



EXECUTIVE SUMMARY

Mitigating Risk of Predation for Woodland Caribou in North-central British Columbia

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Y093065 - Use of adaptive management to mitigate risk of predation for woodland caribou in north-central British Columbia

Purpose and Management Implications

Our goal was to implement a 3-year, adaptive management project in collaboration with other partners to test the efficacy of two treatments potentially useful in mitigating the risk of predation within threatened herds of caribou in north-central British Columbia. While partners tested the treatment effect of a regulated reduction of moose, we implemented a treatment to spatially focus regulated trap lines used to reduce predators in locations of known mortality risk. We monitored caribou, moose, and wolves in the treatment areas as well as in a third area, the latter as the experimental control for both treatments. The management implications were two-fold: 1) we expected to provide results to help managers throughout BC choose between two compelling approaches for mitigating the decline of caribou populations and 2) we anticipated immediate improvement to survival rates and population status for 2 local caribou herds.

Executive Summary:

Our specific objectives were to: 1) provide information to a local, licensed trapper that would assist the annual removal of specific wolves or wolf packs known to cause predation-related deaths of caribou in the treatment herd area; 2) monitor the status and relative distribution of radio-collared caribou and wolves in the treatment area and in an adjacent control herd area; 3) investigate mortalities of moose and caribou within the two herd areas to determine location, timing, and cause of death; 4) conduct population surveys of caribou and wolves within these two herd areas to obtain estimates of their population size and recruitment statistics; and 5) assess the collected data to determine efficacy of the treatment in achieving improved population status relative to the control herd. Information to help guide trapping was obtained from modeled predation risk and an analysis of the spatial and temporal patterns of radio-collared caribou mortality; data on both being available from previous study. Kill sites that were investigated were identified from aerial monitoring of radio-collared animals or by an analysis of Global Positioning System data downloaded from radio-collars placed on wolves adjacent to the removal zone. Aerial monitoring of collared animals and population surveys were conducted with partner funding and were based on standard inventory methods.

We were able to partition the caribou herd areas into zones likely to be occupied by moose which we assumed would lead to a direct relationship with the abundance of wolves; hence predation risk for caribou. Likelihood of moose occupancy was based on stand age, ecological unit (i.e. shrub, dominated, productive forest, or unproductive shrub), elevation, and relative hunting level. Predation risk for caribou was assumed to be the probability of incidental encounter with wolves and was considered high in a 5-km area around modeled moose habitat. We also determined that previous predation on radio-collared caribou occurred predominately during migrations in spring and fall as animals moved through valley bottoms between high-elevation seasonal ranges. The combination of this information led to the identification of a zone within the treatment herd area in which to focus removal of wolves. A cumulative total of 54 wolves were removed from the treatment herd area over the 3-yr study (18 annually, SE = 4). In the 4

years prior to the study a further 39 wolves were removed but at about half the rate (10 annually, SE = 3). Previous to this there was no focused effort to remove wolves from the treatment herd area. We knew of 13 and 3 wolf deaths in the treatment and control herd areas respectively that were from causes other than trapping during the 8 years prior to the study (9 deaths in the removal zone). Two wolf deaths occurred from causes other than trapping in each of the study areas after the study began. These non-treatment related deaths were identified from screening historic information and from previous monitoring of radio-collared wolves. No observations intended wolf removals came from the control herd area although anecdotally we suspected at least 1 or 2 incidents were likely. Other historic information compiled to support the study was derived from monitoring radio-collared animals and by estimates of wolf distribution and population status based on a scat and hair trap surveys. These data contributed to our understanding of seasonal movements of wolves and caribou and other ecological factors of relevance. Over the length of the study we caught and collared 80 caribou and 25 wolves. We investigated 61 known mortalities and 21 clusters of wolf relocations that were thought to be kill sites. Twenty one of these deaths (11 and 10 from the treatment and control herds respectively) were radio-collared caribou (7 annually, SE = 2). These deaths represented ~19% and 16% of the collared populations in the treatment and control herd areas, respectively. The only collared animal deaths found in the wolf removal zone were: 1 wolf, 7 caribou, and 6 goats; all the caribou and goats were found just inside the outermost removal zone limit (i.e., 15 km from the trapping sites) except for one caribou that was killed within 5 km of a trapping site. Of the 61 located mortalities, 33 were determined (or suspected) to have been caused by wolves. The remaining investigated deaths were by avalanche (3 goats), hunter kill (3 caribou and 2 moose), natural causes (1 goat), vehicle (1 wolf), lynx (1 caribou), suspected wolverine (1 goat), suspected grizzly bear (2 caribou), unknown predator (2 caribou), and unknown cause (1 moose, 1 wolf, 2 goats, and 4 caribou).

