Aishihik and Kluane Northern Mountain Caribou Herds Census, 2009

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SUMMARY

We conducted censuses of the Aishihik and Kluane northern mountain caribou herds during March 2009.

The Aishihik census met a key recommendation of the *Champagne–Aishihik Traditional Territory Community-Based Wildlife Management Plan (CATT Plan)*. The census of the Kluane herd fulfilled the monitoring recommended for small herds in the proposed *National Management Plan for Northern Mountain Caribou*.

There were 2044 caribou in the Aishihik herd (95% confidence interval: 1724 – 2507) and 181 caribou in the Kluane herd (95% confidence interval: 165 – 197). This estimate of the Aishihik herd indicates the management objective of 2000 animals has been achieved. This target was identified during the development of the CATT Plan. Results of these censuses indicate the Aishihik herd is growing at approximately 5% per year ($\lambda = 1.05$) and that the Kluane herd is declining at approximately 4% per year ($\lambda = 0.957$).

The results of these surveys suggest that the current management approaches for both herds are appropriate. In the Aishihik herd, the existing permit regime for licensed hunters has supported herd growth. The Kluane herd should remain closed to licensed harvest because of the continued population decline.

Snow depths during March 2009 were much higher than average and animals were generally aggregated in a few key drainages. Because of the severity of these winter conditions, these areas may represent key winter areas for these herds, and are identified in this report. Development interests in these areas should take into account the importance of wintering habitats for the Aishihik and Kluane caribou herds.

We evaluated a new method for population estimation in the Yukon, a dye-marking mark-resight approach. This approach shows promise for estimating the size of other mountain caribou herds and recommendations for its future use are also provided in this report.

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INTRODUCTION

The draft *Champagne–Aishihik Traditional Territory Community-Based Wildlife Management Plan* (2008 – 2013) identifies a population estimate (census) of the Aishihik mountain caribou herd as a key management objective in the area. To meet the objectives noted in the Management Plan and to assess whether the herd has reached the management target of 2000 animals (Hayes *et al.* 2003), Environment Yukon did a population estimate of the Aishihik woodland caribou herd during 4 – 15 March 2009.

The Aishihik herd was last censused in 1997 when a herd size of 1150 animals was estimated (Hayes *et al.* 2003). In 2007, 1475 animals were seen during a fall composition survey suggesting that the herd size had increased. While this was not a formal population estimate, it can be considered to be the minimum number of animals in the herd.

The adjacent Kluane herd (also known as the Burwash herd) is often surveyed along with the Aishihik herd because its proximity and small size means it can be done with minimal additional cost. The most recent count of the Kluane herd was in 2003 when it was estimated at 235 animals, based on a total count. There is currently no licensed harvest on the Kluane herd due to its small size. Under the Management Plan for the Northern Mountain Population of Woodland Caribou in Canada (currently under review) small herds such as Kluane receive a higher priority for monitoring due to their heightened risk of extirpation (local extinction) and decline (e.g., McLellan *et al.* 2010). Thus, estimating the size of the Kluane herd also meets Yukon government obligations under this national strategy.

METHODS

Animal Marking

We adopted a mark-resight approach (Neal *et al.* 1993, Gould *et al.* 2005, Skalski *et al.* 2005*b*) to estimate the size of both herds. From a helicopter, groups of animals were classified and tallied. We then attempted to mark ~20% of each group to reduce bias associated with differential group sizes (Skalski *et al.* 2005*a*). Animals were marked with a temporary oil-based dye (Skalski *et al.* 2005*a*, Pauley and Crenshaw 2006). Marks were delivered using a CO2-charged rifle (Tippmann A-5; Tippmann Sports LLC). Most animals were marked with a bright green dye, although some were marked with blue, red, or orange dye to compare detectability of different colours. Dyes (Nelson Paint Company) were non-toxic and were of the same type used by veterinarians in the livestock industry in the assessment of animal health. To avoid potential eye injuries, we focussed marking efforts on the hind quarters of the animals. We also avoided marking calves.

Our objective was to mark a minimum of 150 animals in the Aishihik herd. This number was determined based on simulations carried out using the software NOREMARK (White 1996) (Figure 1). These simulations indicated that with 2 resighting sessions (see below), an assumed population size of 2000, and a moderate survey intensity, marking any more than 150 animals would not meaningfully increase the precision (i.e., 95% confidence interval) of our estimate.

We used historical late-winter animal locations to guide our aerial search and to increase our efficiency by avoiding those areas that are never used by the herd during late-winter. Additionally, prior to marking we used a fixed-wing aircraft to survey the perimeter of the herd's range to identify the outer edge of the study area by locating tracks or animals. All marking was carried out using an A-Star rotary aircraft with a 3-member crew. One individual acted as the shooter and was positioned behind the pilot. A second member acted as the shooter's assistant and was also in the rear seat. A third member was the recorder/navigator and was positioned in the front passenger seat.

