Boreal Caribou Progress Report:

Hay River Lowlands and Cameron Hills Study Areas

1 April 2008 – 31 March 2010

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Background

Boreal caribou inhabit the Taiga Plains ecozone in the Northwest Territories including the boreal forest west of the Slave River Lowlands in the South Slave Region. Boreal caribou are listed as *Threatened* under the Federal Species at Risk Act (COSEWIC 2002). In southern Canada, habitat loss and disturbance have reduced the habitat and range of boreal caribou. The cumulative effects of habitat destruction, hunting, disturbance by humans (including roads, seismic lines, and pipelines), predation (by wolves and black bears) and climate change are implicated in the decline of boreal caribou (COSEWIC 2002, Latham et al. 2010; McLoughlin et al. 2003). Boreal caribou are listed as *Sensitive* in the NWT (Working Group on General Status of NWT Species 2006).

This study began in 2003 to collect information on boreal caribou population demographics (adult survival, calf recruitment and population trend), condition, and habitat selection in the Hay River Lowlands. The study area was extended south to the Cameron Hills/ Bistcho Lake area in 2004 because the small sample of collared cows showed that cows in the southern area use distinctly different areas than the collared cows north of the Cameron Hills plateau.

In 2009 the Department of Environment and Natural Resources (ENR) released the NWT Boreal Caribou Action Plan 2010-2015 (ENR 2009). The goals of this Action Plan are to: (1) Prevent boreal caribou from becoming a species at risk in the NWT; (2) Maintain the current contiguous distribution of boreal caribou in the NWT for the benefit of all NWT residents and future generations; and (3) Manage boreal caribou and their habitat to contribute to the healthy biodiversity of the NWT.

Research and monitoring of boreal caribou is important because it contributes information that is necessary to determine if these ranges provide sustainable habitat for boreal caribou, to understand how boreal caribou respond to development, climate change and other pressures, and to make effective management decisions that will conserve boreal caribou for future generations.

This progress report provides an update on boreal caribou research and monitoring results in the South Slave region from 1 April 2008 to 31 March 2010. Next steps for boreal caribou research in the South Slave region are addressed at the end of this report.

South Slave Program and Study Areas

There are two boreal caribou study areas in the South Slave region: Hay River Lowlands and Cameron Hills. Together they are bounded by the Hay River to the east, the Mackenzie River and Great Slave Lake to the north, the Redknife and Kakisa Rivers to the west and the Hay River to the south (Figure 1). The Hay River Lowlands study area encompasses the Ka'a'gee Tu Candidate Area in the NWT Protected Areas Strategy (Figure 1). Monitoring of the Cameron Hills/Bistcho Lake study area is shared with Alberta.

The Hay River Lowlands area has relatively little past or current industrial development. The Cameron Hills area has past and existing oil and gas activities and ongoing industrial development. The density of seismic lines in the Hay River Lowlands study area is 0.36 seismic lines per km^2, compared with 3.32 seismic lines per km^2 in the Cameron Hills study area. These different levels of human use provide a good opportunity to compare boreal caribou population demographics and condition in a heavily impacted landscape with caribou well-being in a less impacted landscape. The differences in study areas also provide an opportunity to compare habitat selection (when caribou use a particular habitat more than expected based on its availability) in environments with different amounts of disturbance.

Information on population demographics and condition is necessary to track population trends and is a key component in determining whether ranges are supporting boreal caribou populations. Understanding what habitat boreal caribou use and select can help people make appropriate land-use management decisions (e.g., deciding on the location of protected areas).

