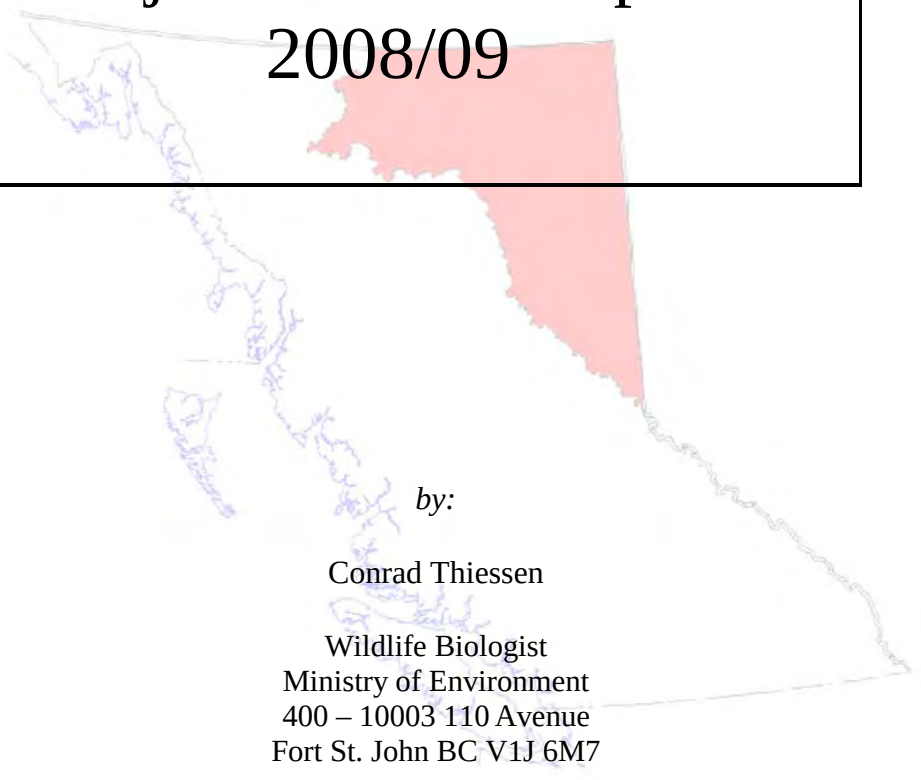
# Peace Wood Bison Project: Annual Report 2008/09



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## Executive Summary

Wood bison (*Bison bison athabascae*) historically inhabited north eastern British Columbia, but were extirpated by 1906. The BC Ministry of Environment re-introduced wood bison to two locations, Nordquist Lake area, and Etthithun Lake area, in 1995 and 1999, respectively. The herds are important for the recovery of wood bison in Canada, yet face a number of management challenges. This research program was developed to monitor herd size, demographics, behaviour and habitat requirements in order to better manage the herds, and to provide management direction and the ability to quantify the success of management actions.

Ground-based population monitoring of both herds was conducted by First Nations community members from the Kaska Dena and Doig River First Nation. Pre-determined transects were driven on established roads and highways through the known bison ranges and information on the number of animals, sex, and age were collected. To collect more detailed information on herd movements we deployed ten GPS (global positioning system) collars on female bison; five on the Etthithun herd and five on the Nordquist herd. The collars were fitted with reflective plating to make them more visible to motorists at night to increase human safety and reduce bison mortality. During the collaring effort for the Etthithun herd an attempt was made to enumerate as many bison as possible while searching for suitable individuals for collaring. Management actions completed over the last year included plowing travel corridors through the snow in the highway right of way adjacent to the Alaska Highway through a portion of the Nordquist herd's range.

During the six monitoring surveys of the Nordquist herd the maximum number of bison observed was 117 during the November 2008 trip. Percentage of calves in the herd declined from a high of 19.8 in October to 4.5 in March 2009. The Etthithun herd was surveyed by road four times. At the time of the surveys bison appeared to be using the habitats away from the Fontas road as no bison were seen on two of the trips and the maximum number seen was 14 on the January trip. Sample sizes for the Etthithun herd were too small to examine demographic parameters. In February and March the ten collars were deployed without incident. During the collaring effort for the Etthithun herd we counted 156 bison, of which 14.7% were calves. During the course of the year 17 bison were known to have been killed in motor vehicle collisions along the Alaska Highway. Between 27 and 45% of bison groups observed during road surveys in the winter months were in plowed sections of the highway.

Funding for this project was provided by the BC Ministry of Environment Conservation Framework, in-kind support from the Fort St John regional office of the Ministry of Environment, and Public Works and Government Services Canada.

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# 1.0 Introduction

## 1.1 Background

Wood bison (*Bison bison athabascae*, Rhoads 1897) historically inhabited the north-eastern portion of British Columbia (Figure 1), but were extirpated through most of their range by 1900 (Soper 1941). The last known individual of the original wild stock of wood bison in BC was shot near Fort St. John in 1906 (MacGregor 1952). The BC Ministry of Environment reintroduced wood bison to northeastern BC in two locations, Nordquist Lake area and Etthithun Lake area, between 1995 and 1999 (Harper et al. 2000). These herds have increased in number since that time, but management issues, such as mortalities due to vehicle collisions, have constrained the growth of both herds (Rowe & Backmeyer 2006, Rowe 2007). Additional management concerns include interactions with domestic bison (disease and genetic issues), displacement of First Nations trapping activities, and interactions with other ungulate species (see Harper et al. 2000 for more detailed account of issues).

This project was initiated to increase our knowledge of bison ecology and to monitor the effectiveness of various management efforts.

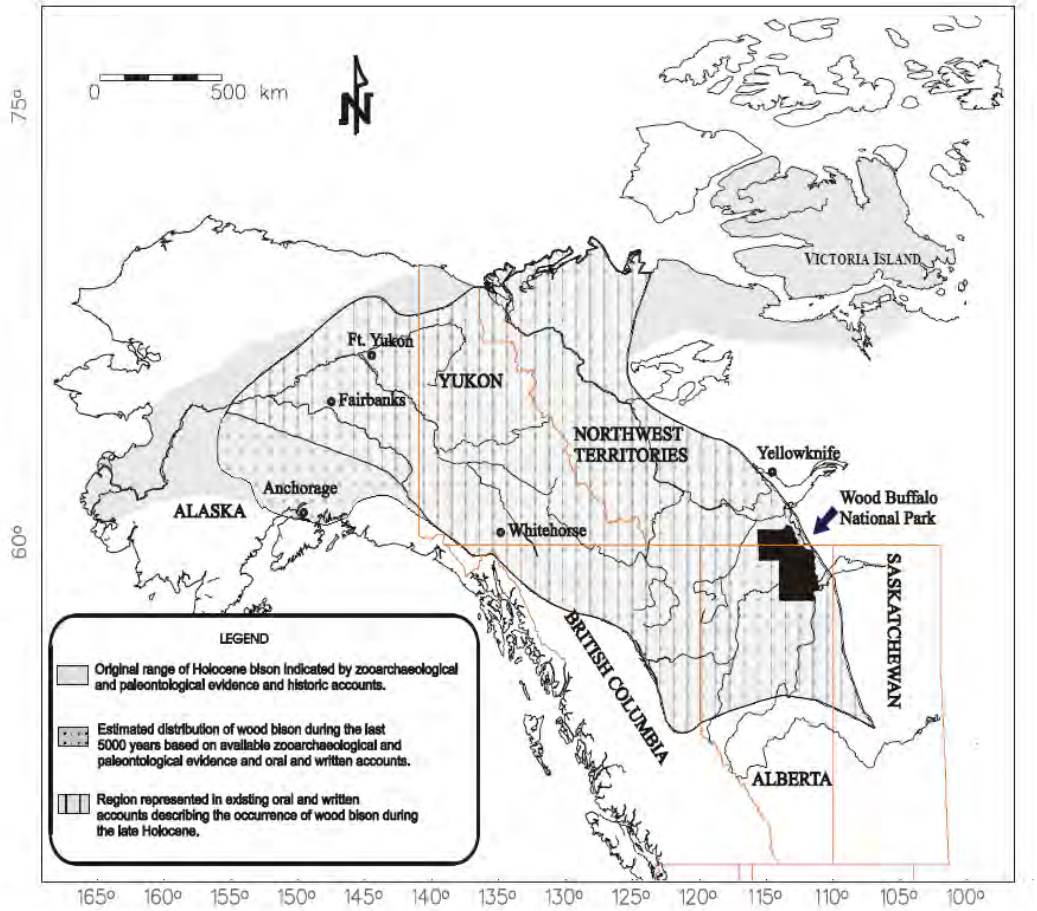


**Figure 1** Historical distribution of wood bison in western North America (from Gates et al. 2001).

## 1.2 Study Area

The study area is comprised entirely of the Boreal White and Black Spruce (BWBS) biogeoclimatic zone. This zone is characterized by long, cold winters and short, warm growing seasons. Wild fires are frequent in the zone and vegetation is generally slow growing (DeLong et al. 1990). The Etthithun herd overlaps the border with Alberta and the Nordquist herd is located near the Yukon border (Figure 2).