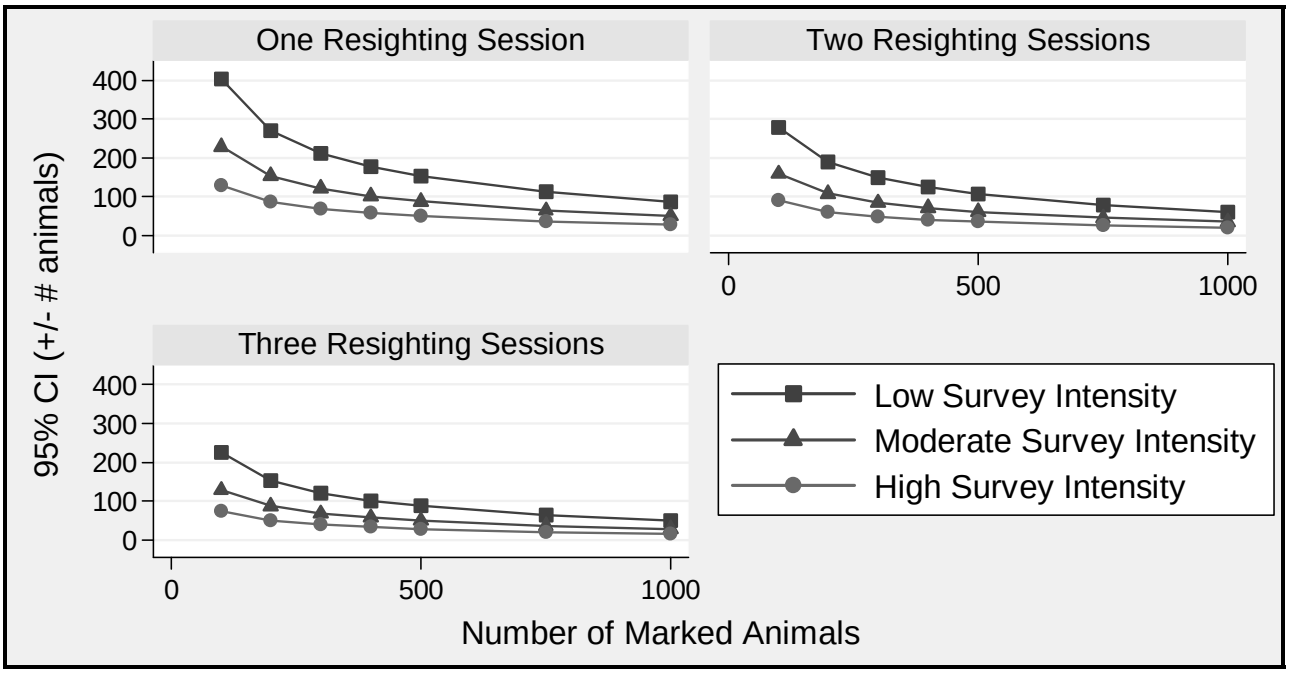

Figure 1. Simulation results for determining an optimal sampling strategy for the Aishihik mark-resight survey. Survey intensity is defined by sightability rates and characterized as low (0.50), moderate (0.75) and high (0.90). Simulations were carried out assuming a true population of 2000 individuals. Various combinations of resighting sessions, survey intensities, and numbers of marked animals were completed. The y-axis is represented by the width of the 95% confidence interval of the estimate.

Resighting Sessions

A few days after marking, we carried out 2 consecutive resighting sessions. Resighting crews were independent of one another and consisted of 3

observers and a pilot. Resighting surveys took place from a Bell 206B (Jet Ranger) helicopter. The pilot remained the same for both surveys but was instructed not to impart any information on animal locations to the second resighting crew to ensure independence between the 2 surveys. During the resighting surveys groups of animals were counted, the number of marked animals recorded and the number of calves recorded. Animals were not classified by sex to reduce the amount of stress given that an individual animal could potentially be exposed to 3 helicopter overflights within a few days. The first resighting session took place 7 – 9 March 2009 (Figure 3) and the second occurred on 10, 11, and 15 March 2009 (Figure 4). Table 1 provides the detailed numbers of animals counted and classified in both herds from both resighting sessions. Given the relatively short time frame between marking and each resighting survey, and because movements are much reduced during winter, we assumed that the population was both demographically and geographically closed during the survey (i.e. no animals died and no animals left or entered the study area).

