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POPULATION ECOLOGY

Preliminary Assessment of Two Techniques for Estimating the Relative Abundance and Spatial Distribution of Wolves

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ABSTRACT

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.

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INTRODUCTION

Background

Woodland caribou (*Rangifer tarandus caribou*) in the Southern Mountain National Ecological Area were designated "threatened" by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) in 2002, were added to the Species at Risk Act (SARA) Schedule 1, and are a species at risk under the Forest and Range Practices Act (FRPA) in British Columbia (BC). Caribou are also commonly considered to be a leading indicator of biodiversity and ecosystem health in the boreal and sub-boreal forests (e.g., see ENGO programs such as Caribou Nation[1], Grey Ghosts[2], and Staring at Extinction[3]). In the late 1970s, the BC government sensed potential mismanagement of caribou with an apparent decline in populations and annual harvests exceeding 1,500 animals (MacGregor 1985). After curtailing hunting, caribou populations continued to decline and, despite the current legal status, the rate of decline indicates extirpation for many herds in a matter of decades (Wittmer 2004). The common denominator in this decline was considered by Messier et al. (2004) to be increased ungulate (other than caribou) populations that lead to increased numbers of predators and, hence, increased predation on caribou. Under those conditions caribou apparently suffer more incidental predation from wolves (*Canis lupus*) than would otherwise occur (Bergerud 1983, Seip 1992, Racey et al. 1999). The increased mortality is exacerbated because caribou are possibly more susceptible to wolf predation than other ungulates (Seip 1991, Seip 1992, Thomas 1995). Increases in non-caribou ungulate populations (e.g., moose, deer, and elk) have been related to the abundance of young seral forests resulting from logging (Hatter 1950, Wallmo 1969, Spalding 1990, 1992, Rempel et al. 1997, Rettie and Messier 1998). Roads and other linear corridors may also benefit predator search rates and allow predator's access to caribou in places that would otherwise be inaccessible (Jalkotzy et al. 1997; Bradshaw et al. 1997, James and Stuart-Smith 2000, Dyer et al. 2001). Corrective measures to reverse the decline of caribou therefore must involve predation mitigation either by managing early seral forest conditions, roads and linear corridors, non-caribou ungulates, predators, or a combination of these.

Forest Investment Account (FIA) Forest Science Program Project Y082065 entitiled "*The use of adaptive management to mitigate risk of predation for woodland caribou in north-central British Columbia*" provides a comparison of two management and one control treatments subjected to three different caribou herds in north-central BC. The first treatment implemented was an increased moose (*Alces alces*) harvest within the Parsnip herd area south of Mackenzie where current moose population levels have historically supported a large wolf population. The Parsnip study is managed by the Ministry of Environment. The second treatment implemented was the direct removal of wolves through regulated trapping in the Chase herd area. The removal of wolves was intended to lessen the direct impact of wolf predation on caribou. The Wolverine herd area received no treatment and therefore acts as the experimental control area. All mortalities to radio-collared animals (53 caribou) within the study areas are being

[1] http://www.caribounation.org
[2] http://23120.vws.magma.ca/work/caribou/index.php
[3] http://www.forestethics.org/article.php?id=1122

investigated to determine the cause of death. Radio-collared wolves are also being monitored to establish pack boundaries, determine pack size and locate kill sites. In order to establish how caribou populations are responding to the treatments, caribou population surveys (Giguere and McNay 2007) are completed in each study area during late winter and spring and fall calving surveys are completed to determine recruitment.