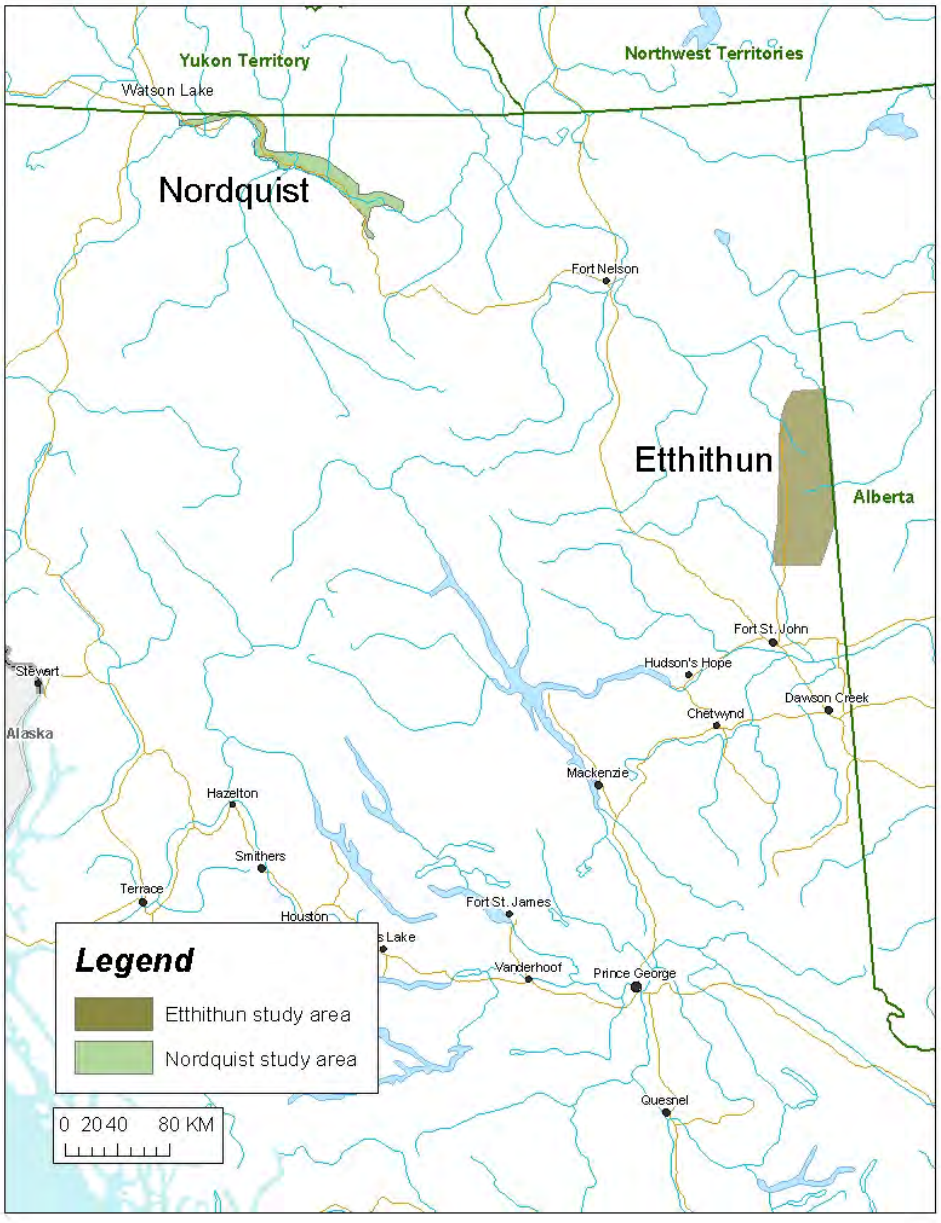


**Figure 2** Study area locations for Nordquist and Etthithun wood bison herds in north east British Columbia.

## 1.3 Objectives

The goal of this project is to manage wood bison in British Columbia in a manner that will lead to self-sustaining and increasing populations that will maintain ecological integrity, contribute to national wood bison recovery, and ultimately allow herds to increase sufficiently to permit consumptive and increased non-consumptive use opportunities in the future. We will address the following objectives with this project:
1) Investigate wood bison demography, distribution, habitat use, and seasonal movements
2) Reduce conflict between wood bison and people/agriculture,
3) Improve public safety and reduce mortality of bison from human causes,
4) Encourage community and First Nation involvement in wood bison management,
5) Devolop herd specific management plans to guide wood bison managment.


Photo C.Thiessen

## 2.0 Methods

### 2.1 Population Monitoring

Road-based classified counts were conducted on a monthly basis between October 2008 and March 2009. The transects were driven with 2 – 3 observers in a vehicle. Prior to starting the transect weather conditions (temperature, days since snow, and cloud cover) were recorded. When a bison group was encountered they were counted and classified. Classification categories included calf, yearling male, yearling female, unknown yearling, adult male, adult female, unknown adult. Classification was based on horn morphology (Figure 5) and external sexual characteristics. For each group encountered the behaviour was recorded (travelling or feeding), direction of travel, response to observers (no response, fled into trees, fled down road, approached vehicle), number of animals observed on the road surface, and latitude/longitude.

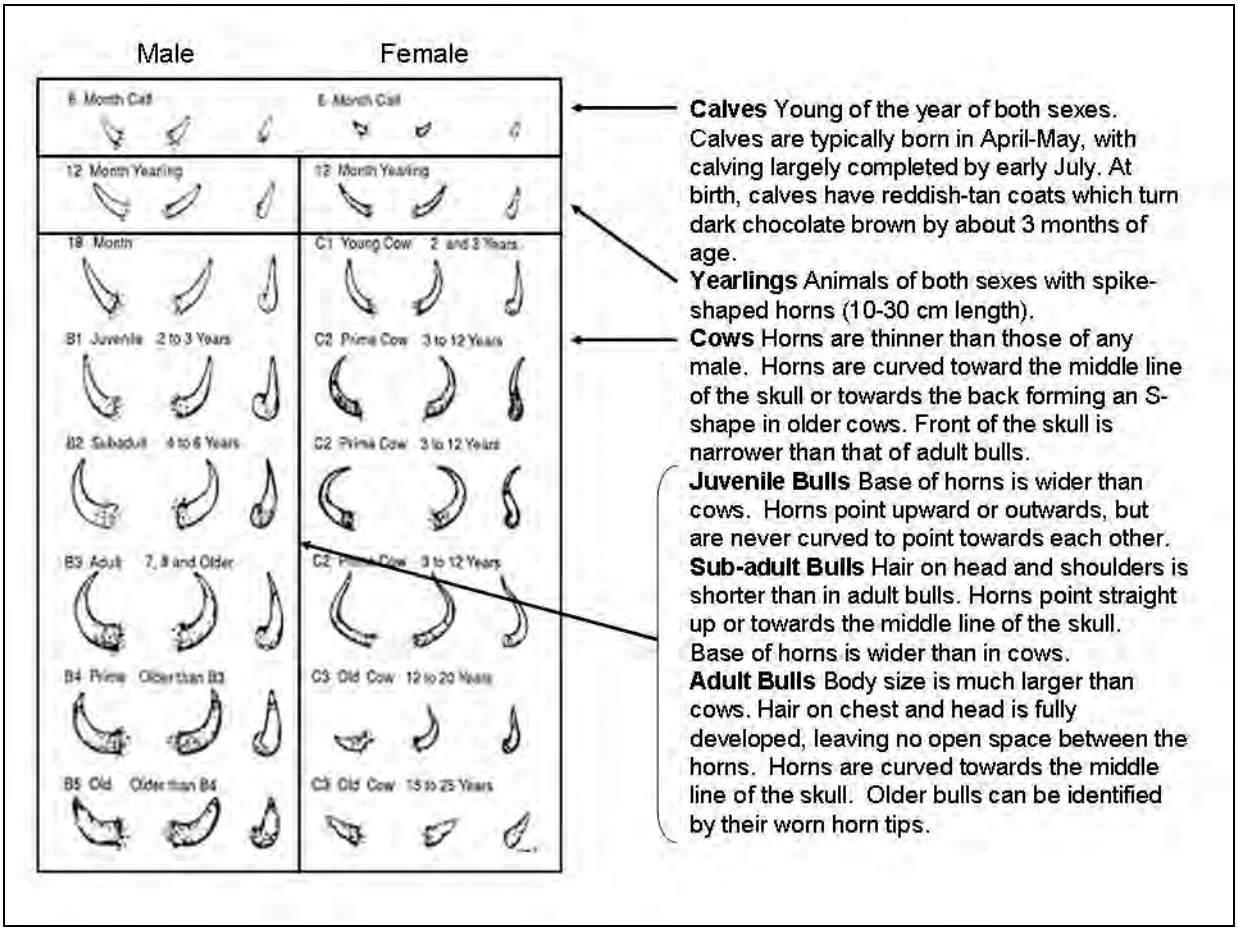


**Figure 3** Bison classification based on horn morphology (reproduced from the Government of the Northwest Territories web site accessed May 27, 2009: http://www.enr.gov.nt.ca/_live/pages/wpPages/wood_bison.aspx

Bison from the Nordquist herd were monitored by members of the Kaska Dena community at Lower Post (Pamela Moon, Floyd Frank, and John Groat). The route followed the Alaska Highway from the edge of Watson Lake (60.04716 º /128.65057º) to Muncho Lake Lodge (59.00953 º/125.77209 º; Figure 4). The transect is approximately 300 km long.