Statistical Analysis

We used the program NOREMARK (White 1996) to estimate the size of the Aishihik caribou herd using a mark-resight approach. The population size was estimated by fitting the data to a joint hypergeometric distribution. Following data collection we were forced to change our analytical approach somewhat to accommodate unforeseen circumstances in the field this season. Animal marking was not as comprehensive and coverage not as complete as desired (Figure 2), primarily due to a large-scale range shift in the late-winter distribution of the Aishihik herd. We had initially used historical location data to guide our marking efforts but we found Aishihik animals were absent from traditionally high-use late-winter areas, possibly due to deeper than average snow (Figure 5). The average snow depth (1994 – 2009) at the Aishihik Lake snow course station on 1 April was 37.4 cm (SD = 9.5) but in 2009, Environment Yukon Water Resources Branch measured 60 cm of snow on the ground on this date.

Additionally, we could not use our preferred dye colour (bright orange) due to technical issues with the dye pellets. We believe the pellets were frozen in-transit to Whitehorse, warping their shape and causing them to burst in the barrel of the marking rifle. Following discussion with the resight crews it became apparent that only the green and blue dyes provided reasonable assurance that marks were not missed. Therefore, for analytical purposes, we considered only those animals tagged with green or blue dye to be “marked” (Table 2). We used the observed counts of marked and unmarked animals from 2 key drainages (Talbot Creek and Raft/Rockslide creeks) in the Aishihik range to estimate a detection rate for each resighting session. These values, in addition to the total number of animals marked in those drainages, were used to estimate the Aishihik herd’s size.

To estimate the overall size of the Kluane herd, we were forced to apply the Aishihik detection rate because we did not see any marked animals during either resighting session (probably because so few animals were marked). With a small sample of marked animals, the likelihood of not seeing any of those animals on subsequent resighting sessions was high, strictly due to random chance. The final herd size then represented a weighted average of the 2 resighting session's estimates, using the 'meta' package (Schwarzer 2010) for the statistical software R version 2.10.1 (R Development Core Team 2009). Throughout this approach, uncertainty in all estimated parameters was propagated to ensure that the estimate of precision (e.g., standard error) of the final population estimate was not biased low. That is, uncertainty at each level was integrated into the final estimate of uncertainty of the population estimate.

To differentiate between Aishihik and Kluane animals, we used a line, based on historical range use from radio-telemetry and survey data, drawn roughly due north of Brooks Creek as a boundary between Kluane animals to the west and Aishihik animals to the east. Further, as a northern boundary for our study we used the Nisling River, whereby all animals south of the river were viewed as Aishihik animals and animals to the north considered members of the Klaza herd. We did not fly north of the Nisling River.

RESULTS

Animal Marking

Overall we marked 127 animals (Aishihik – 122; Kluane – 5) from a total of 839 observed animals (Aishihik – 793; Kluane – 46) (Table 1, Figure 2). Marking took place on March 4, 5, and 7, 2009. In some cases when large groups were located we did not mark 20% of the animals because we felt it would have resulted in too much disturbance to the animals. Additionally, marking was stopped if animals were located in treed areas and it was deemed too dangerous to fly near enough to mark effectively.

Resighting

Detection rates between the 2 resighting sessions were very similar (Table 2) and indicated that nearly half of the animals were observed during each survey. During the first resighting session, 1012 and 87 animals were observed in the Aishihik and Kluane herds, respectively (Table 1). In the second resighting session, 928 and 85 animals were observed in the Aishihik and Kluane herds, respectively (Table 1). However, in the time between the 2 resighting sessions, a group of Aishihik caribou was seen at Little Buffalo Lake, representing an eastward range shift beyond the traditional winter range. The second resighting session included those animals (n = 48) but they were not included in the first resighting session's total. Thus, for estimating the Aishihik herd size, this group (corrected for detection) was subsequently included in the estimated total.

Table 1. Details of the numbers of animals counted and classified during the marking and resighting surveys of the Aishihik and Kluane herds, March 2009.

	Aishihik Herd	Kluane Herd
Marking Session		
Number observed	793	46
Total number marked	122	5
Resighting Session 1		
Number observed	1012	87
Calves observed	126	9
Calf percentage (95% CI)	12.5 (0.11 – 0.15)	10.3 (0.06 – 0.19)
Resighting Session 2		
Number observed	928*	85
Calves observed	94	7
Calf percentage (95% CI)	10.1 (0.08 – 0.12)	8.2 (0.04 – 0.16)

*Includes 48 animals observed at Little Buffalo Lake which were not surveyed in either the marking or first resighting sessions.

Table 2. Details of the numbers of marked animals counted and available to be counted in the Talbot and Raft/Rockslide Creek drainages in each resighting session used to estimate detection rates.

