# MODELING RELATIONSHIPS BETWEEN FIRE, CARIBOU, WOLVES, ELK AND MOOSE TO AID PRESCRIBED FIRE AND CARIBOU RECOVERY IN THE CANADIAN ROCKY MOUNTAIN NATIONAL PARKS.

**Winter 2009 Primary Prey Aerial Survey**

March 2009

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## Introduction

The effect of primary prey and shared predators on caribou mortality is a focus of our current research project. As telemetry data and population estimates for other ungulate species (moose, elk, and deer) are limited in most regions of the study area, aerial surveys may provide the only viable data source regarding alternate prey throughout the greater region. As such, the Canadian Rockies woodland caribou project, of which the Mountain National Parks project is part, has proposed to conduct at least one aerial survey in areas surrounding each of four caribou herds under study (Jasper, Narraway, A La Peche, and Redrock Prairie Creek) over the course of the project. The first of these surveys was conducted in Jasper National Park during February 2008, a second survey was conducted in Jasper during January of 2009. The goals of these surveys is to:

1. Provide relative density of primary prey (elk and moose) within and adjacent to all caribou areas.

2. Provide point locations to develop RSFs of prey species in the absence of telemetry data (i.e. elk and moose outside the parks) and to assess RSF models independently developed from existing telemetry data ( i.e. elk models developed for Jasper from data collected in Banff)

3. Be comparable to past surveys conducted within Banff and Jasper and by Alberta Fish and Wildlife (AFW) outside the National Parks.

During February 2009, a third survey was conducted in Alberta game management unit 440 directly north of Jasper National Park including portions of Willmore Wilderness Park. This survey was part of the greater caribou project and a component of Wibke Peters' ongoing Master's research into moose ecology.

Aerial surveys are widely used to quantify a variety of wildlife populations ranging from whale sharks (Cliff et al. 2007) to dall sheep (Udivetz et al. 2006). Sightability, or sighting probability, is the likelihood that an animal will be detected by an observer during a survey (Krebs 1999). Using logistic regression (sight/no-sight) a sightability model quantifies detection probabilities across habitats, seasons, years, species, or distances, and derives the 'statistical variation in detection' for different combinations of these variables (Williams et al. 2002). Sightability corrected estimates are generally regarded as better than regular index data as they account for variations in animal movements between years and within populations (i.e. differential habitat use from year to year and by differing age and sex classes).

In northern Alberta, provincial wildlife agencies use a form of sightablity model, the Gasaway method (Gasaway 1986) to quantify moose populations. The Gasaway method works well for moose (e.g. Walker et al. 2007, Russell 2007) however it cannot be used for gregarious or herd animals such as elk (Allen 2005). During a meeting of stakeholders in Jasper in January 2008, it was decided to pursue the use of a random stratified block design to quantify elk and moose within the National Park.

## Methods

Aerial surveys followed guidelines set forth by Unsworth et al. (1994). The montane region of Jasper National Park was divided into 30 elk winter range subunits ranging from 23 $km^2$ to 39 $km^2$ (x = 29.9 $km^2$) (Figure 1). Each subunit was classified into a high, medium, or low stratum for both elk and moose prior to the survey. Subunit classification was based on ground observations, a priori knowledge of Parks Canada biologists, and results from the 2008 aerial survey. Elk and moose strata were adjusted one level up or down depending on 2008 raw counts. Moose strata was adjusted from 2008 so that areas where more than one group of moose were observed were set to high (i.e. units 19, and 21), areas where single groups were observed were set to medium (i.e. units 11, 51, 54, and 39), and areas where no moose were observed were adjusted down one strata level. A comparison of 2008 and 2009 stratification levels is provided in table 1.

Twenty of the 30 subunits were selected at random representing a mix of all three strata for both moose and elk. All units flown were included in the survey for both species. For instance, a unit that was flown as high for elk was considered low or medium stratum for moose. In addition to elk and moose, observations of deer, wolves, and bighorn sheep were recorded during the survey although these observations were not sightability corrected.