We found that wolf scat deposition rates were related to modeled moose habitat but have not yet determined a relationship between scat deposition rates and estimated wolf abundance. We stratified the two caribou herd areas into wolf census zones based on historic information about individual wolf distribution, observations of wolves during monitoring surveys, wolf scat deposition rates and distributions, and downloaded GPS data. We recommended these zones be used for a reapplication of the scat survey and that effort should be made to determine the relationship between scat deposition rates and wolf abundance by using information from radio-collared wolf packs. This would allow for the projection of wolf population status over the study area based on the relationship with modeled moose habitat.

The estimated population size for the Wolverine herd remained stable over the three years: 373 (SE = 7), 373 (SE = 8), and 377 (SE = 12) with juvenile recruitment estimated to be 13% (SE = 2), 18% (SE = 2), and 15% (SE = 1). The conclusion about population status for Chase herd however remains equivocal: 302 (SE = 5), 556 (SE = 16), and 475 (SE = 8) with juvenile recruitment estimated to be 13% (SE = 2), 18% (SE = 2), and 15% (SE = 2). Preliminary analyses indicated that the treatment herd has begun to respond positively to the wolf reductions although the information, especially in the last year of

study, lead to some questionable conclusions. We have recommend continuation of the study for a subsequent funding cycle in order to derive more clear evidence of the efficacy of the applied treatment.

Project Basic Information

Start date: April 2006

Length: 3 years

Former project number: Y071065

Other funding sources:

Abitibi Consolidated Company of Canada

Canadian Forest Products Ltd.

Peace Williston Fish and Wildlife Compensation Program

Methodology overview:

We implemented reduction of wolves in specific locations through the use of regulated trap lines. Effects of the wolf removal were assessed on the basis of recruitment rates sampled in the removal zone and the experimental control zone bi-annually at October and March. In addition, caribou survival rates were estimated from observations of monthly mortality determined from a population of radio-collared animals. Wolf packs surrounding the removal zone were collared for the purposes of monitoring kill rates and use of space in relation to the removal zone.

Project scope and regional applicability: Northern British Columbia

Interim conclusions: (see interim deliverables below)

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Deliverables

1. McNay, R.S. 2009. Patterns of wolf predation on woodland caribou in north-central British Columbia. J. Wildl. Manage. xx:xxx-xxx. Also catalogued as Wildlife Infometrics Inc. Report No. 233. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada and PFWWCP Report No. 323, Peace Williston Fish and Wildlife Compensation Program, Prince George, BC

Where woodland caribou populations are declining, reversing the population trend in the short-term will depend on mitigating predation rates until other factors (e.g., forest age structure) are managed in ways that discourage overlap among predators and caribou. In other work, I proposed to test the notion that removal of sufficient predators (wolves) can be accomplished by regulated, licensed trap line holders if their trapping is focused (spatially and temporally) on that objective. If proven successful, the need for a broader indiscriminate approach to wolf reduction may be unnecessary. I therefore assessed the utility of predation risk models to discriminate specific locations where radio-tagged caribou were killed by wolves from other sites used by caribou when they were alive, and from random sites on the landscape. I assembled 58,411 relocations of 231 radio-tagged caribou, 43 of which died from predation by wolves, and used logistic regression to distinguish wolf kill sites from other sites based on the possible combinations of seven independent factors: (1) caribou age class at death, (2) caribou sex, (3) season of death, and factors (4)-(7) which were four spatial estimators of predation risk: (i) shortest linear