	Resighting Session 1	Resighting Session 2
Marked animals available	59	59
Marked animals counted	29	27
Detection rate (SE)	0.492 (0.065)	0.458 (0.065)

Population Estimation

The overall estimate of the Aishihik herd was 2044 animals (95% CI: 1724 – 2507). In keeping with historical reporting of Yukon caribou herd estimates, the 90% confidence interval was 1768 – 2420. This represents an increase from the size in 1997, with an average annual growth rate (λ) of 1.05, or an average increase of 5% per year. The pooled calf percentage for Aishihik was 11.3% (95% CI: 10.0 – 12.8; Table 3).

Using the detection rates from Table 2, the overall estimate of the Kluane herd was 181 animals (SE = 8.3), with a 95% and 90% confidence intervals of +/- 16 (8.8%) and +/- 14 (7.7%), respectively. This represents a decrease from the herd's size in 2003, with an average annual growth rate (λ) of 0.957, or an average decrease of 4.3% per year. The pooled calf percentage for the Kluane herd was 9.7% (95% CI: 5.8 – 14.6; Table 3). The estimated sex and age structure of both herds are provided in Table 3. Sex ratios obtained from the October 2009 composition surveys were used to estimate numbers of each class.

Table 3. Population composition of the Aishihik and Kluane caribou herds based on sex ratios estimated in October 2008 and herd sizes and calf percentage estimated in March 2009.

Parameter	Aishihik Herd	Kluane Herd
Population estimate (95% CI)	2044 (1724 – 2507)**	181 (165 – 197)
Calf percentage (SE)	11.3% (0.023)	9.7% (0.076)
Sex ratio (Bulls:100 Cows)	54:100	42:100
Bull ratio (Mature:Immature)	0.66	0.86
Number of calves*	231	18
Number of adult females*	1177	66
Number of immature males*	383	52
Number of mature males*	253	45
Annual growth rate (λ)	1.05	0.957

*Derived from age ratios collected during this study and sex ratios from the 2008 fall composition survey.
** Confidence intervals using the joint hypergeometric estimator in NOREMARK are based on profile likelihoods and are therefore not necessarily symmetric around the mean population estimate.