Subunits were flown in transects approximately 300 m apart at a speed of 60 to 80 km/hr as dictated by terrain and animal density (Unsworth et al. 1994). When animals were sighted, the location and total number of animals observed in the group were recorded. Groups were then broken into sex and age classes (i.e. bull, cow, calf), or documented as unclassified. The activity of the first animal observed (bedded, standing, moving), as well as vegetation class (grassland, sagebrush, juniper, aspen/deciduous brush, conifer), percent snow cover (10% increments in immediate area surrounding the sighted animal), and percent canopy cover (10% increments above sighted area) were recorded at each observation (Unsworth et al. 1994). In subunits where no animals were sighted, zeroes were entered in all fields for analysis. Sightability of elk was corrected using the Elk Hiller 12-E Idaho model, and for moose using the Moose Hiller-Siloy Wyoming model. The moose model contains a covariate for terrain ruggedness which was considered important in early iterations of the aerial survey program (Unsworth et al 1994), but which has since been removed (Anderson and Lindzey 1996). Although it has no effect on the population estimate, the input still requires that this field contain some value therefore it was set to 0 for all observations.

During the 2009 survey, in some instances when large groups of elk were encountered, a digital photo was taken in order to compare our count from the air with what was assumed to be a more accurate count using the digital record. Raw counts, one using the original totals and one using the corrected counts from digital photos, were analyzed in the Aerial Survey software separately in order obtain separate total population estimates.

**Figure 1. Thirty aerial survey units delineating elk winter range of varying quality in the montane region of Jasper National Park.**

