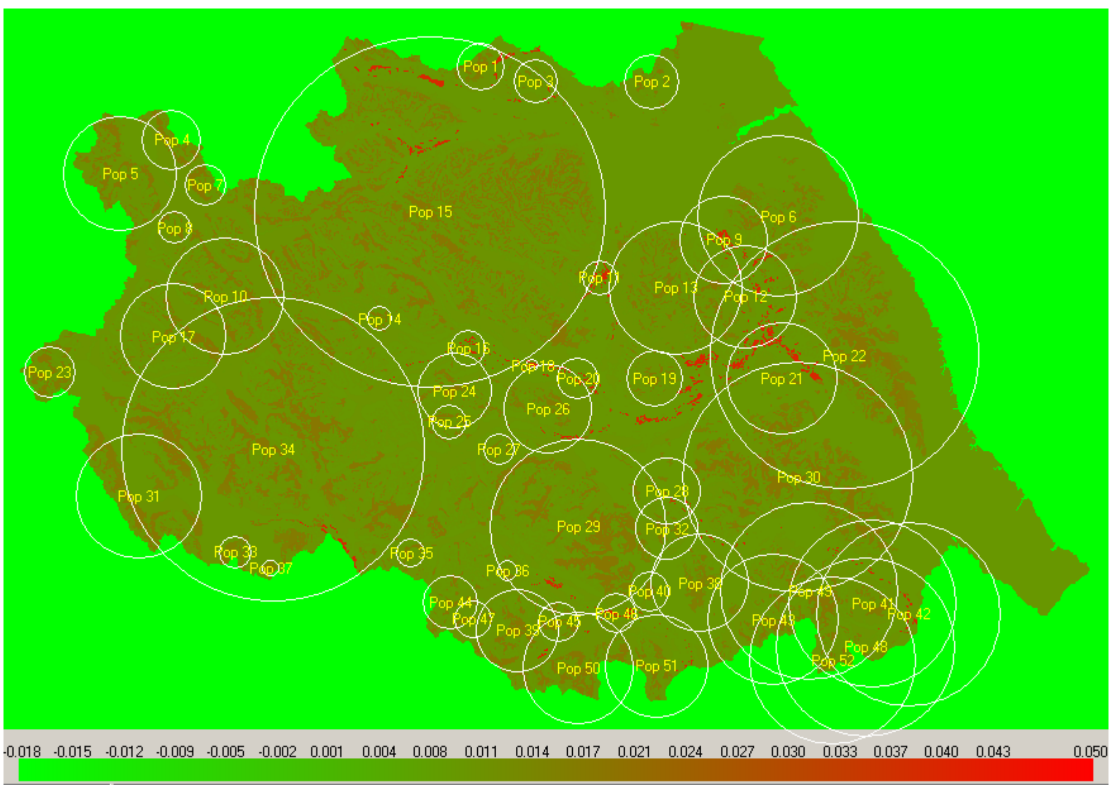

Figure 2. Subpopulations of the Chase caribou herd predicted using RAMAS GIS and seasonal range maps of McNay et al. (2006).

Tomais and Helicopter Lakes routes respectively although the majority of the overall effect from the latter route was concentrated in population 15 which had a carrying capacity o f 178. By comparison, the Corina-Tomais route affected more populations and carrying capacities that were relatively more distributed across the affected populations.

Overall abundance of the meta-population in the Factor Ross scenario was predicted to reach relative stability after 50 years in the simulation (Figure 3) at a range from 351 to 531 animals (Table 1).