Hair Traps

Understanding grey wolf abundance and spatial distribution in areas where woodland caribou populations are threatened is an essential step to increasing caribou survival rates. Without accurate distribution and abundance knowledge of wolves within the study areas, proper monitoring and mitigation cannot be implemented. However, accurate information on grey wolves can be difficult to collect due to their elusive nature. Live capture of wolves to affix VHF (very high frequency) or GPS (global positioning system) collars provides high quality information, but can be very difficult, and locating packs is often left to chance. DNA (deoxyribonucleic acid) analysis through non-invasive hair removal traps presents a new approach to obtaining similar information or supporting information gathered from radio collaring. DNA hair trapping has achieved success with determining grizzly (*Ursus arctos*), black bear (*Ursus americanus*) and wolverine (*Gulo gulo*) distribution and population estimates throughout Alberta, British Columbia and Washington (Mowat et al. 2005, Romain-Bondi et al. 2004, Mowat et al. 2003, Poole et al. 2001, Mowat and Strobeck 2000, and Woods et al. 1999). The technique has yet to be extensively applied to wolves. Besides Poole et al (2001) incidentally capturing wolf hair while hair trapping grizzlies in Northeastern BC, to my knowledge there has only been one wolf specific hair removal project undertaken. David Latham successfully captured hair off wolves while conducting a hair removal program in Northern Alberta to determine the distribution of wolves, coyotes (*Canis latrans*), and black bears (personal communication, Nov 25, 2007).

Objectives

As part of this project our objectives here were to:

1. determine the feasibility and relative effectiveness of hair removal traps for DNA analysis as a technique for estimating the relative abundance and spatial distribution of wolves within the Chase and Wolverine caribou herd areas; and
2. determine the feasibility and relative effectiveness of scat transect surveys as a technique for estimating the relative abundance and spatial distribution of wolves within the Chase and Wolverine caribou herd areas.

STUDY AREAS

Study areas were the Recovery Planning Areas (RPAs) for two herds of woodland caribou described by Heard and Vagt (1998): the Wolverine and Chase herds (figure 1). The Wolverine herd derived its name from the Wolverine Range, a long range of mountains running north-south located on the east end of the study area, The Chase herd was named after Chase Mountain, which is centrally located within the Chase study area. The hunting of wolves is permitted throughout both study areas.