distance to roads, (ii) shortest linear distance to early-seral forest, (iii) weighted distance to areas of predicted predation risk based on a previously published logistic regression model, or (iv) location relative to high or low classes of predicted predation risk based on a previously published Bayesian Belief Network. Age class of caribou at death, season, and the Bayesian model of predation risk provided a robust description of mortality sites where death was due to predation by wolves. Although more adults died than calves, the probability that a kill site was a calf was higher than for adults, kill sites for both age classes were more likely to occur during winter and spring migration than during other seasons, and kill sites were most likely within the zone of modeled predation risk. Also, caribou kill sites were more often and more successfully discriminated when nonrespondent data were caribou relocations rather than random locations. It was apparent from these results that radio-tagged caribou may have been selecting for range that had lower predation risk than otherwise but needed to undergo relatively short periods of high risk coincident with migration in order to do so. Although the Bayesian model performed well in most seasons, the predicted zone of risk failed to account for 12 deaths, most of which were calves that died either just prior to or during calving when the probability of a kill site being for an adult was lowest. With that qualification, I concluded that predation risk models can be useful tools to advance recovery planning for declining caribou populations because their use can help identify spatial and temporal parameters that characterise risk of predation by wolves. Knowing this can help managers focus management actions where and when they will be most effective; actions such as: reduction of wolves' primary prey, vegetation management that deters population increases in wolves' primary prey, and/or site-specific removal of wolves.

2. Digital data 2006/07 to 2008/09- telemetry relocations, capture statistics, and population surveys - data sent to Species Inventory Database System

3. Giguere, L. and R.S. McNay. 2007. Abundance and distribution of woodland caribou in the Chase, Wolverine, and Scott recovery plan areas. Wildlife Infometrics Inc. Report No. 225. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada
We conducted a population survey of woodland caribou in the Wolverine, Chase, and Scott recovery planning areas from February through March 2007. The area surveyed for these herds were primary located within the Mackenzie Timber Supply Area. The relatively severe weather experienced during this winter was characterized by higher than average snow depths which presumably caused caribou to seek easier foraging opportunities in areas blown free of snow at high elevations. We therefore chose a total count census method since most caribou were known to be using high- rather than low-elevation winter range. We divided land >1300m in each recovery planning area into sample units ranging in size from 550 to 1530 km² to allow a total count of known sub-groups (i.e, the sample unit size helped us minimize the likelihood that unpredictable events would compromise our ability to conduct a total count). We surveyed 19 sample units, 7 of which were only partially surveyed, during which time we accounted for 16 of 20 radio-collared caribou for a sightability correction factor of 0.95 for high elevation strata and 0.29 for low elevation strata. We observed 144 groups of caribou and a total of 818 individuals for estimated populations of 375, 560, and 23 in the Wolverine, Chase, and Scott recovery planning areas, respectively. For the Wolverine and Chase areas,

juvenile recruitment was estimated at 15 and 14%, respectively. With the exception of the Scott area, these observations represent the highest number of caribou ever recorded in the planning areas. The increase cannot totally be explained by increased effort and change in weather. We conclude that evidence is consistent with a slightly increased population in at least the Wolverine herd area.

4. McNay, R.S. and L. Giguere. 2007. Mitigating risk of predation for woodland caribou in north-central British Columbia: year 1 of 3 data report. Wildlife Infometrics Inc. Report No. 230. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