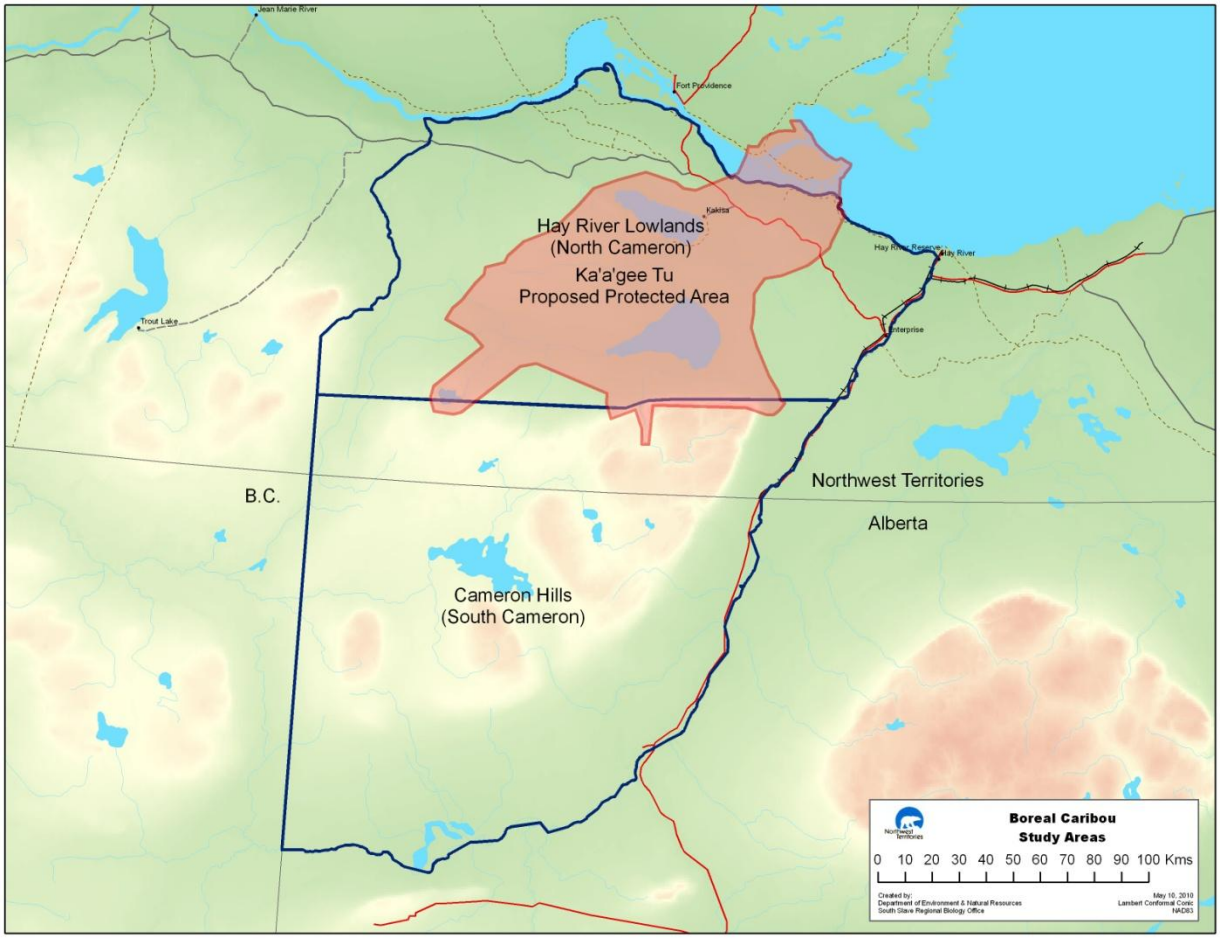


Figure 1. Map of South Slave region boreal caribou study areas (Hay River Lowlands and Cameron Hills) and the proposed Ka'a'gee Tu protected area.

Main project objectives

- Monitor population demographics: adult female survival, calf production, ten-month calf recruitment, and finite rate of population increase (the relative change in size of population from one year to the next)
- Document seasonal range use, annual home ranges and fidelity to calving areas (whether cows use the same area to calve year after year)
- Examine boreal caribou habitat use and selection in relation to natural and human caused disturbance (e.g. wildfire, development) and landscape features (e.g. forest type)
- Monitor presence of disease and parasites (establish baseline database)

Radio collars

It is difficult to collect information on boreal caribou using conventional wildlife population surveys (e.g., aerial or ground counts) because they tend to be sparsely distributed and hard to see because of forest cover. As a result, radio-collars are used to locate caribou during surveys and to provide information on cow survival (alive, dead or not found). Specific indicators (survival rates of adult females, calf recruitment) can be combined to provide a relative estimate of changes in population size. This provides information on the status of boreal caribou in the study area without needing to estimate the total boreal caribou population in the study area.

Radio-collars are also used to determine boreal caribou locations, movement rates and habitat use. This provides detailed information on what types of habitat boreal caribou select (i.e., use more than expected by chance alone) and how this changes throughout the year.