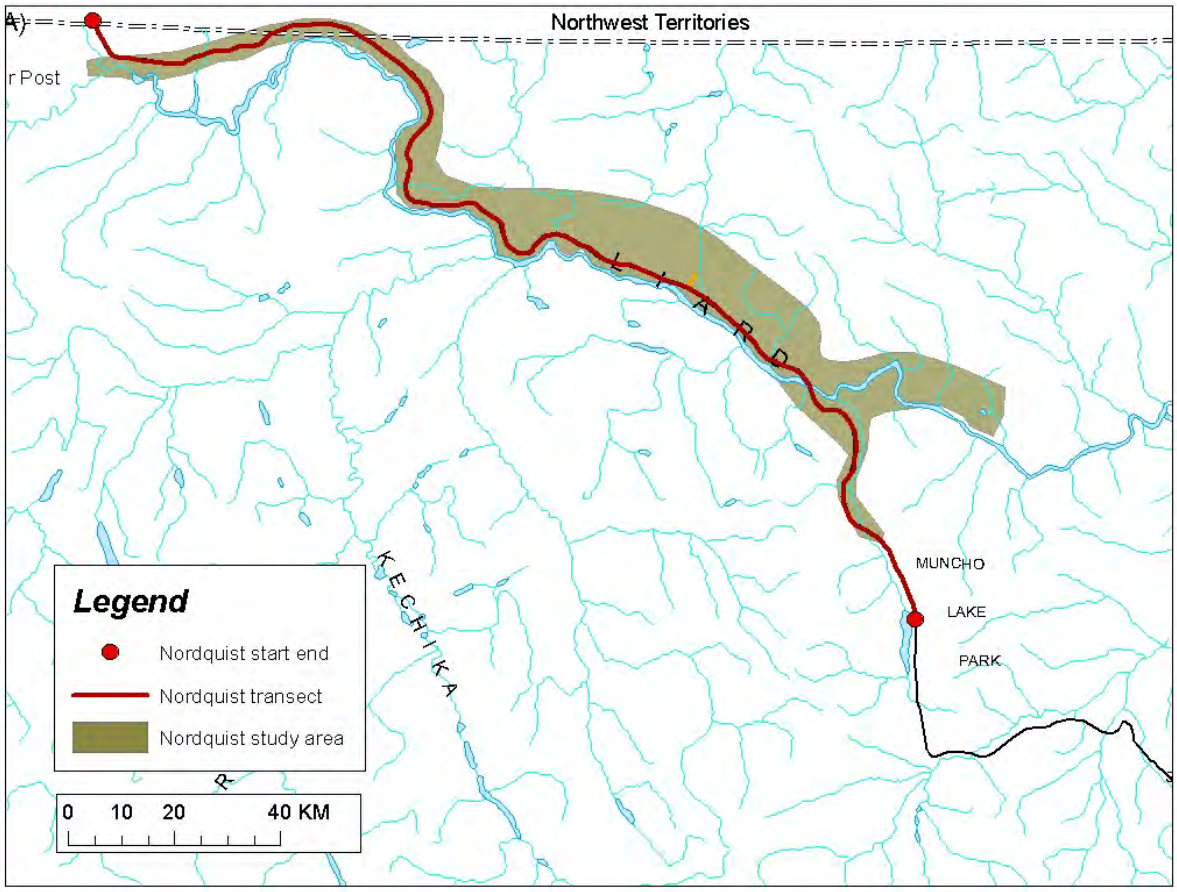


**Figure 4** Nordquist wood bison study area and population monitoring transect.

Bison from the Etthithun herd were monitoried by members of the Doig River First Nation (Annie Acko, Sammy Acko, Kevin Attachie, and Roger Pouce Coupe). The route followed the Fontas Road from kilometer 0 (57.04750°/120.57300°) to kilometer 120 (57.74226°/120.00000°) at the Alberta border (Figure 4). The transect is approximately 250 km long.

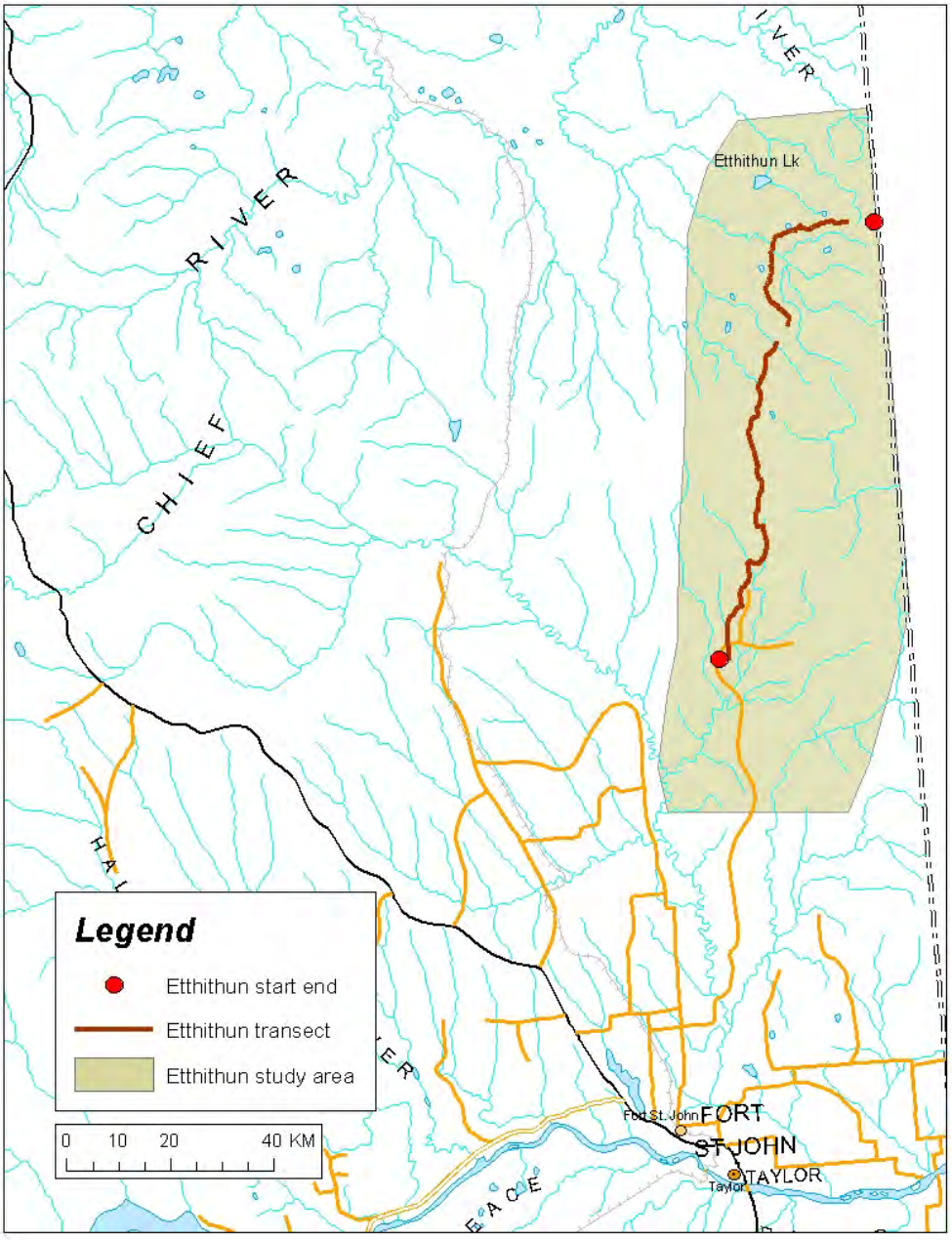


**Figure 5** Etthithun wood bison herd study area population monitoring transect.

## 2.2 Capture and Collaring

Five female bison from the Nordquist herd and five from the Etthithun herd were captured and collared with Lotek GPS3300L GPS (global positioning system) collars (Lotek, Newmarket, Ontario) in February and March 2009. The GPS collars were programmed to collect and store a location once per hour for 737 days, assuming an average fix time of 70 seconds per fix. Collars were equipped with VHF (very high frequency) beacons timed to transmit signals between 0900 and 1700, and to transmit a mortality signal when stationary for 8 hours or more. The belting length on the collars was 1 meter and adjusted to fit individual neck sizes. A release mechanism is timed to release collars 104 weeks after deployment and sensors inside the collar record ambient temperature and up/down movements of the head. To increase visibility of the collars for motorists a plate (8 x 13 cm) of white, reflective road sign material was riveted to a sheath of yellow fire hose tubing (13 cm wide) that covered the collar belting. All bison were ear-tagged with unique number identifiers.