We report on the data collected and progress made during the first year of a 3-year research project established to test the efficacy of using regulated trap-lines to reduce predation risk for threatened herds of woodland caribou in north-central British Columbia. Objectives in the first year included: 1) peer-reviewed analyses of caribou mortality data and HSM-based predictions of predation risk; 2) regulated trapping of wolves in one herd area; 3) enhanced harvest of moose in a second herd area; 3) augmentation of, and systematic monitoring of, radio-collared animals; and 4) census of caribou, moose, and wolves to obtain estimates of population size and recruitment. A total of 63 wolves have been removed primarily from the removal zone, which includes trapping effort conducted by local trappers prior to official initiation of the project. A further 31 wolf deaths (11 from the removal zone) were derived from screening historic information from monitoring radio-collared wolves in the study areas. Other compiled information to support the study was derived from monitoring radio-collared animals. These data contributed to our understanding of seasonal movements and other ecological factors of relevance and came from monitoring 235, 50, 21, and 36 radio-collared caribou, moose, goats, and wolves, respectively. We investigate a total of 20 mortalities of radio-collared animals during the year. The only collared animal deaths, found in the wolf removal zone, were; 1 wolf, 2 caribou, and 4 goats; the caribou and goats were found just inside the outermost removal zone limit (i.e., 15km from the trapping sites). Three population surveys were conducted to derive population parameters for the 2 caribou herds. Total minimum counts for the Wolverine and Chase herds were 356 and 431, respectively. Several improvements to the study were recognized and recommended for implementation in the subsequent year.

5. Giguere L. and R. S. McNay. 2008. Abundance and distribution of woodland caribou in the Chase and Wolverine recovery plan areas. Wildlife Infometrics Inc. Report No. 272. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

We conducted a total-count population survey of woodland caribou (*Rangifer tarandus caribou*) in the Wolverine and Chase recovery plan areas during February 2008. We stratified land >1300m elevation into sample units ranging in size from 550 to 1530 km² (i.e., the sample unit size was chosen to minimize the likelihood that the total count would be compromised by unpredictable events). We authoritatively sampled land <1300m by surveying areas that we knew had a high likelihood of being occupied by caribou. In total, we surveyed 19 sample units, 9 of which were only partially completed. Although most animals were found in alpine habitats, a significant number of collared animals in the Chase area were found in low (15%) or subalpine (38%) habitats. We accounted for 18 of 20 radio-collared caribou known to be in the survey area prior to conducting the survey which led to detection correction factors of 0.94 and 0.50 for high-

and low-elevation sampling strata, respectively. Another 9 radio-collared caribou were found after the survey, 8 of which were located in subalpine habitat. We observed 94 groups of caribou and a total of 686 individuals for estimated populations of 505 and 748 in the Wolverine and Chase recovery planning areas, respectively. For the Wolverine and Chase areas, juvenile recruitment was estimated at 14 and 18%, respectively.

6. McNay, R.S., F. MacDonald, and L. Giguere 2008. Preliminary assessment of two techniques for estimating the relative abundance and spatial distribution of wolves. Wildlife Infometrics Inc. Report No. 275. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

We conducted trials of two techniques for assessing wolf (*Canis lupus*) abundance and spatial distribution; a wolf scat survey and a wolf hair trap survey. The scat survey was designed as a stratified random sample of transects established along roads within the Wolverine and Chase caribou (*Rangifer tarandus caribou*) recovery plan areas. One sample was conducted during late summer with the goal to assess the efficiency of data collection and to assess the relative quality and usefulness of data collected. We designed a hair trap for wolves based on techniques more commonly used for assessing population status and distribution of grizzly bears (*Ursus arctos horribilis*). The hair traps were established at three sites within the herd areas where our knowledge of wolves was relatively lower than other locations. The traps were sampled on two sessions through the winter retrieving 61 hair samples. Although both surveys showed promise, we concluded that the scat survey was the more pragmatic and efficient approach to obtaining baseline information about the distribution of wolves in the study areas.