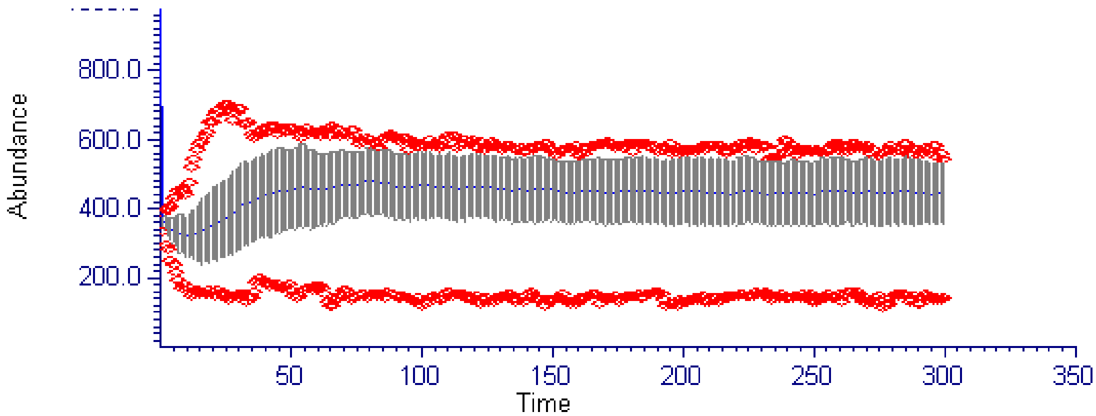

Figure 3. Trajectory summary of caribou abundance from a simulation of meta-population dynamics using RAMAS GIS (see methods for details).

Table 1. Evaluation statistics resulting from population simulation results of three alternate road access scenarios proposed for the Chase caribou herd area in north-central British Columbia.

Scenario	Carrying Capacity	Long-range Population Size	Probability of declining to 300	Probability of 60% Decline
Factor Ross	799	351-531	8	27
Corina-Tomias	795	256-365	33	100
Helicopter Lakes	795	233-335	65	100

Both of the new access routes being proposed were predicted to decrease the Chase meta-population by about 100 to 200 animals over the current access route (Table 1). Furthermore, while the current population has a low likelihood of declining to 300 animals, both of the new access routes would make this event much more likely.

DISCUSSION

Although the analysis is hypothetical, it does represent our best interpretation of habitat values being based on the same information used for current recovery planning efforts (McNay et al. submitted). Overall population vital rates were taken from recent syntheses of field data (McNay and Voller submitted) and population predictions were consistent with those obtained from surveys conducted in the Chase herd area (Giguere and McNay 2007). Even with this apparent reassurance from the empirical data, it's not imperative to rely on the actual predictions of populations but rather on the relative comparisons from one scenario to the other. This is especially so since the actual effect of linear development remains unknown and in my analysis was simply assumed to have a constant arbitrary effect on survival rates for populations adjacent to the development. The most important result was that development of either new access route is likely to put the Chase caribou herd at greater risk of decline than the herd currently experiences with the Factor Ross access route. Furthermore, although the predicted population size resulting from the Corina-Tomais route seems to indicate a somewhat more favorable option than the Helicopter Lakes route, the relative difference was insignificant.

A better base case for the comparisons would have been that of natural disturbance and although this comparison was available, resources for the analysis did not permit me to investigate this scenario. However, having some familiarity with these data, I expect the population simulations would have reflected the reported habitat dynamics (McNay et al. submitted). If so, then the estimate of the Chase meta-population from the current Factor Ross access route is likely to be somewhere between the estimates expected from the two natural disturbance scenarios – above that expected with moose in the system and below that expected without moose (Figure 16, McNay et al. submitted).

An even more appropriate comparison would have been to include the likely associated change in other cumulative effects such as timber harvesting. Again, this scenario was available for analysis but resources did not permit me to investigate that scenario either. Understanding the likelihood of continued resource development in the Chase herd area, I would expect the cumulative effects on caribou to be more dramatic than those predicted here. Notwithstanding the assumptions required for this analysis, I have shown that either new access route is likely to significantly increase risk of caribou population decline. The important question to address from a recovery planning perspective, however, is how much cumulative decline is expected relative to the base case of natural disturbance? Without further analysis, I cannot provide any further elaboration.

Improvement to this analysis would involve multiple simulations within which adustments are made to the assumed impact of linear development (i.e., the factored decrease in survival rates for adjacent sub-populations). Such analysis would then provide for elaboration on the sensitivity of the population results to this primary assumption.

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