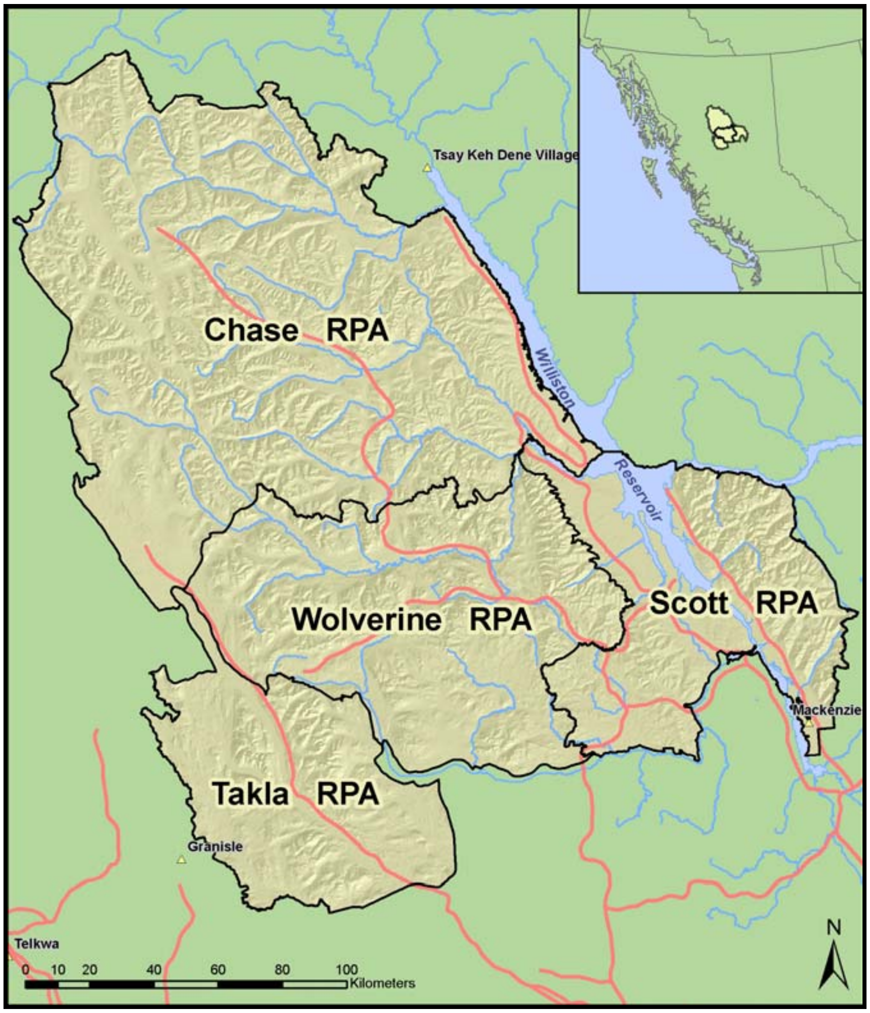

Figure 1. Location of recovery plan areas (RPA) for herds (Chase, Wolverine, Takla, and Scott) of threatened woodland caribou in north central British Columbia.

Wolverine

The Wolverine RPA is 844,313 ha, ranging in elevation from 676 to 2134m in rolling high-elevation foothills, and includes four major watersheds of the Omineca, Manson, Klawli, and Germansen Rivers. It is roughly bounded in the north by the headwaters of Goat, Nina, and Big Creeks, in the west by Takla, Tsayta, and Indata lakes, in the south by Tchentlo, and Chuchi lakes, and in the east by Sylvester and Gaffney creeks and the eastern slopes of the Wolverine Mountain Range. At low- to mid-elevations, the area is dominated by a Boreal White and Black Spruce subzone (BWBSdk1), two of the Sub-Boreal Spruce subzones (SBSmk1 and SBSmk2 variants), and an Engelmen Spruce-SubApline Fir subzone (ESSFmv3) dominates the mid- to high-elevations. The Alpine Tundra (AT) prevails above tree line. Extensive areas within the study area have been managed for production of timber. Two hair traps were established within the Wolverine RPA. One trap was set in the area south of Manson Lakes and the other near the junction of Silver Creek and the Omineca River.

Chase

The Chase RPA 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 biogeoclimatic variants, and at mid- to high-elevations the ESSF Omineca variant (ESSFmv3) predominates. The Alpine Tundra (At) prevails above the tree line. One trap was located within the Chase RPA. The Chase hair trap was set in the area East of Flatfish Lake, in close proximity to the Mesilinka River.

METHODS

Two hair removal sites were established within the Wolverine study area and one was set up within the Chase study area (figure 2). Figure 3 depicts our previous knowledge, gained through collaring and fixed-wing radio telemetry monitoring, of known wolves and their respective relocations for 2007 (8 additional wolves were collared in 2008). Traps were placed in areas where no wolves were actively collared. One wolf, W043W, was collared near the location for traps W-B01 and W-B02. However, W043W was not located again after capture during the winter of 2006/07 so the status of wolf packs in that area was still unknown. Traps were accessed with a Bell 206 Jet Ranger helicopter between December 18, 2007 and February 24, 2008. One hair trap (W-A02) was accessed by foot on March 3, 2008 during an attempt to live capture wolves using rubber padded leg hold traps.