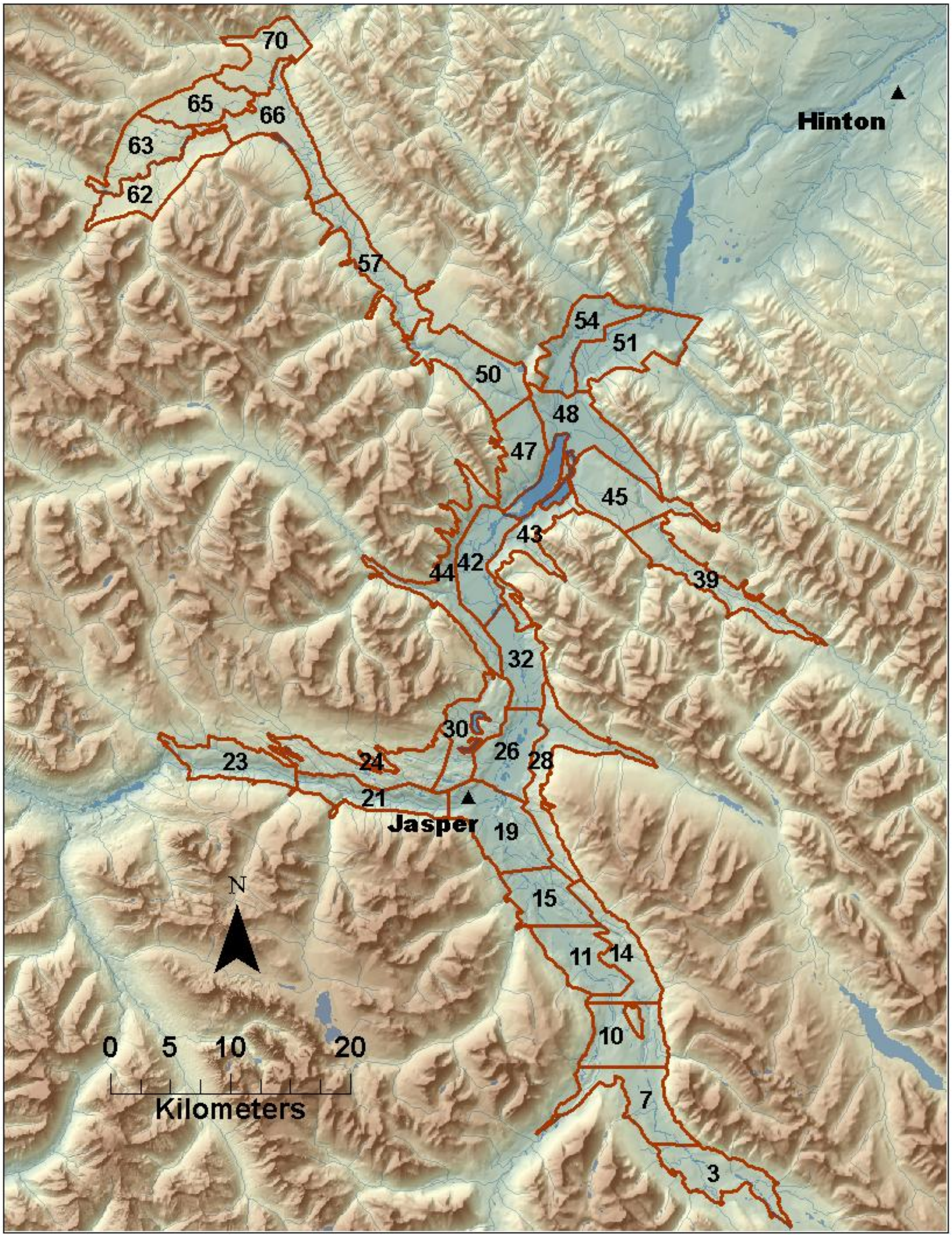


**Table 1. Survey unit stratifications for elk and moose in the montane region of Jasper National Park, 2008 and 2009 (counts left blank when a unit was not surveyed in a particular year).**

| Unit | Elk 2008 | | Elk 2009 | | Moose 2008 | | Moose 2009 | |
|---|---|---|---|---|---|---|---|---|
| | Strata | Count | Strata | Counts | Strata | Count | Strata | Count |
| 3 | Low | 0 | Low | | High | 0 | Medium | |
| 7 | Low | | Low | 0 | Low | | Low | 1 |
| 10 | Low | | Low | | Low | | Low | |
| 11 | Medium | 0 | Low | 0 | Medium | 2 | Medium | 0 |
| 14 | Low | 0 | Low | 0 | Low | 0 | Low | 0 |
| 15 | Medium | | Medium | | Medium | | Medium | |
| 19 | High | 55 | High | 76 | Low | 2 | High | 1 |
| 21 | Medium | 0 | Low | 0 | High | 3 | High | 0 |
| 23 | Low | 0 | Low | 3 | High | 6 | High | 8 |
| 24 | Low | | Low | | Medium | | Medium | |
| 26 | High | 13 | High | 61 | Low | 0 | Low | 0 |
| 28 | Low | | Low | 0 | Low | | Low | 0 |
| 30 | Medium | | Medium | 2 | Medium | | Medium | 5 |
| 32 | High | 52 | High | 66 | Low | 1 | Medium | 0 |
| 39 | Low | 5 | Medium | | Low | 1 | Medium | |
| 42 | High | 0 | Medium | 3 | Medium | 0 | Low | 0 |
| 43 | Medium | 9 | Medium | | Low | 0 | Low | |
| 44 | Low | | Low | | Low | | Low | |
| 45 | High | 42 | High | 31 | Medium | 1 | Medium | 2 |
| 47 | Medium | | Medium | 1 | Medium | | Medium | 0 |
| 48 | High | 85 | High | 68 | High | 0 | Medium | 2 |
| 50 | Low | | Low | | Low | | Low | |
| 51 | Low | 0 | Low | 0 | High | 1 | Medium | 4 |
| 54 | Medium | 6 | Medium | | Medium | 2 | Medium | |
| 57 | Low | | Low | 25 | High | | High | 2 |
| 62 | Low | 0 | Low | | Medium | 1 | Medium | |
| 63 | Medium | | Medium | 1 | Medium | | Medium | 4 |
| 65 | Medium | 19 | Medium | 0 | Medium | 2 | Medium | 5 |
| 66 | Low | 5 | Medium | 3 | High | 10 | High | 9 |
| 70 | Medium | | Medium | 8 | Medium | | Medium | 9 |