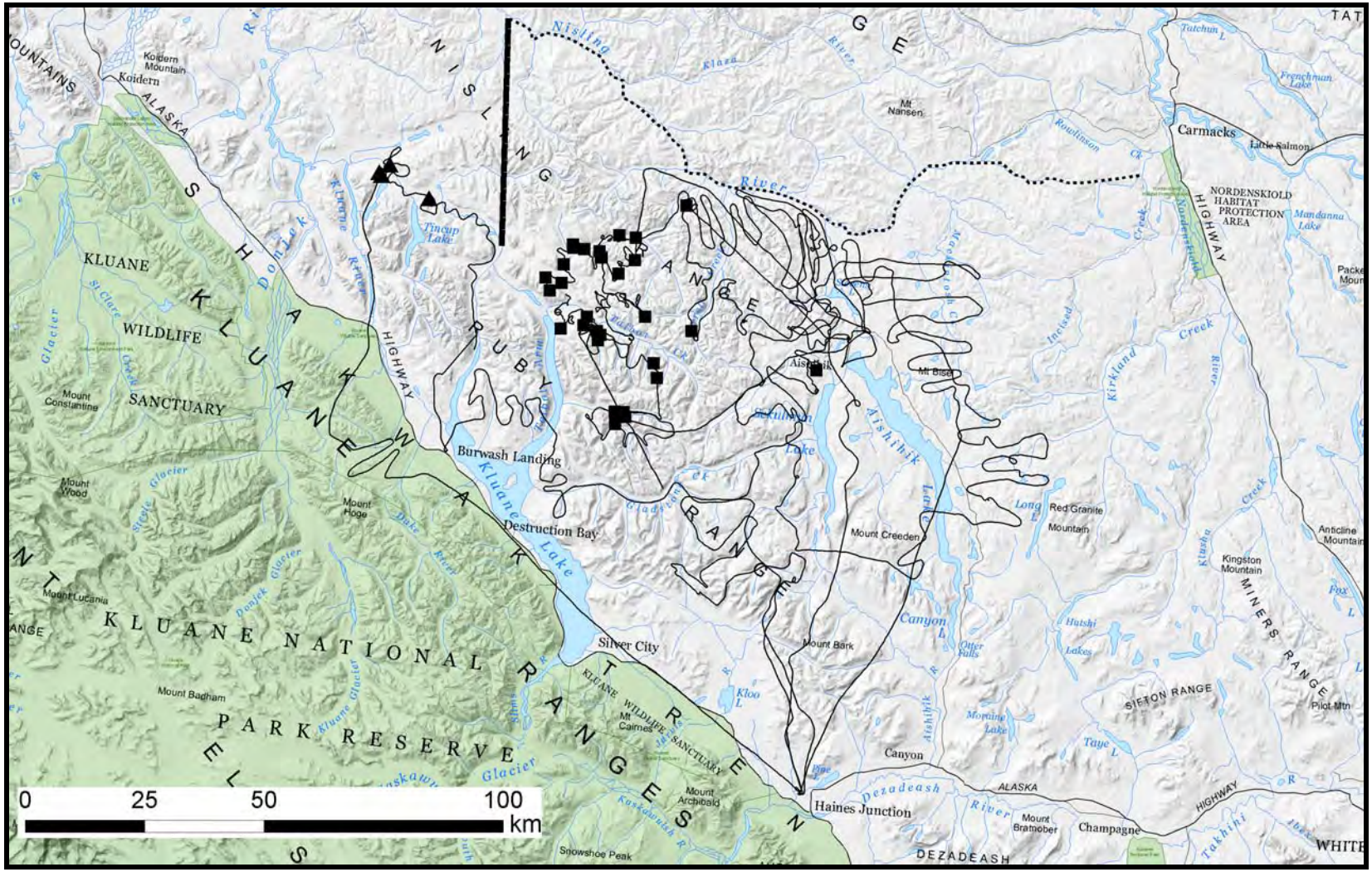

Figure 2. Locations where animals in the Aishihik (squares) and Kluane (triangles) mountain caribou herds were marked (4–7 March 2009). The thick black line north of Brooks Arm of Kluane Lake indicates the separation line between Aishihik and Kluane animals. The Nisling River is also highlighted with a dashed line and represents the northern boundary of the study area. Thin black lines represent flight tracks during the marking session.