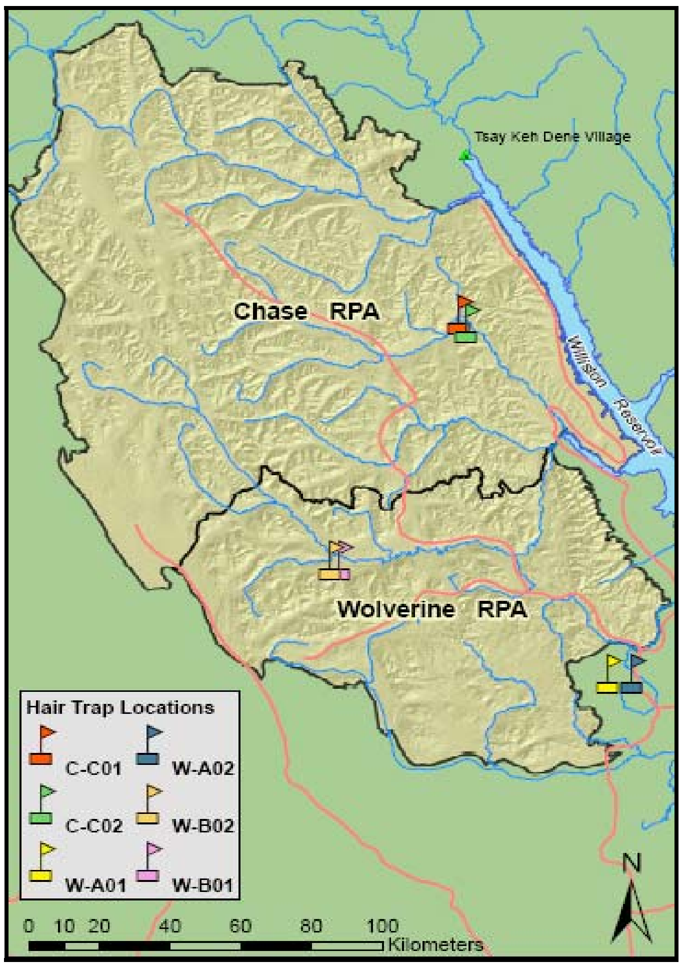

Figure 2. Wolf hair trap locations in the Wolverine and Chase study area for the winter of 2007/08

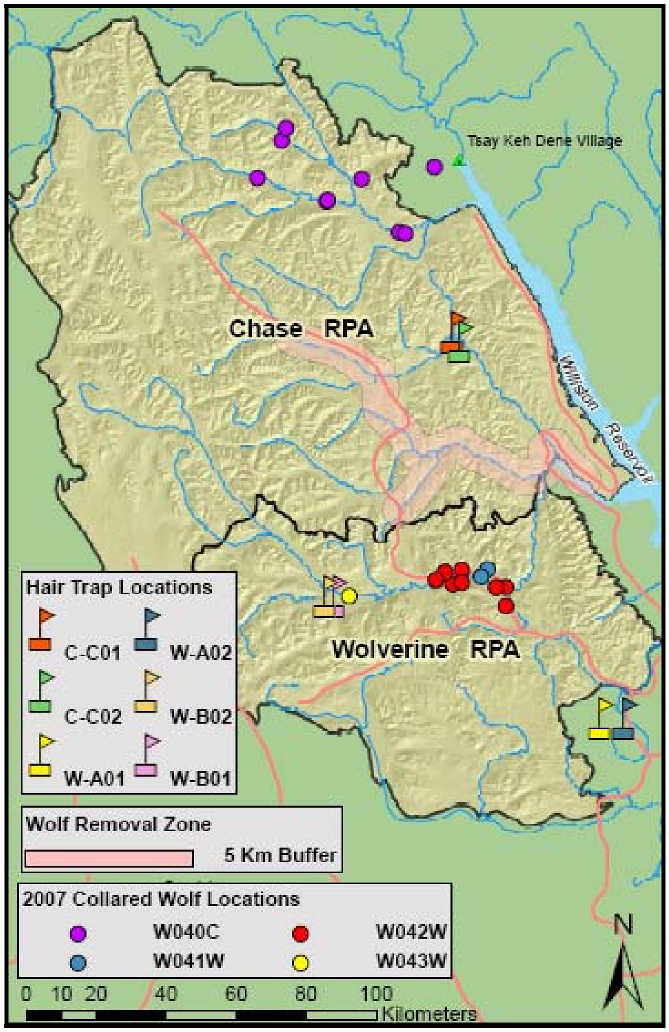

Figure 3. Wolf hair trap locations and collared wolf locations in the Wolverine and Chase study area for 2007