Bison were chemically immobilized using a standard dose of 4 mg of the opioid carfentanil citrate (3 mg/ml Wildnil®, Wildlife Pharmaceuticals, Canada) with 50 mg of xylazine hydrochloride (100 mg/ml, Rompun®, Bayer, Canada) administered by a double ported needle Pneudart dart fired from a Pneudart (Williamsport, PA) tranquilizer rifle. Each cow was reversed using a standard dose of 500 mg (125 mg per mg carfentanil) of naltrexone hydrochloride (50 mg/ml Trexonil®, Wildlife Laboratories, Ft Collins, CO) that was administered by hand injection. For the Nordquist herd darts were fired from the ground or a truck at close range (<50 meters), and bison from the Etthithun herd were darted from a Bell 206B Jet Ranger helicopter at similar distances. Bison are dangerous and carfentanil is an extremely potent and dangerous drug to humans so immobilization and reversal were conducted by experienced and trained Ministry of Environment staff; wildlife veterinarian Helen Schwantje and wildlife biologist Rob Woods. Hair, fecal and blood samples were collected from all animals and stored by H. Schwantje in Victoria.

## 2.3 Etthithun Count

During the capture effort for the Etthithun herd all bison seen were enumerated while flying. The count was not systematic and did not cover the entire known range of the Etthithun herd. Incidental species were recorded also. Observers during the count were Roger Pouce Coupe, Helen Schwantje, Rob Woods and pilot Cam Allen.

## 2.4 Management Actions

In the winters of 2007/08 and 2008/09 the federal Public Works and Government Services Canada, who are responsible for maintaining the majority of the Alaska Highway, plowed trails through the snow in the highway right of way parallel to the highway. The plowed trails are to provide alternative travel routes for bison to reduce the amount of time bison spend on the road. The plowing occurred twice over the course of the winter, and covered the area between the Liard River bridge at Liard Hotsprings Provincial Park and the community of Coal River. Public Works and Government

services also recorded bison mortalities from motor vehicle collisions over the course of the year.

## 3.0 Results

### 3.1 Population Monitoring

The Etthithun transect was monitored 4 times (October 28, December 2, January 8, and March 10). No bison were observed during the October and March surveys, but 3 bison were seen in December and 14 in January (Table 1). Anecdotal reports of bison away from the transect were recorded by other Doig River First Nation members. They reported approximately 100 bison near Keyhole (KM70 of Fontas Road) while flying in the area for archaeology work on October 28. On March 10 there were reports of bison on the Ladyfern Road (KM 36 of the Fontas Road), and efforts were made by the monitoring crew to see these bison, but poor road conditions made it impossible to access the area. The sample size was too small to calculate calf/cow or bull/cow ratios for the Etthithun herd.

**Table 1** Wood bison count and classification results from the Etthithun transect in 2008/09.

| Month | Total | Calf | Yearling Male | Yearling Female | Adult Unkn | Adult Male | Adult Female |
|---|---|---|---|---|---|---|---|
| October 2008 | 0 | | | | | | |
| December 2008 | 3 | | | | | 3 | |
| January 2009 | 14 | 1 | 2 | | 4 | 4 | 3 |
| March 2009 | 0 | | | | | | |

The Nordquist transect was monitored 6 times (September 29, November 11, December 1, January 7, February 10, and March 7). Bison were observed during every survey, from a high of 117 to a low of 66 (Table 2). The average group size observed was 11 animals (range 1 – 103). The percentage of calves from the sampled part of the population generally decreased from fall through late winter with a high of 19.8% in October 2008 and a low of 4.5% in March 2009 (Figure 7).

**Table 2** Wood bison count and classification results from the Nordquist ground-based transect in 2008/09.

| Month | Total | Calf | Unknown Yearling | Male Yearling | Female Yearling | Unknown Adult | Male Adult | Female Adult |
|---|---|---|---|---|---|---|---|---|
| October 2008 | 81 | 16 | 2 | 4 | 5 | | 39 | 15 |
| November 2008 | 117 | 9 | 10 | 11 | 12 | 3 | 27 | 45 |
| December 2008 | 115 | 15 | 11 | | | | 39 | 50 |
| January 2009 | 109 | 10 | 17 | | | 8 | 43 | 31 |
| February 2009 | 81 | 7 | 14 | 1 | 1 | 14 | 18 | 26 |
| March 2009 | 66 | 3 | 8 | 1 | 1 | 10 | 24 | 19 |

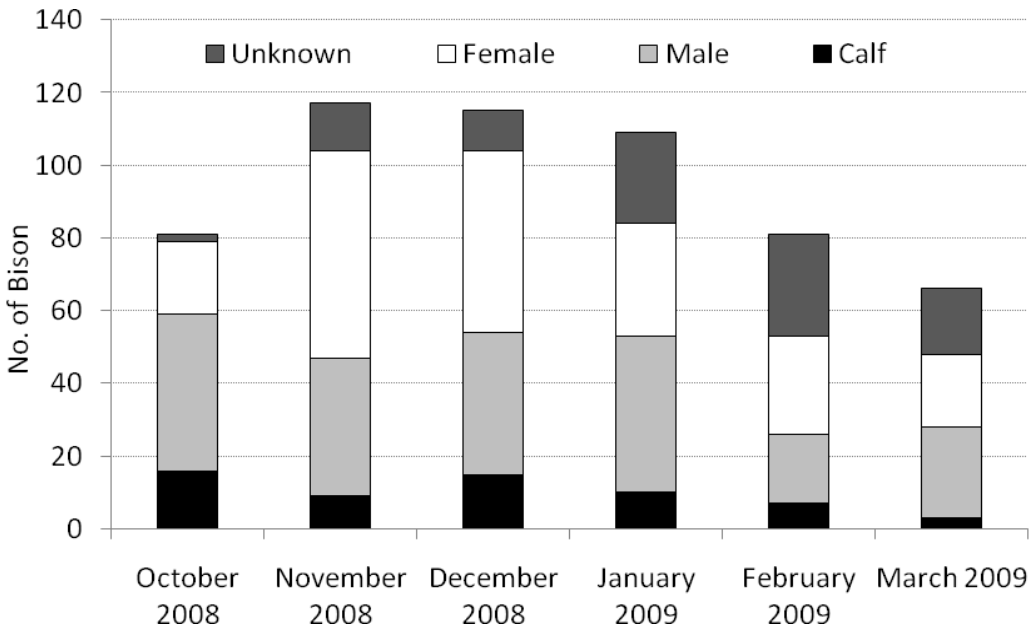


**Figure 6** Number of bison by gender for each of the survey periods from the Nordquist herd.

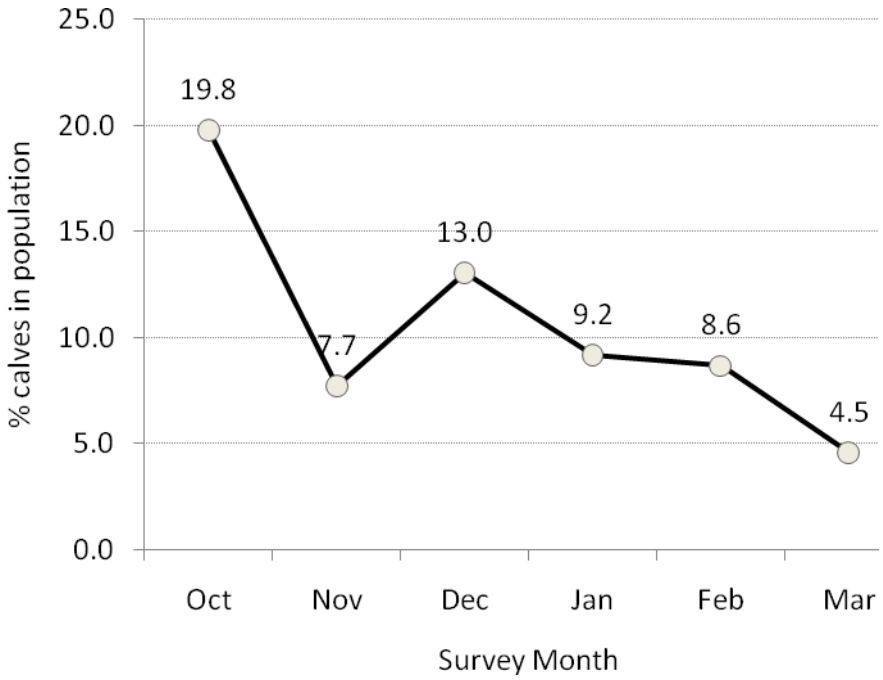


**Figure 7** Percent calves in sampled population by month for the Nordquist wood bison herd in 2008/09.

### 3.2 Capture and Collaring

On February 17, 2009 five female bison from the Nordquist herd were captured and collared, and on March 12, 2009 five females from the Etthithun herd were captured and collared. One female still had an ear tag (#99056) from the original re-introduction of the Etthithun herd, and was not re-tagged. The average length of time for immobilization with carfentanil was approximately 3 minutes. Revival following administration of the reversal agent took approximately 12 minutes. Anecdotal reports suggest the reflective collars are effective at making the collared bison more visible to motorists at night.