7. MacDonald, F. 2008. Monitoring the distribution of radio-collared caribou and wolves in north-central British Columbia. Wildlife Infometrics Inc. Report No. 276. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

Radio-collared caribou (*Rangifer tarandus caribou*) and wolves (*Canis lupus*) within the Wolverine and Chase caribou herd areas were relocated on 12 occasions from May 11, 2007 to March 28, 2008 for the purposes of tracking their general spatial positions and to confirm their status as either dead or alive. In total, I collected 443 relocations of radio-collared animals, 148 of which came from activities conducted on partnered FIA projects, and located 19 mortalities (7 caribou, 9 moose (*Alces alces*), 2 wolves, and 1 still unknown) that were made available for subsequent investigation on a related FIA Forest Science Program project (Y082065). In general, distribution of caribou was not different from that observed in previous monitoring projects although, caribou in the Chase herd area continued using low-elevation winter range in and around Corina-Tomias Lakes most of the winter instead of moving to high-elevation winter range. In February, field crew caught and replaced radio-collars on 2 caribou and established new collars for the first time on 25 caribou and 8 wolves. The animals that did not previously have collars were from 4 new wolf packs and possibly 1 new group of caribou apparently unknown to us in recent years. The total number of active radio-collars at year end was 53 caribou and 8 wolves.

8. McNay, R.S. and L. Giguere. 2008. Mitigating risk of predation for woodland caribou in north-central British Columbia: year 2 of 3 data report. Wildlife Infometrics Inc. Report No. 274. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

We report on the data collected and progress made during the second year of a 3-year research project established to test the efficacy of using regulated, licensed trap-lines to reduce predation risk for threatened herds of woodland caribou in north-central British Columbia. Objectives in the second year were: 1) continued removal of wolves in the Chase caribou herd area; 2) continued enhanced harvest of moose in the Parsnip caribou herd area (a partnered project reported elsewhere); 3) continued augmentation of, and systematic monitoring of, radio-collared animals; and 4) continued census of caribou and wolves. A cumulative total of 73 wolves have been removed from the Chase herd area since 2003. The timing and spatial distribution of a further 33 wolf deaths (11 from the removal zone) were derived from screening historic information collected while monitoring radio-collared wolves. Compiled information about predation by wolves (n = 49) was screened from data collected while monitoring the fate of radio-collared caribou, moose, and goats. This year, we collected 443 relocations of radio-collared animals, located 16 new ungulate mortalities (7 caribou and 9 moose), and conducted site visits to investigate cause of death for 9 of those mortalities. The only animal deaths, not related to trapping, that were found in the removal zone over the two years were: 1 wolf, 4 caribou, 4 goats, and 1 moose. All but one caribou and one moose were found just inside the outermost removal zone limit (i.e., 15km from the trapping sites). We also investigated other potential kill sites (n = 16) identified by screening gps relocations of radio-collared wolves where those locations were distinguished by their relative concentration in space and time. Preliminary analyses of these data revealed considerable potential for estimating kill and consumption rates, stratified by prey species, and for analyses of the spatial distribution of kills made by wolves. The collared population was augmented by replacing radio-collars on 2 caribou and by establishing new collars for the first time on 25 caribou and 8 wolves bringing the total number of active radio-collars to 53 caribou and 8 wolves. We conducted trials of two techniques for assessing wolf abundance and spatial distribution; a wolf scat survey and a wolf hair trap survey. Although both surveys showed promise, we concluded that the scat survey was the more pragmatic and efficient approach to obtaining baseline information about the distribution of wolves in the study areas. In conjunction with partners, we had the opportunity to analyze bone marrow content sampled from dead animals remains collected during previously conducted kill-site investigations. We were (not) able to discriminate ungulates killed by wolves or other predators as being in relatively poorer condition than those not killed by predators. The estimated number of caribou in the Wolverine and Chase herds was 505 and 748, respectively. Calf abundance in late-winter was 14% and 18% of the population (Wolverine and Chase herds, respectively). A preliminary comparison of these population parameters across years indicated that the treatment herd has begun to respond positively to the wolf reductions.

9. McNay, R.S. 2008. Caribou & Wolves: Testing the relationship. Wildlife Infometrics Inc. Brochure No. 27. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

This brochure extends preliminary results of, and raises the profile of, the current adaptive management project.

10. Johnson, C.J., M. Hebblewhite, and R.S. McNay. In Prep. Modelling the efficacy of human interventions for manipulating multi-prey predator population dynamics – outcomes for the conservation of woodland caribou.