## Results

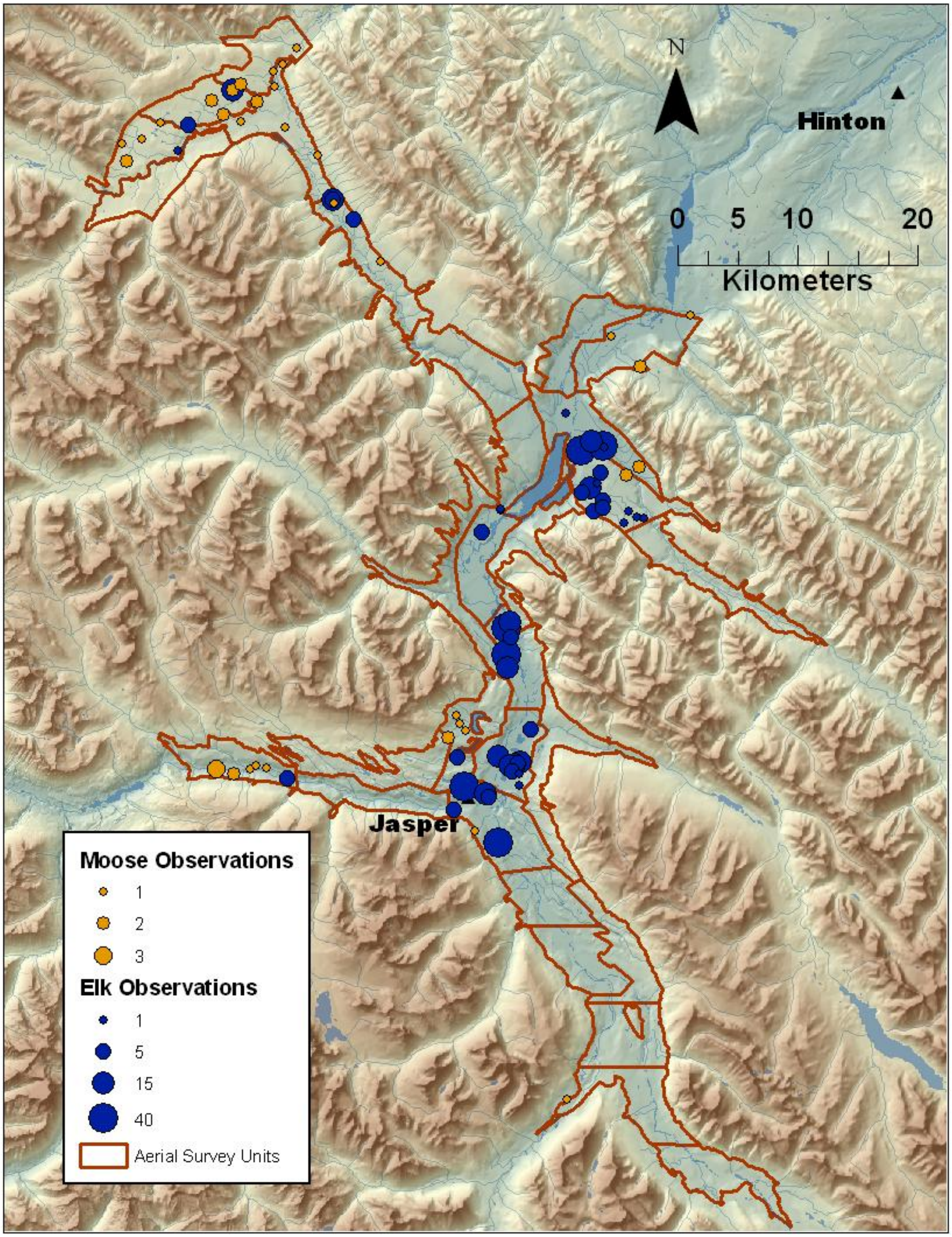
The survey was conducted over 5 consecutive days from January 6th to January 10th, 2009. Twenty units were flown including 13 units that had been flown in 2008 and 7 units that were flown for the first time in 2009. A total of 848 animals were observed (table 2) including 5 of 7 species of ungulate present in the park (neither caribou nor mountain goats were observed in the montane survey units). The largest concentrations of elk were observed in and around the townsite, near the airstrip, and at the base of the Rocky River burn (figure 2). Most moose observed were near the Dominion meadows, and the Snake Indian (figure 2).