**Table 3** Wood bison collar frequencies, serial numbers, and ear tags for individuals captured from the Nordquist and Etthithun herds in late winter 2009.

| Herd | Frequency | Collar SN | Ear Tag |
|---|---|---|---|
| | 149.040 | GPS05479 | 99056 (metal) |
| | 149.060 | GPS05480 | 375 purple |
| | 149.080 | GPS05481 | 247 blue |
| | 149.100 | GPS05482 | |
| Etthithun | 149.180 | GPS05483 | 35 red |
| | 149.360 | GPS05484 | 37 orange |
| | 149.371 | GPS05485 | 56 green |
| | 149.400 | GPS05486 | 374 purple |
| | 149.440 | GPS05487 | 36 orange |
| Nordquist | 149.474 | GPS05488 | 40 orange |

### 3.3 Etthithun Count

During the capture effort of the Etthithun herd on March 12, 2009 we counted 156 bison (Table 4) between the Fontas River and Cautley Creek (Figure 8). Part of the search included the Alberta side of the range, and two groups of bison totalling 40 animals were seen there (included in the 156 total). Not all bison were classified by age and gender, but calves were identified when present. The percentage of calves relative to the sampled population was 14.7%. In addition to bison, 4 moose and 6 caribou were counted during the flight.

**Table 4** Location and classifications of bison counted during the capture effort for the Etthithun wood bison herd in March 2009.

| Lat | Long | Total | Calf | Yearling | Unknown adult | Adult Male | Adult Female | Collars |
|---|---|---|---|---|---|---|---|---|
| 57.69982 | -120.14026 | 1 | | | | 1 | | |
| 57.69927 | -120.23528 | 23 | 6 | | 17 | | | 2 |
| 57.68451 | -120.28416 | 5 | | | | 5 | | |
| 57.67723 | -120.30318 | 37 | 6 | | 31 | | | 2 |
| 57.68127 | -120.31858 | 1 | | | | 1 | | |
| 57.69470 | -120.31947 | 3 | | | | 3 | | |
| 57.86976 | -120.19013 | 10 | 2 | 2 | | | 6 | 1 |
| 57.90126 | -119.97465 | 14 | 1 | 2 | | | 11 | |
| 57.91525 | -120.00093 | 29 | 3 | 3 | 23 | | | |
| 57.87015 | -119.98568 | 26 | 4 | | 22 | | | |
| 57.19981 | -120.48779 | 5 | | 1 | | 4 | | |
| 57.85260 | -120.07455 | 2 | 1 | | | | 1 | |
| | **Total** | 156 | 23 | 8 | 93 | 14 | 18 | |

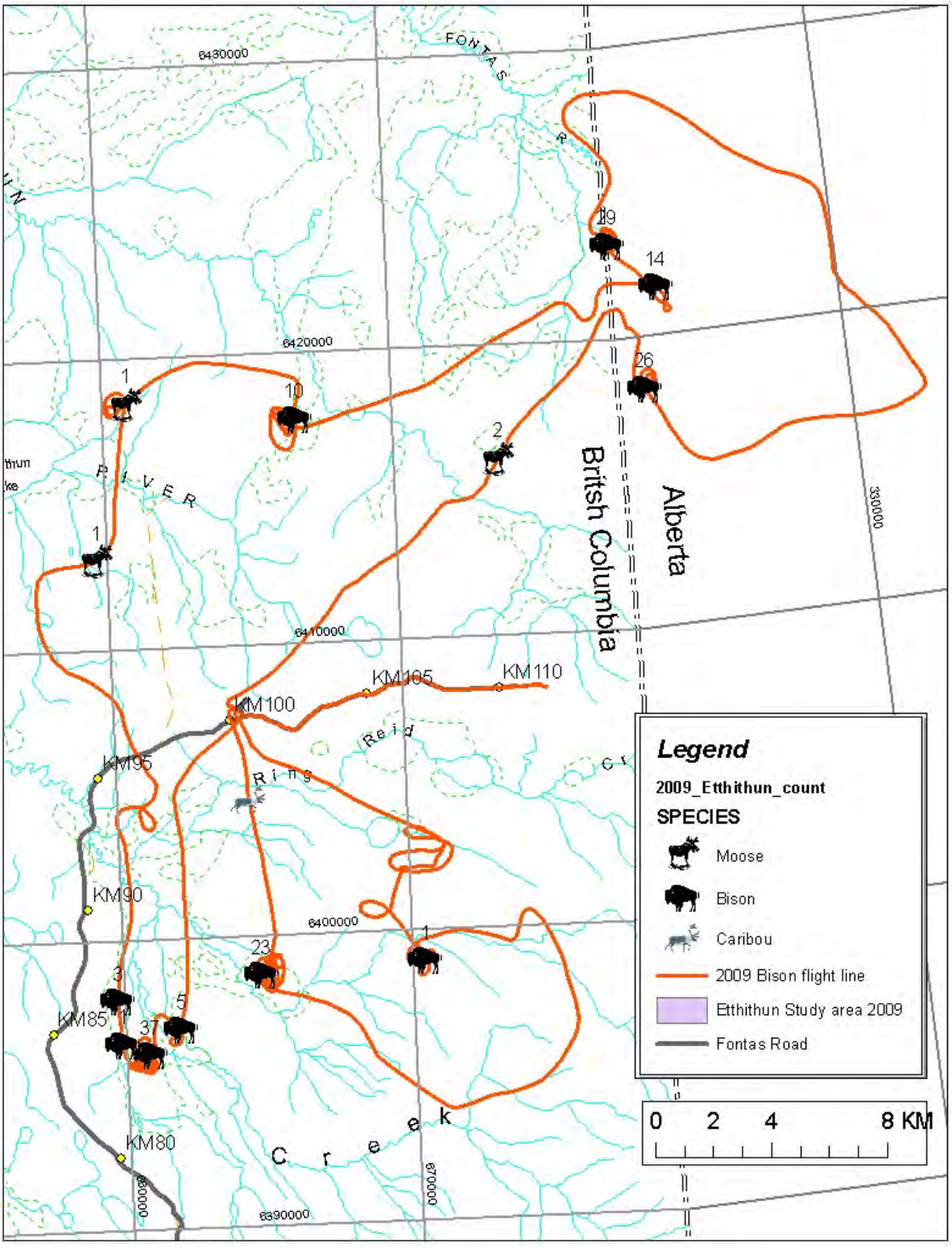


**Figure 8** Flight path and locations of wildlife spotted during the March 12, 2009 Etthithun wood bison capture effort and count. Numbers beside symbols represent the number individuals seen in that group.

### 3.4 Management Actions

During the population monitoring surveys bison groups were classified as being within the plowed section of the highway right of way or outside of the plowed area (Figure 9). In January 25% (n = 8 groups) of the bison groups were observed in the plowed section of the highway, in February 27% (n = 11 groups), and in March 44% (n = 9 groups).

17 bison were known to have died from the Nordquist herd due to collisions with motor vehicles (C.Leake, personal communication).

One bison bull was observed south of Muncho Lake near Mile 438 of the Alaska Highway on July 30, 2008. Al Hansen of BC Parks attempted to locate the animal to encourage it to move northward into the normal bison range, but was unable to locate it. It is presumed the animal returned north to join the rest of the herd as it was not reported again.