11. R.S. McNay, R. Sulyma, and L. Giguere. 2009. Abundance and distribution of woodland caribou in the Wolverine and Chase recovery plan areas. Wildlife Infometrics Inc. Report No. 319. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada
We updated population summaries for caribou in the Wolverine and Chase recovery plan areas by conducting periodic aerial surveys to estimate neonatal calf survival (June), post-summer calf survival (November), potential juvenile recruitment (February), and a total count of animals (February). We authoritatively sampled land <1300 m elevation by surveying areas that we knew had a high likelihood of being occupied by caribou and sampled as much open alpine habitat as our budget would allow. We accounted for 49 of 49 radio-collared caribou known to be in the survey area. We observed 73 groups of caribou and a total of 652 individuals for estimated populations of 378 and 475 in the Wolverine and Chase recovery planning areas, respectively. For the Wolverine and Chase areas, calf recruitment was estimated in late winter at 11 and 15%, respectively. Estimates of calf recruitment from the June and November calf recruitment surveys indicated that most mortality of calves occurred during the summer months for both herd areas. Calves appeared to remain relatively free of mortality during winter months.

12. MacDonald, F. 2009. Monitoring the distribution of radio-collared caribou and wolves in north-central British Columbia. Wildlife Infometrics Inc. Report No. 313. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.
Radio-collared caribou (*Rangifer tarandus caribou*) and wolves (*Canis lupus*) within the Wolverine and Chase caribou herd areas were relocated on six occasions from May 24, 2008 to March 21, 2009 for the purposes of tracking their general spatial positions and to confirm their status as either dead or alive. In total, the telemetry crews collected 269 relocations and located seven collared caribou mortalities for subsequent investigation on a related FIA Forest Science Program project (Y093065). Due to an extended period of no snowfall in mid winter the distribution of caribou was different from that observed in previous monitoring projects during the mid to late winter months. Approximately half the caribou continued using low-elevation winter range instead of moving to high-elevation winter range. In late February and early March, field crew caught and replaced radio-collars on one caribou and established new collars for the first time on 26 caribou and 12 wolves. The animals that did not previously have collars were from three new wolf packs and possibly one new group of caribou apparently unknown to us in recent years. The total number of active radio-collars at year end was 73 caribou and 18 wolves.

13. McNay R.S., F. MacDonald, L. Giguere. 2009. Mitigating risk of predation for woodland caribou in north-central British Columbia. Wildlife Infometrics Inc. Report No. 314. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.
(See executive summary above)

14. McNay, R.S., F. MacDonald, and L. Giguere. 2009. The relative abundance and spatial distribution of wolves in north-central British Columbia. Wildlife Infometrics Inc. Report No. 317. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

We conducted a survey to enumerate wolf scats within the range of two “threatened” caribou (*Rangifer tarandus caribou*) herds in north-central British Columbia. The scat survey was conducted along roads within a stratified random sample of watersheds in the Wolverine and Chase caribou recovery plan areas. Watersheds were selected as part of the potential survey population if they were within a subset of the study area known to be used by wolves (based on previous radio-collaring) and if an accumulation of 100-m road buffers represented $\geq 30\%$ of the watershed (enough roads to sample). Stratification of sampling was based on the proportion of high-quality moose habitat within watersheds. One preliminary sample taken October, 2008 was augmented with four monthly samples from late June to late September, 2009. We observed 496 scats along 543 kms of transect, in 12 randomly selected watersheds. We found a significant relationship between the pooled scats / km and the amount of moose habitat within the sampled watersheds. By comparing our data to two other published relationships of wolf density and a standard wolf scat index, we determined that approximate wolf densities in our watersheds could have ranged from 1 to 12 wolves/km². However, as all these relationships are preliminary in nature, based only on low sample sizes, and in some cases, extrapolation of data from other ecological systems, more work is required to confirm or substantiate these results.

15. McNay, R.S. 2008. Contrasting experiences in adaptive management. Slide show presented as training during an MOFR sponsored workshop on adaptive management in Neslon 080922.