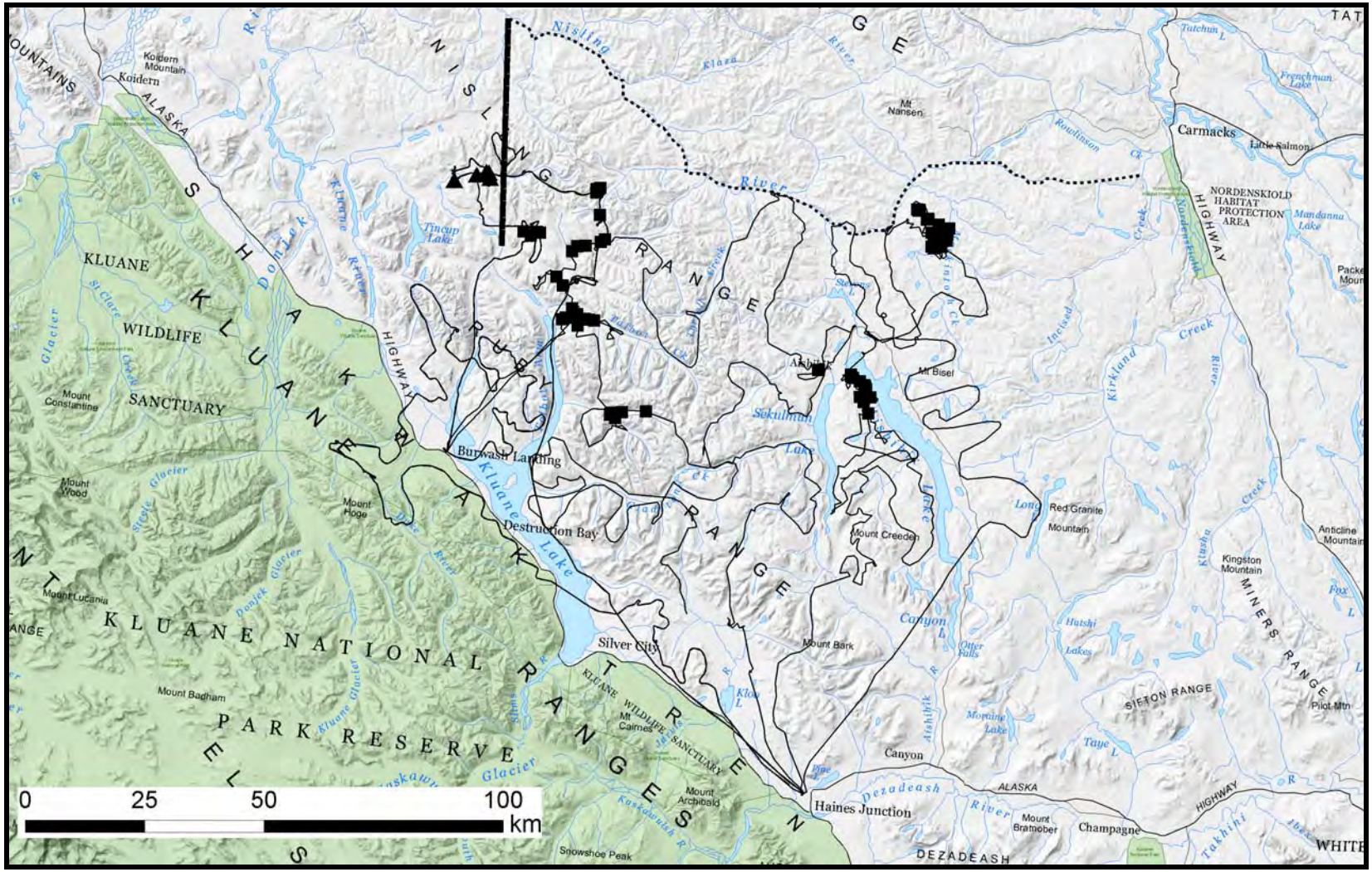

Figure 3. Locations where animals in the Aishihik (squares) and Kluane (triangles) mountain caribou herds were observed during the first resighting session (7–9 March 2009). The thick black line north of Brooks Arm of Kluane Lake indicates the separation line between Aishihik and Kluane animals. The Nisling River is also highlighted with dashed line and represents the northern boundary of the study area. Thin black lines represent flight tracks during the marking session.