Hair trapping was conducted during the winter months in order to avoid grizzly and black bear interference with the bait. At each location two sites were chosen for trapping. Sites were chosen based on helicopter access, tree spacing and live capture potential (i.e. from helicopter) as criteria. Black spruce (*Picea mariana*) wetland complexes provided suitable locations for all the traps. At each trapping site three hair traps were set. The first trap consisted of one large trap baited with various forms of moose meat in addition to scent. The two remaining traps were smaller and contained approximately half the bait of the large trap with no additional scent. More desirable moose parts, such as the hides and heads, were always placed in the large trap. Wolves are extremely protective of their food and in order to obtain enough hair samples from a wolf pack three traps were required. Members of the pack, regardless of their dominance level within the hierarchy, will actively defend any food in their possession (Mech 1970, Mech 1999). The addition of two satellite traps allowed several wolves to feed, rather than just one dominant wolf thus prospectively increasing our sample size, as they were located approximately twenty meters away from the main trap and out of direct line of sight of each other.

A method for recording samples and trap locations was developed. Below is the standard we created, shown for clarification purposes when individual traps are discussed.

1. Study area, either Wolverine (W) or Chase (C)
2. Location
    a. Manson/Wolverine Lakes
    b. West Omineca River
    c. Flatfish Lakes
3. Site (1 or 2), there were two trapping sites per location
4. Trap (1 to 3), there were three traps per site
5. Strand (1 to ?) strands were added as the trapping progressed, recorded from bottom up, used for actual sample collection
6. Date, year/month/day

Example: W-A01-1-1-071204*
*Note: A sample number was added when hair samples were collected

Actual trap design was largely based on a similar trap design utilised for grizzly bears (Mowat and Strobeck 2000, Woods et al 1999). A trap consisted of two strands of barbed wire (15.5 gauge, 4 point, 5" barb spacing) set at 30-35 cm intervals around trees to form an enclosure (figure 4). The 30-35cm spacing interval was determined after examining shoulder height records of wolves caught in the study areas during previous live captures for radio collaring purposes. In the center of the barbed wire enclosure bait was placed. Bait consisted of quarters and heads from road killed moose or trimmings from local meat cutters frozen into manageable blocks. Bait such as quarters or rib cages were secured to a tree inside the trap with snare cable. Securing the bait prevented the bait from being dragged outside the enclosure, thus increasing the chances of obtaining more than one sample by causing the wolf to struggle with removing the bait. Skunk essence, mixed with glycerine to prevent freezing, was deployed as the primary scent. The mixture was poured into film canisters containing a cotton ball and then nailed high on a tree inside the main enclosure to allow the scent to carry in the air (Mowat et al. 2003).

During each revisit bait was restocked, hair was collected if present and additional barbed wire strands were installed depending on snow accumulation. Hair sample collection was done by hand as bare hands will not degrade the samples (Mowat et al. 2003). A single sample was equal to all the hair on one barb. After hair was collected off a barb, the barb was cleaned with a propane torch to prevent inaccuracies with future sample collections. Samples on strands that were buried under the snow were not collected and will not be collected until spring as DNA will not degenerate in the cold winter months, rather DNA is degenerated by warmer weather coupled with exposure to UV rays (Mowat et al. 2003). Sample storage methods had the possibility of affecting the success during analysis (Waits and Petkau 2005). Samples were stored dry in envelopes at room temperature (Mowat et al. 2003). Samples must contain the root of the hair for successful analysis (Woods et al 1999). Hair sample DNA analysis can be done through Wildlife Genetics International Inc. (Neslon, British Columbia, Canada).

Figure 4. A wolf hair trap (W-A02-2)

RESULTS

Hair Trapping

A total of 61 samples were collected from December 18, 2007 to March 3, 2008 during two collection periods (table 1). Time between trap establishment and the first collection period was 24 days. Nine samples were obtained in the first collection period. Time between the first collection period/re-baiting and the second collection period was 33 days. Forty-five samples were collected during the second collection period. W-A02 was collected from a third time, as the trap site was a location for live trapping wolves for radio-collaring later in the winter. Seven samples were acquired during this collection. Samples ranged from a single hair to large clumps of hairs containing 20 hairs or more. Samples were found on the bottom strand 94% of the time and on the top strand the remaining 4%. There was no sign of any wolves jumping over the wires into the traps. Wolf sign, such as tracks, diggings, urine, and scat, were found at all sites. All sign suggested that packs visited the sites rather than a lone wolf or even a pair. Wolverine and fisher sign was also present at many of the trap sites.