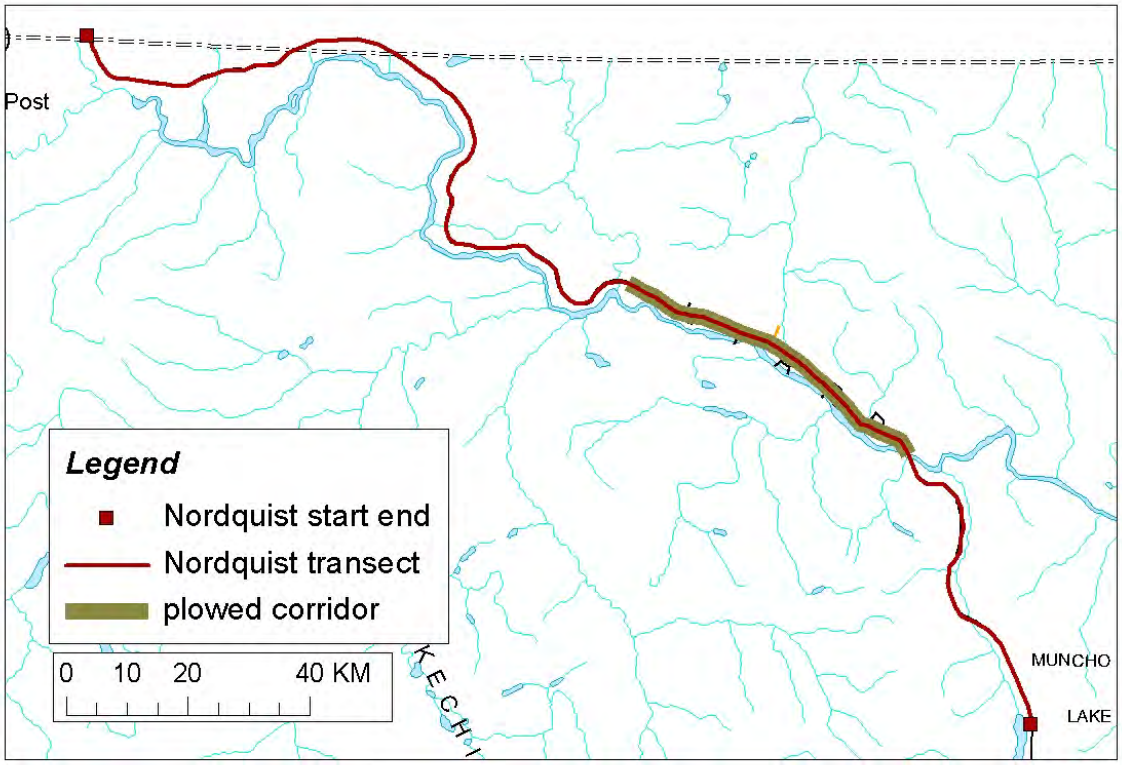


**Figure 9** Location of plowed travel corridors (Coal River to Liard River Hotsprings) for bison in highway right of way during winter months for the Nordquist wood bison herd. The southern end of the transect is Muncho Lake and the northern end is Watson Lake, Yukon.

## 4.0 Discussion

Only four ground-based surveys were conducted for the Etthithun herd, and few bison were seen. From the surveys and other anecdotal information it appears as though the Etthithun herd tend to use habitats away from the Fontas road during winter months. Bison tracks were seen on all surveys which indicates bison still use the roads during winter, but at reduced frequency.

A standard demographic measure for wildlife species is the number of young observed per 100 adult females. For the Etthithun herd the sample size obtained was too small during any of the surveys to permit this calculation. For the Nordquist herd we could not calculate calves:100 cows consistently across the survey periods due to a high proportion of unclassified adults (up to 34.6% in February 2009) in the sample. Bison, especially younger adults, can be difficult to assign gender when they are viewed from a distance, or when laying down, which leads to classification as 'unknown adult'. However, calves are easily recognized from other age classes, so an alternative to calves:100 cows is to classify the percentage of calves in the population, as done for the Nordquist herd. The percentage of calves in the sampled population declined from 19.8% in October to 4.5% in March suggesting high mortality of calves over the winter months. For the coming year of surveys it will be informative to track changes in calf survival from birth through late winter to determine periods of highest mortality.

For the Nordquist herd in January, February and March groups appeared to be smaller and more dispersed, while in September, November and December there tended to be one large group with several smaller groups or single animals (Appendix 4). We were not able to systematically quantify any preference for plowed corridors parallel to the highway as it was a continuous plowed section in the middle of the bison range. However the increased use of plowed areas in late winter may be due to increased snow depths and difficulty of travel elsewhere. A priority for the coming year will be to set up an experimental design that includes plowed sections and control sections with no plowing. The use of the plowed areas by bison will be monitored by road surveys and GPS locations from the five collared animals.

For the Etthithun count we focussed efforts in areas of presumed high quality winter range for bison and were able to count 156 bison. We had no way of calculating a sightability correction factor or number of animals missed in areas not surveyed. The count gives a minimum number of animals known to be alive in the area, and is not an estimate of the total population.

Positive steps are being taken through this project to increase our knowledge of wood bison and to ensuring their viability in British Columbia. These positive steps are possible by the continued cooperation and communication among First Nation governments, provincial government agencies, federal government agencies, and local communities.

## 5.0 Acknowledgements

Funding for the population monitoring, collar purchase and deployment, and the Etthithun count was provided by the BC Ministry of Environment Conservation Framework. Funding administration and assistance was provided by Joanne Neilson from the BC Conservation Foundation. Plowing travel corridors adjacent to the Alaska Highway for the Nordquist herd was funded by Public Works and Government Services Canada and coordinated by Colin Leake.

Sincere thanks to Chief Bill Lux for his support of the project within the Kaska Dena traditional area. Captures of the Nordquist herd were conducted by Helen Schwantje and Rob Woods (MoE). Capture assistance for the Nordquist herd was provided by Al Hansen (BC Parks), Sonja Leverkus (BC Ministry of Forests and Range), Colin Leake (Public Works and Government Services Canada), Pamela Moon, Floyd Frank, and John Groat (Kaska Dena).

Sincere thanks to Chief Norman Davis of the Doig River First Nation for his support of the project within the community's traditional area. Captures of the Etthithun herd were conducted by Helen Schwantje and Rob Woods (MoE).Capture assistance for the Etthithun herd was provided by Caitlyn Nelson (BC Ministry of Environment), Sammy Acko, and Roger Pouce Coupe (Doig River First Nation).

Cam Allen from Qwest Helicopters Inc. provided safe and skilled flying for the duration of the Etthithun survey and capture effort.

## 6.0 References

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## 7.0 Appendices

Appendix 1. Photographs.


Plate 1. Bison from Nordquist herd with GPS collar and ear tag. Photo C.Thiessen.

Plate 2. Roger Pouce Coupe of Doig River First Nation with immobilized wood bison from the Etthithun herd. Photo R.Woods.

Plate 3. Male wood bison from Etthithun herd. Photo C.Thiessen.

Plate 4. Pamela Moon, John Groat, Floyd Frank, and Colin Leake with immobilized female wood bison from Nordquist herd. Plowed alternate travel route in background. Photo C.Thiessen.

Plate 5. Plowing alternate travel route for bison in highway right of way. Photo C. Thiessen

Appendix 2. Observations of Etthithun wood bison herd from ground-based surveys in 2008/09.

| Date | LAT | LONG | Total | Calf | Unknown Yearling | Yearling Male | Yearling Female | Adult Unknown | Adult Male | Adult Female |
|---|---|---|---|---|---|---|---|---|---|---|
| 28-Oct-08 | | | 0 | | | | | | | |
| 02-Dec-08 | 57.81745 | -120.15523 | 3 | | | | | | 3 | |
| 08-Jan-09 | 57.69304 | -120.34449 | 14 | 1 | | 2 | | 4 | 4 | 3 |
| 10-Mar-09 | | | 0 | | | | | | | |

| Date | Observer1 | Observer2 | Observer3 | Cloud Cover | Temperature | Days Since Snow |
|---|---|---|---|---|---|---|
| 28-Oct-08 | Kevin Attachie | Sam Acko | Conrad Thiessen[1] | 5 | 6 | n/a |
| 02-Dec-08 | Kevin Attachie | Annie Acko | | 5 | -7 | 30 |
| 08-Jan-09 | Kevin Attachie | Annie Acko | | 5 | -34 | 60 |
| 10-Mar-09 | Sam Acko | Roger Pouce Coupe | | 0 | -40 | 90 |

[1] Other observers included Nick Baccante, Jane Calvert, and Jason Lee.