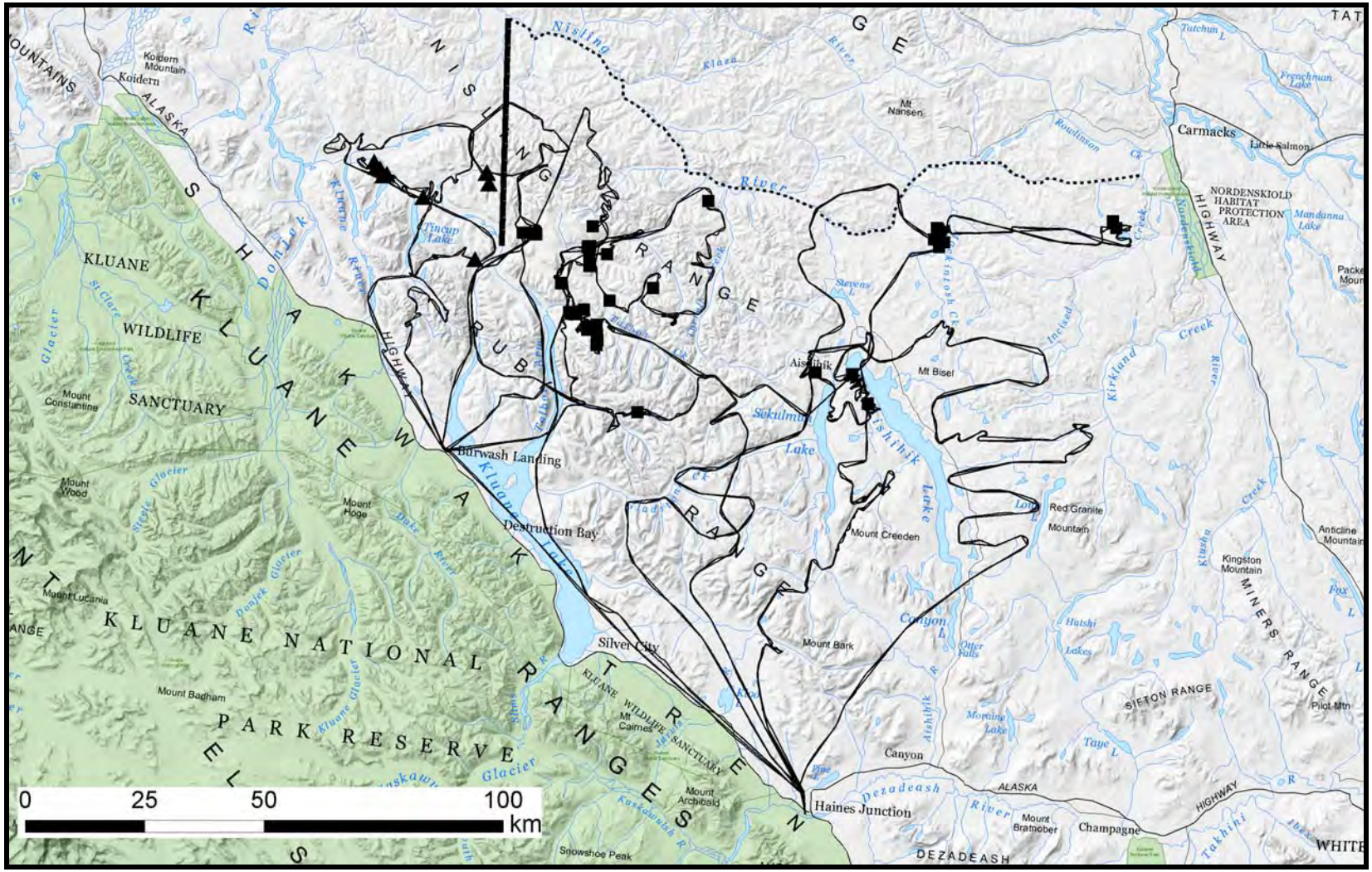

Figure 4. Locations where animals in the Aishihik (squares) and Kluane (triangles) mountain caribou herds were observed during the second resighting session (10–15 March 2009). The thick black line north of Brooks Arm of Kluane Lake indicates the separation line between Aishihik and Kluane animals. The Nisling River is also highlighted with a dashed line and represents the northern boundary of the study area. Thin black lines represent flight tracks during the marking session.

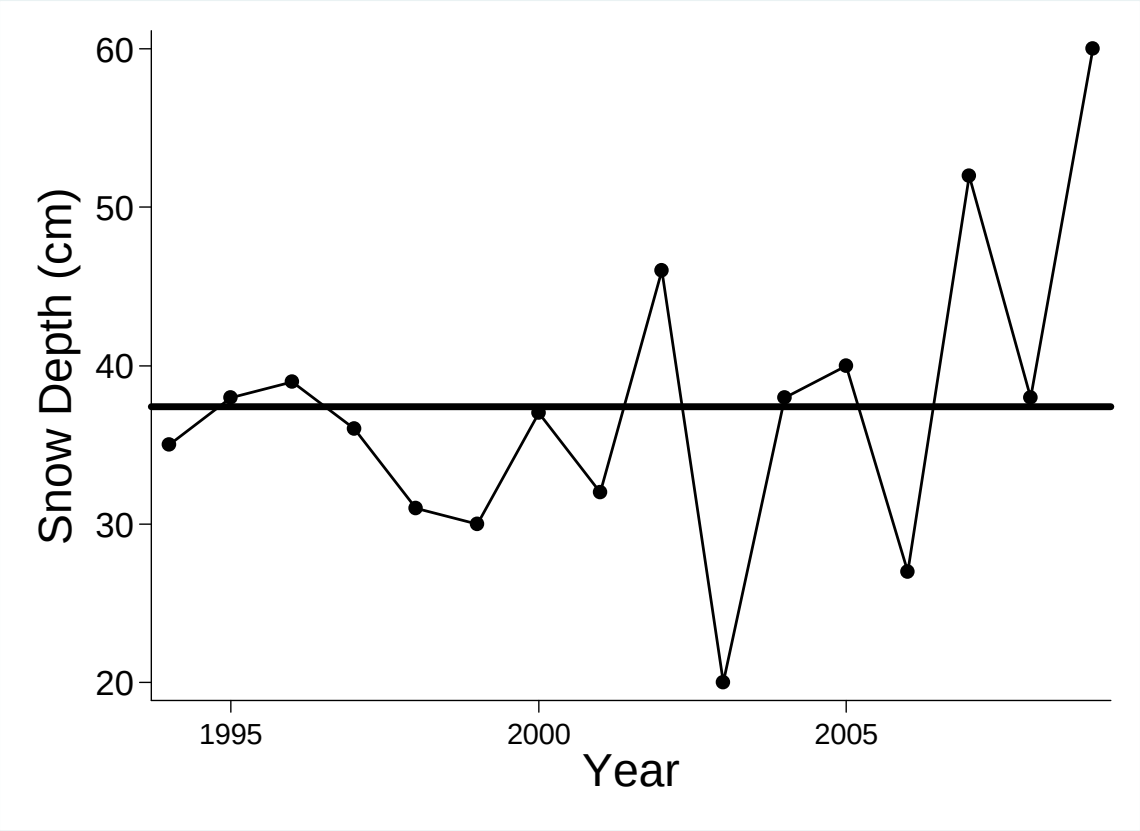

Figure 5. Late-winter snow depth (1994 – 2009) at Aishihik Lake (Water Resources Branch, Environment Yukon) measured on the first week of April. The solid black horizontal line represents the average (1994 – 2009) snow depth (37.4 cm).

DISCUSSION AND MANAGEMENT IMPLICATIONS

Aishihik Herd

The current population estimate of the Aishihik herd indicates the management objective of 2000 animals has been achieved. The current increasing trend (~5%/year) of the herd is a positive indication of its status.

The Aishihik herd is currently harvested under a permit system for licensed harvest. From 2002 to 2008, the average annual licensed harvest (resident + non-resident) was 19 animals per year (bulls-only). Given the increasing trajectory, the current harvest management system appears to be successful in providing hunting opportunities on the herd in a sustainable manner. Currently, 24 permits are available for licensed Yukon resident hunters. Three outfitting concessions are located within the Aishihik herd range and have negotiated caribou harvest quotas.