Table 1. Hair trap collection results in the Wolverine and Chase study area for the winter of 2007/08

Trap ID	Trap Established	Collection Period 1 (08/01/12-08/01/14)	Collection Period 2 (08/02/15-08/02/24)	Collection Period 3 (08/03/03)	Total Samples Collected
W-A01-1	07/12/18	0	4	NA	4
W-A01-2	07/12/18	0	0	NA	0
W-A01-3	07/12/18	4	2	NA	6
W-A02-1	07/12/19	0	3	2	5
W-A02-2	07/12/19	0	4	1	5
W-A02-3	07/12/19	2	1	4	7
W-B01-1	07/12/19	0	4	NA	4
W-B01-2	07/12/19	0	0	NA	0
W-B01-3	08/01/13	0	1	NA	1
W-B02-1	07/12/19	0	6	NA	6
W-B02-2	07/12/19	0	2	NA	2
W-B02-3	08/01/13	0	0	NA	0
C-C01-1	07/12/20	2	9	*	11
C-C01-2	07/12/20	1	1	*	2
C-C01-3	07/12/20	0	0	*	0
C-C02-1	07/12/20	0	6	*	6
C-C02-2	07/12/20	0	1	*	1
C-C02-3	07/12/20	0	1	*	1
TOTAL		**9**	**45**	**7**	**61**

* Traps did not get re-baited in collection period 2

To date, no hair samples have been analysed.

DISCUSSION

Hair Traps

Hair trapping has become a widely used non-invasive method of estimating the abundance and distribution of bears and even wolverines to a lesser extent. However, bears and wolverines exhibit much different behaviour than wolves and there was some scepticism at the beginning of this project regarding whether or not it was even possible to obtain hair from wolves using this or any method. The difficulty of trapping wolves due to their intelligence and keen senses is widely known. It was impossible to hide the hair traps and minimizing scent was very difficult. It appeared that once the wolves learned that they could access and consume the bait without harm, they had little worry about the traps. Different results may have been obtained in an area where wolves are or have been actively trapped for collaring or removal.

Following a strict collection and re-baiting schedule was not essential, as the project was only a preliminary assessment of the hair trapping technique, if fully implemented then a firm collection schedule would have to be maintained.

Although hair collection at all trap sites was successful, there are several suggestions for improvement that should be presented. The first suggestion is to start earlier in year, so that the wire lies under the snow from the onset. This will prevent wolves from digging under the bottom strand deep enough to crawl into the enclosure without leaving a sample. This suggestion is supported by the dramatic increase in number of samples collected during the second session, after the snow had settled over the bottom strand of wire (table 1). If future trapping commences earlier in the year, care must be taken to ensure that bears habituating the area have entered hibernation; an active bait pile will delay them from entering hibernation.

Choose sites with a central tree to act as a well placed anchor that will prevent meat from being pulled outside of the enclosure. Anchoring was an afterthought during this preliminary hair trapping program. Most enclosures did not include a center tree and therefore perimeter trees were often used. It should be noted that wolves will break through any bone and the meat will be removed despite the anchor, but by increasing the struggle the chance for hair removal increases.

Use 15.5 gauge barbed wire, it has a much lighter weight per foot and is easier to manipulate in the field. Weight was a reoccurring issue when using the jet ranger for transportation. Barb spacing and number of points was also important. Four point wire increased chances of obtaining hair.

Of the two wire spacings used, 30 and 35cm, 30 cm produced more samples. It seems likely that the reason for this is that the wolves had to crouch lower with 30 cm but couldn't crawl under the strand low enough to entirely avoid the wire. Another reason may be that we started out with 35cm spacing and switched to 30 cm after the first collection period. During the first collection period it would have been fairly easy for a wolf to dig under the bottom strand deep enough to avoid the wire altogether as there were no strands below it.