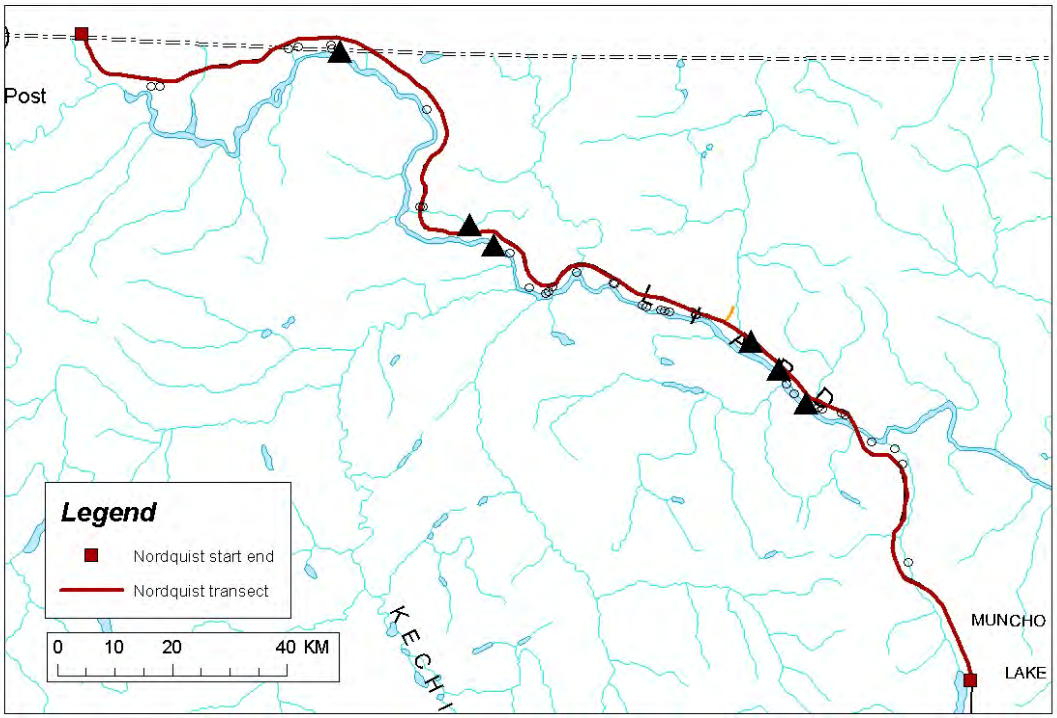
Appendix 3. Observations of Nordquist wood bison herd from ground-based surveys in 2008/09.

| Date | LAT | LONG | Total | Calf | Unknown Yearling | Yearling Male | Yearling Female | Unknown Adult | Adult Male | Adult Female |
|---|---|---|---|---|---|---|---|---|---|---|
| 29-Sep-08 | 59.72753 | -127.29734 | 76 | 16 | 2 | 4 | 4 | | 35 | 15 |
| 29-Sep-08 | 59.69726 | -127.22026 | 1 | | | | 1 | | | |
| 29-Sep-08 | 59.50616 | -126.33851 | 1 | | | | | | 1 | |
| 29-Sep-08 | 59.45369 | -126.25495 | 1 | | | | | | 1 | |
| 29-Sep-08 | 59.55028 | -126.42497 | 1 | | | | | | 1 | |
| 29-Sep-08 | 59.99712 | -127.71114 | 1 | | | | | | 1 | |
| 11-Nov-08 | | | 4 | | | | | | 4 | |
| 11-Nov-08 | | | 4 | | | | | 3 | 1 | |
| 11-Nov-08 | | | 3 | | | | | | 3 | |
| 11-Nov-08 | | | 1 | | | | | | 1 | |
| 11-Nov-08 | | | 7 | | | | | | 7 | |
| 11-Nov-08 | | | 98 | 9 | 10 | 11 | 12 | | 11 | 45 |
| 11-Nov-08 | | | 0 | | | | | | | |
| 01-Dec-08 | 59.9337 | -128.29439 | 4 | | | | | | 4 | |
| 01-Dec-08 | 60.00171 | -127.7339 | 1 | | | | | | 1 | |
| 01-Dec-08 | 59.75559 | -127.43997 | 4 | | | | | | 4 | |
| 01-Dec-08 | 59.65608 | -126.96239 | 1 | | | | | | 1 | |
| 01-Dec-08 | 59.60649 | -126.76037 | 103 | 15 | 11 | | | | 27 | 50 |
| 01-Dec-08 | 59.60292 | -126.74597 | 1 | | | | | | 1 | |
| 01-Dec-08 | 59.35824 | -125.95976 | 1 | | | | | | 1 | |
| 07-Jan-09 | 59.93381 | -128.26633 | 4 | | | | | | 4 | |
| 07-Jan-09 | 59.99992 | -127.86864 | 4 | | | | | | 4 | |
| 07-Jan-09 | 59.63201 | -127.10759 | 12 | | 4 | | | | 3 | 5 |
| 07-Jan-09 | 59.62263 | -127.05893 | 6 | | 1 | | | | 2 | 3 |
| 07-Jan-09 | 59.63303 | -127.03553 | 5 | | | | | | 5 | |
| 07-Jan-09 | 59.6063 | -126.75964 | 20 | 2 | 2 | | | | 11 | 5 |
| 07-Jan-09 | 59.43904 | -126.14445 | 2 | | | | | | 2 | |
| 07-Jan-09 | 59.39401 | -126.05396 | 56 | 8 | 10 | | | 8 | 12 | 18 |
| 10-Feb-09 | 60.00634 | -127.73638 | 3 | | | | | | 3 | |

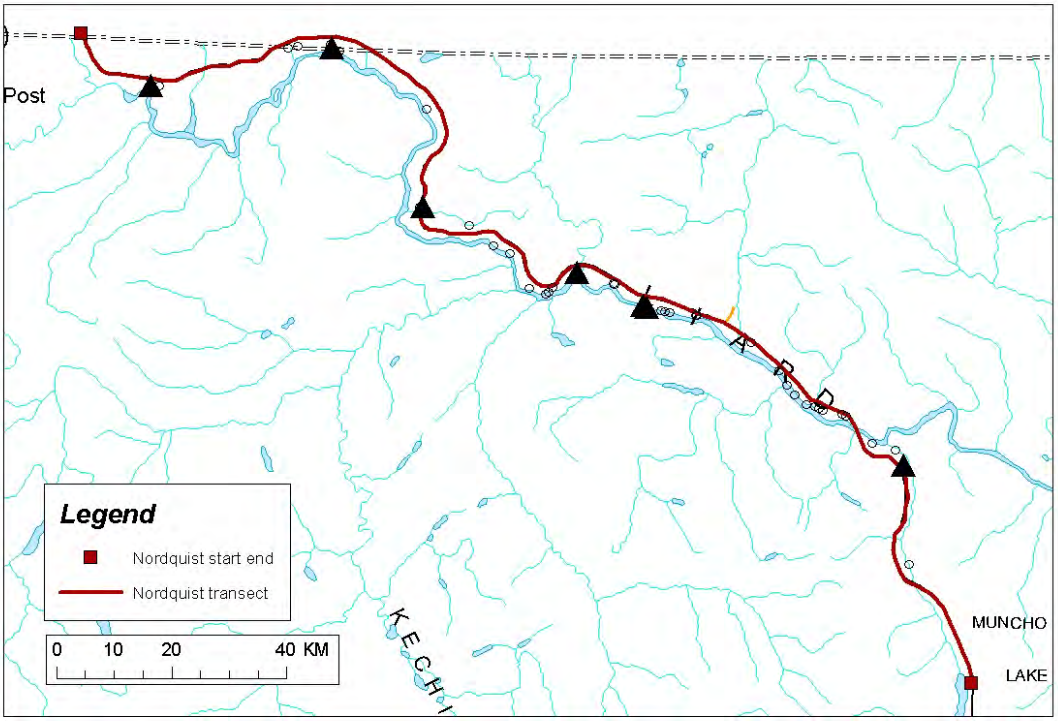
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-Feb-09 | 59.75564 | -127.45081 | 1 | | | | | | | 1 | |
| 10-Feb-09 | 59.68474 | -127.1705 | 2 | | | | | | | 1 | 1 |
| 10-Feb-09 | 59.6263 | -127.0486 | 1 | | | | | | | 1 | |
| 10-Feb-09 | 59.64119 | -126.8503 | 9 | 2 | 2 | | 1 | 1 | | | 3 |
| 10-Feb-09 | 59.59794 | -126.68986 | 21 | 5 | 7 | 1 | | | | 2 | 6 |
| 10-Feb-09 | 59.59246 | -126.59245 | 3 | | | | | | | 3 | |
| 10-Feb-09 | 59.48431 | -126.31361 | 5 | | | | | 5 | | | |
| 10-Feb-09 | 59.45024 | -126.22855 | 35 | | 5 | | | 8 | | 7 | 15 |
| 10-Feb-09 | 59.44521 | -126.20448 | 1 | | | | | | | | 1 |
| 10-Feb-09 | 59.38353 | -125.98318 | 0 | | | | | | | | |
| 07-Mar-09 | 60.00259 | -127.83933 | 1 | | | | | 1 | | | |
| 07-Mar-09 | 59.9082 | -127.43642 | 4 | | | | | | | 4 | |
| 07-Mar-09 | 59.75563 | -127.44113 | 1 | | | | | | | 1 | |
| 07-Mar-09 | 59.63869 | -126.84488 | 6 | | 1 | | | | | 4 | 1 |
| 07-Mar-09 | 59.59891 | -126.7015 | 13 | 1 | 3 | 1 | | 2 | | 3 | 3 |
| 07-Mar-09 | 59.59681 | -126.67418 | 6 | | | | | 1 | | 2 | 3 |
| 07-Mar-09 | 59.59267 | -126.59379 | 23 | 1 | 4 | | | 6 | | 5 | 7 |
| 07-Mar-09 | 59.46894 | -126.2911 | 4 | 1 | | | 1 | | | | 2 |
| 07-Mar-09 | 59.44752 | -126.21623 | 2 | | | | | | | 2 | |
| 07-Mar-09 | 59.43614 | -126.13195 | 3 | | | | | | | | 3 |
| 07-Mar-09 | 59.20473 | -125.94093 | 3 | | | | | | | 3 | |

| Date | Observer1 | Observer2 | Observer3 | Cloud Cover | Temperature | Days Since Snow |
|---|---|---|---|---|---|---|
| 29-Sep-08 | Pamela Moon | C. Thiessen | | 4 | 11 | N/A |
| 11-Nov-08 | P. Moon | Shawne Sanders | | 5 | -9 | 2 |
| 01-Dec-08 | P. Moon | John Groat | Floyd Frank | 4 | -3 | 1 |
| 07-Jan-09 | P. Moon | J. Groat | F. Frank | 0 | -38 | 2 |
| 10-Feb-09 | P. Moon | F. Frank | | 3 | -20 | 3 |
| 07-Mar-09 | P. Moon | J. Groat | | 5 | -4 | 1 |