**Table 2. Aerial survey results summary, Jasper National Park 2009 (strata, and sightability corrections provided for moose and elk only).**

| Species | Units Flown (high, med, low) | Total Units (high, med, low) | Raw Count | Sightability Corrected (90% CI) |
|---|---|---|---|---|
| Elk | 20<br>(5, 7, 8) | 30<br>(5, 11, 14) | 348 | 435 (67) |
| Elk (counts corrected using digital photos) | 20<br>(5, 7, 8) | 30<br>(5, 11, 14) | 359 | 445 (67) |
| Moose | 20<br>(5, 10, 5) | 30<br>(5,16, 9) | 52 | 296 (245) |
| Bighorn Sheep | | | 260 | |
| Whitetails* | | | 107 | |
| Mule Deer* | | | 52 | |
| Wolves | | | 6 | |

*An additional 23 deer were observed but species was not determined.

**Figure 2. Locations of elk and moose observations (by group size) from aerial surveys conducted in Jasper National Park, January 2009.**



## Discussion

The aerial survey program corrects for missed animals using logistic regression models to quantify the probability that an animal or group of animals will be seen given a number of variables (i.e. group size, snow cover, vegetation cover, etc.). These corrected observations are then extrapolated to survey units not flown. This method introduces three sources of variance (sampling, sightability, and model). Sampling variance is reduced through accurate stratification of subunits and by increasing the percentage of units flown within each strata. For instance, flying all units within a single strata reduces sample variance to 0, while observing equal numbers of animals in each unit within one strata also reduces variance estimates.

The high degree of variance calculated in the moose population estimate comes mostly from observations in the medium strata (appendix 2). Despite restratification of the survey units this high level of variance continues to disappoint. Both the sample and sightability variance are extremely high. While the sample variance may be explained by the fact that 10 of 16 medium strata units were flown (compare high strata were all 5 units were surveyed resulting in 0 sample variance), the high sightability variance is not easily explained. The authors of the moose sightabiltiy model state "The sensitivity of the variance components of this model suggest that surveys should be applied during early winter when moose are most likely to occupy open habitat types and estimates are most precise" (Unsworth et al 1994:62). Several of the moose observations are in cover greater than 60% canopy, causing the variance attributed to sightability within the model to inflate. As a result, the moose population estimates should be viewed with a level of caution. It is unlikely that the moose population within Jasper National Park increased from an estimated level of 180 (±130) in 2008 to 296 (±245) in 2009, but rather that the location of moose in high levels of canopy cover during January and February when elk surveys are best conducted, may limit the utility of this particular model.

In contrast to the moose model, the elk population estimates appear to be more consistent and reliable. The 2008 survey was conducted in late February with little snow cover and resulted in a population estimate of 410 (±73). The 2009 survey was conducted in early January when snow cover in most areas was 100% and resulted in a population estimate of 435 (±67). The high level of snow cover made detection of all species, including elk, easier as evidenced by the higher total count in 2009 (848 total observations) compared to 2008 (491 total observation). The model takes into account this higher detection probability however, resulting in comparable estimates between years despite disparate environmental conditions.

The use of digital photography in enumeration of large groups of elk had little effect on the total population estimate. Eleven animals were detected in the photographs that were not originally seen from the air.  As these animals were in generally open cover (i.e. the cutblocks above the townsite, and inside the Rocky River burn) the model did not inflate the population estimate beyond the number of additional animals observed.  However if these groups were in more dense cover the difference in model estimates would likely be greater.  As these sightability models were not originally developed using photographs to correct for missing animals but rather based solely on observer bias it is likely imprudent to correct counts from the air using this method.

The use of models developed in other regions may introduce a form of bias in our population estimates.  Although this bias is constant and therefore can be discounted when making comparisons between survey years, a more accurate estimation of real populations will be possible through development of a local sightability model.  Data collected during this survey regarding radio collared elk, both observed and unobserved, will be used to develop a sightability model peculiar to Jasper National Park.

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