There is a possibility that some wolves may have jumped into the enclosure and ate the bait without leaving a sample. However, given the cautious nature of wolves, evidence of wolves digging under the wire, and the fact that the vast majority of samples were collected from the bottom strand where wolves had cautiously crawled under the wire rather than rushed in, it is doubtful that this occurred at all. Typically, when hair was found on the top strand it was due to the bottom strand being buried by snowfall or only a few centimetres of the top of the snowpack.

Even though it would add greatly to the expense of a project, trail cameras could help to verify success. We assumed that having three traps rather than one would increase the number of samples, but that was hard to validate. Cameras could allow the researcher to compare the number of wolves captured by film versus the number of individual samples collected. Although success is not guaranteed with cameras, lighting and lack of distinguishing features can make it hard to determine individuals, they would be very useful when used in combination with hair traps.

Heavy snowfalls this winter presented a problem. When returning to collect samples and re-bait, strands were occasionally buried by snow. New strands were added if this happened. It appeared that success was not affected by snowfall since hair was collected from each of the sites. It is rather likely that baits were eaten not long after they were put out. Ravens (*Corvus corax*) found the bait almost immediately. Between the powerful scents and the sight of the ravens gathering it would not have taken long for the wolves to find the bait before the snow had covered the wire. It was also possible that after the second round of baiting that investigating the trap sites was integrated into the packs' routine.

When traps are taken down once the ground is snow free, scat that has been deposited by wolves visiting the traps sites in the winter should be collected. The scat contains intestinal epithelial cells which can also be analysed to obtain the same results as the hair (Waits and Paetkau 2005). Any hair remaining on the wires would still provide a useful sample and should be collected.

None of the hair samples collected have been analysed in any form. Analysis was not necessary since the study design was such that analysis would only tell you how many individuals you removed hair from. The numbers could not be used in a mark recapture analysis. In addition the main objective was to assess the effectiveness of hair trapping wolves for possible future use in determining abundance and distribution. During our 2008 caribou census 8 wolves were caught for radio collaring. Hair samples were taken off these 8 wolves. Analysis for the purpose of matching collared individuals with certain packs would be beneficial. It would be especially valuable to determine if wolf W043W was alive. W043W was caught in 2007 near traps W-B01 and W-B02 and has not been relocated since. During capture a hair sample was taken, we could attempt to prove animal status (i.e. alive or still unknown) by DNA comparison with samples collected at the hair removal sites. If a match was proven it would suggest a faulty GPS collar.

By comparison to hair trapping, scat transects proved to be the more pragmatic and efficient method for assessing wolf distribution and abundance. Primarily, scat transects have a much lower cost associated with their implementation. All that is needed to complete them is a 2 person crew, a pickup truck, and all terrain vehicles (ATVs). To effectively hair trap to determine the abundance and distribution of wolves a grid of traps would have to be set throughout the study areas so that accurate mark-recapture analysis could be performed. Due to the remoteness of the study areas, especially in the winter when only arterial roads are snow-free, all traps would have to be accessed by helicopter. Woods et al. (1999) estimated the costs (Canadian funds 1999) of obtaining hair samples at approximately 5 dollars per sample, during a grizzly hair trapping project within a smaller study area using helicopters to access traps. The subsequent DNA analysis was estimated between 50 and 100 dollars per sample (Woods et al 1999). Considering that collared animals provide the highest quality information and that there are now 8 radio-collared wolves within the study areas our efforts should concentrate on adding collars to existing collared packs, and establishing collars on unknown wolf packs. Scat transects could be utilised to determine distribution and abundance of unknown wolf packs. Live trapping through rubber padded leg hold traps in the spring, summer, and fall could increase the sample size in these unknown areas. In addition, helicopter hours that would have been used to establish and monitor hair traps could be used for capturing more wolves in the winter. Once packs have a collared wolf within them, aerial capture is much easier as locating the packs can otherwise consume a large amount of time.

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