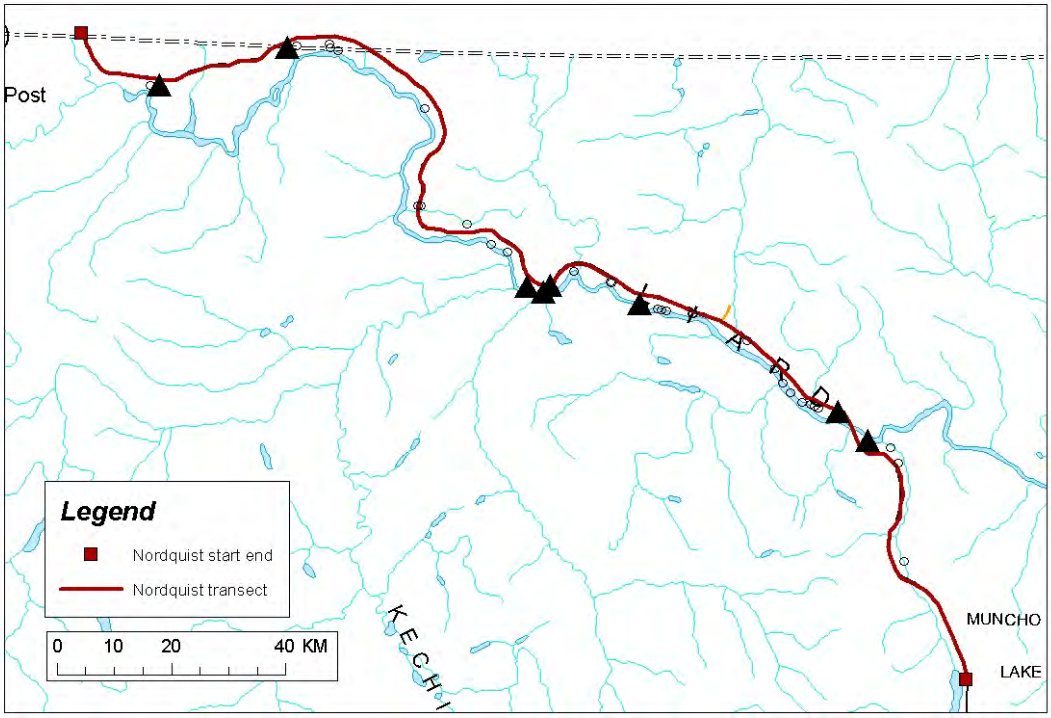
Appendix 4. Distribution of Nordquist herd sightings during ground based surveys.



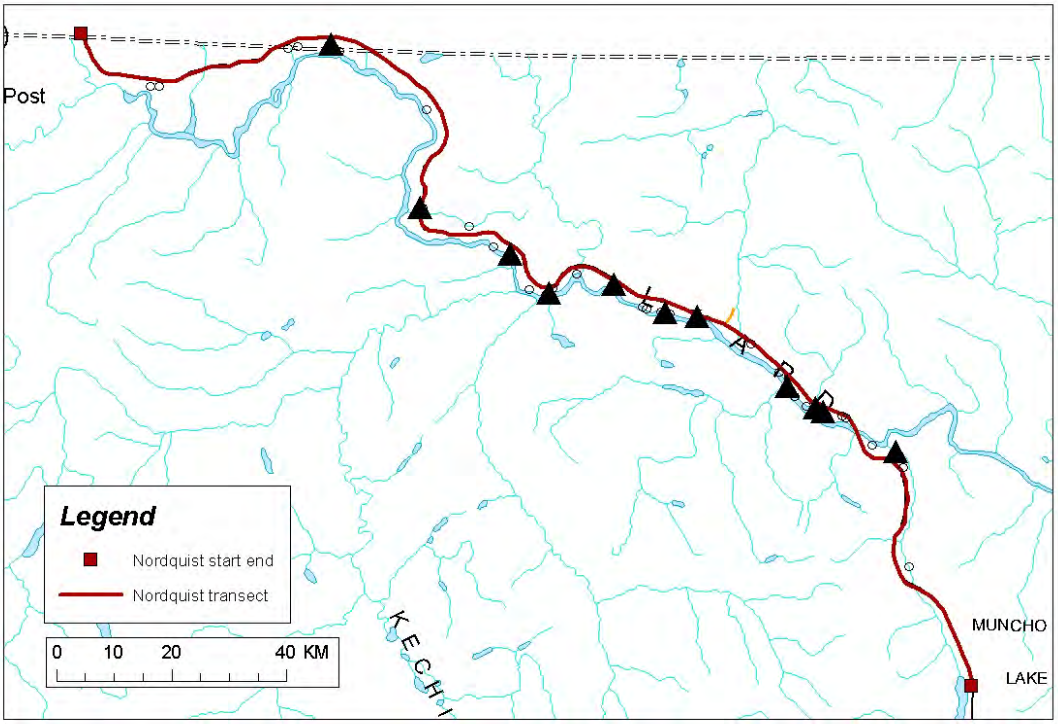

Nordquist herd sightings September 2008 (black triangles).



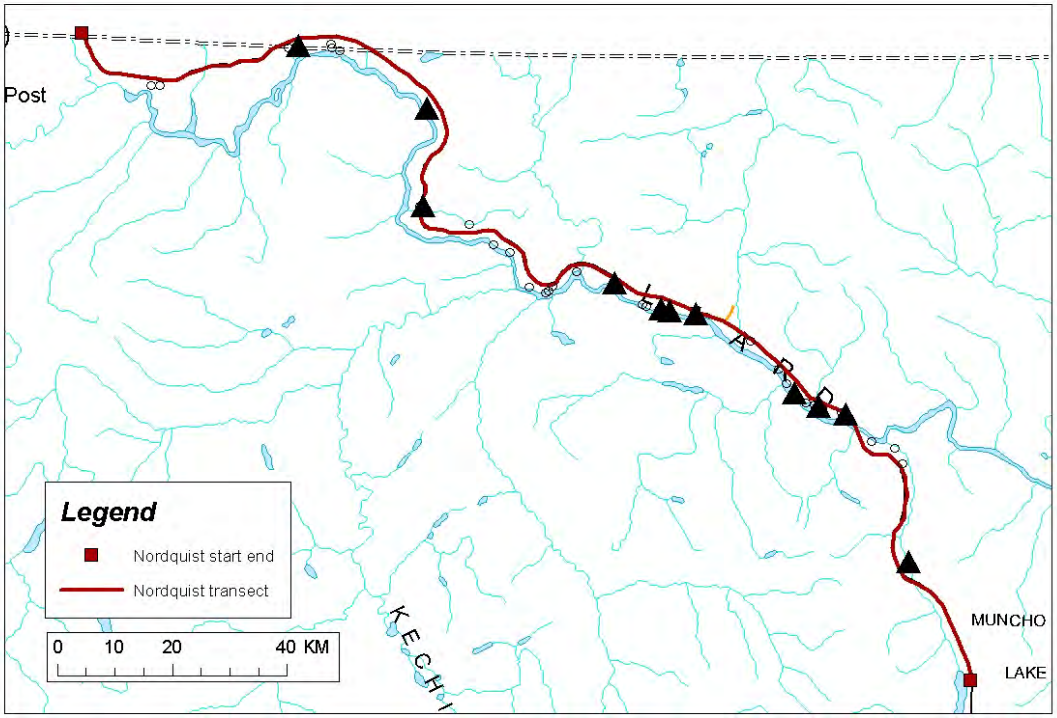

Nordquist herd sightings December 2008 (black triangles).




Nordquist herd sightings January 2009 (black triangles).




Nordquist herd sightings February 2009 (black triangles).




Nordquist herd sightings March 2009 (black triangles).