Management implications:

- Survey results suggest that current harvest management of the herd has allowed for growth. The permit hunt for licensed hunters, with the current availability of permits, should be continued.
- All harvest of the herd should be "bull-only". Recruitment in mountain caribou herds is highly variable from year to year and is often affected by annual climatic conditions. Thus, it is possible for recruitment to be poor for several years in a row. Any losses of adult females from the herd could have detrimental impacts on its growth and exacerbate poor recruitment, as these members are its "reproductive engines". The lack of adult female harvest of the herd may be one component in its observed increase. Recent population modelling for the Carcross caribou herd (Bakker and Heinemeyer 2009) indicated that that herd can remain stable in the presence of a moderate bull harvest (15–20 bulls/year).
- The high snowfall in the winter of 2009 (Figure 5) provided an opportunity to evaluate potential critical winter ranges as places where these caribou concentrate in extreme conditions. For the Aishihik herd, these areas are: Raft, Rockslide, Talbot, Dwarf Birch, and Mackintosh creeks. Additionally, aggregations of animals were located at Little Buffalo Lake and the northern area between Aishihik and Sekulmun lakes. Development interests in these areas should take into account the importance of these habitats to wintering Aishihik caribou.

Kluane Herd

The Kluane herd is one of the smallest herds in Yukon. Given its small size, it receives greater priority for monitoring under the *Management Plan for the Northern Mountain Population of Woodland Caribou in Canada* (currently under review). Licensed harvest of the herd is closed. The current estimate of 181 animals suggests the herd is declining at approximately 4% per year. This population estimate and trend should, however, be viewed cautiously as the resighting rate used for estimating the Kluane herd's size was based on Aishihik animals. Few animals were marked in the Kluane herd and they were located primarily in Tincup and Onion Creeks (Figures 2–4), a somewhat more treed area than where Aishihik animals were typically located. From all surveys flown, the entire herd appeared to be located within this region because no animals or animal sign (e.g. tracks) were observed elsewhere.

While the parameters used in estimating the herd's size may have been less than ideal, its small size and apparent declining trajectory are cause for concern. Recent research into the dynamics of small mountain caribou herds in southern British Columbia indicate that due to Allee effects (i.e., inverse density dependence), declining growth rates of these small populations may in fact accelerate as the herd becomes smaller (McLellan *et al.* 2010, Wittmer *et al.* 2010).

Management implications:

- Survey results support the current closure for licensed harvest of the Kluane herd.
- Another census of the Kluane herd should be done within the next few years to reassess the status of this herd, given its small size and apparent decline in numbers since 2003.
- The high snowfall in the winter of 2009 (Figure 5) may have resulted in animals congregating into key wintering areas. Thus, where we observed animals under these relatively harsh winter conditions may indicate critical habitats. For the Kluane herd, these areas are Tincup and Onion creeks. Proposals for development should take into account the importance of these areas to wintering Kluane caribou. Additionally, due to burned areas immediately north of this range, terrestrial lichen supporting habitats are likely to be reduced, furthering the importance of these creeks for this herd.

Dye-Marking as a Census Technique for Mountain Caribou

This was the first attempt at using a dye-marking mark-resight approach for estimating mountain caribou population sizes in the Yukon. Some of the benefits of using this approach are that it is based on sound and relatively straight-forward statistical theory, there is the ability to have a relatively high number of marked animals thus leading to good precision, marking animals in this way may be less stressful than other forms of marking such as collaring, and abundance is estimated rather than density. We provide a number of recommendations based on lessons learned from this survey.

Management implications:

- The distribution of the herd should be delineated to identify an appropriate study area prior to marking caribou, This will increase the efficiency of marking and ensure all animals are "available" to be marked.
- This population estimation approach appears to work best when carried out when animals have thinner coats allowing marks to be seen more readily. The visibility of marks may have been hampered by the thicker winter coats of caribou during late-winter. A similar dye-marking approach was used on the Aishihik wood bison herd in July 2009 when these animals had shorter coats and marks were much more visible.
- Blue appeared to be a highly visible colour, providing a strong contrast against the animal's natural coat colour. We tested a number of different colours for this census. Our preferred colour, bright orange, could not be used due to possible freezing of the dye balls during transit. From the trials in this study, and the wood bison study during the summer of 2009,
- The initial study design simulations provided a generally accurate estimate of observed precision. A key component of a study design should assess the numbers of animals to be marked. NOREMARK (White 1996) provides a very easy to use platform to undertake this step.

- A helicopter capable of providing the necessary speed and manoeuvrability should be used and marks needed to be deployed within approximately 10m. Our experience with an A-star suggests that this class is most appropriate for this work based on performance and relative cost.

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