Collar Deployments

Since the beginning of this study, 60 boreal caribou cows have been fitted with radio collars in the Hay River Lowlands area by ENR. 51 boreal caribou cows have been fitted with radio collars in the Cameron Hills/ Bistcho Lake area by ENR. Alberta has also collared caribou in the Cameron Hills/Bistcho Lake area (conventional VHF collars); collars managed by Alberta are not included in this report.

Various types of collars have been used in this survey. Conventional VHF collars were used at the beginning of the survey because they are less expensive to purchase than GPS collars and provide information for basic monitoring of population demographics. GPS collars have been deployed since 2006 to provide more detailed movement and location data and to reduce the number (and cost) of aerial surveys required to relocate collared caribou.

All collars transmit a VHF (very high frequency) signal that can be relocated from the ground or air using a receiver and antennae. Although conventional VHF collars are less expensive than GPS collars, cows wearing conventional VHF collars need to be relocated using an aircraft to determine their current location. Satellite and GPS collars provide locations that are sent via satellite and downloaded to a computer. Telonics ST-18 and ST-20 collars provide locations every day during the calving season (from 1-31 May) and locations once every 3 days for the rest of the year (1 June – 30 April). Telonics TGW-3680 collars provide 3 locations per day. Collars have a release mechanism that is programmed to “let go” on a predetermined date, allowing the collar to drop off the caribou. The GPS collars are programmed to release after about 3.5 years, which allows a collared cow to be tracked through 4 calving seasons.

Table 1: History of boreal caribou collar deployment in the South Slave region.

Hay River Lowlands	Deployment date					
Collar type:	Mar-03	Mar-04	Mar-05	Feb-06	Jan-07	Feb-08
Conventional VHF	17	18	2	3	6	4
Satellite-Argos (Telonics ST-18)					3	
Satellite -Argos (Telonics ST-20)						6 [a]
GPS (Telonics TGW-3680)						4 [a]

[a] 3 existing VHF collars were replaced with ST-20 (2) or GPS (1) collars; the total number of collared cows as of Feb 2008 increased by 11

Cameron Hills	Deployment date					
Collar type:	Mar-04	Dec-04	Mar-05	Feb-06	Jan-07	Feb-08
Conventional VHF	3	4	6	2		
Satellite-Argos (Telonics ST-18)			8			
GPS (Telonics TGW-3680)				10	13	7 [b]

[b] 2 existing VHF collars were replaced with GPS collars; the total number of collared cows as of Feb 2008 increased by 5

Since the beginning of this study several collared cows have died (see section on Mortality) and many collars have released according to schedule. As of March 31, 2010 there were 10 VHF, 5 satellite and 2 GPS collars active in the Hay River Lowlands area. As of March 31, 2010 there were 4 VHF and 9 GPS collars active in the Cameron Hills area.

Several collars were programmed to release in spring/summer 2010: 2 VHF and all 5 satellite collars in the Hay River Lowlands, and all 4 VHF and 5 of the GPS collars in the Cameron Hills. These collars were retrieved in the fall of 2010.

As of December 2010, there are 3 active GPS collars in the Cameron Hills area, and no VHF collars managed by NT. These 3 GPS collars are scheduled to release in July 2011. In the Hay River Lowlands, as of November 2010, there are 2 active GPS collars and 6 active VHF collars. The 2 GPS collars are scheduled to release in July 2011. Three of the VHF collars are scheduled to drop in June 2012 and 2 are scheduled to drop in April 2013. One VHF collar did not release as scheduled in April 2010 and this collared cow was observed in Nov 2010.

Methods and Results I: Population demographics up to March 31, 2010

Adult female survival

Adult female survival rates are based on the collared female cows in each study area (Figure 2). VHF collars are relocated with fixed-wing aircraft to determine if the collared cow is alive, dead, or “censored” (signal was lost or collar released, either prematurely or as scheduled). VHF collars were relocated monthly from April 2003 to March 2005; since March 2005 they have been relocated 2-5 times per year. GPS and satellite collars are assigned a status (alive, dead,

or censored) for each month. Detailed results and calculation methods are in Appendix 1, Table 1 at the end of this report. Adult female survival rates are shown in Figure 2.

The annual cow survival rate has been relatively stable in the Hay River Lowlands since 2005, ranging from 85% to 91%. In 2004 cow survival was lower at 76%. The annual cow survival rate has been more variable in the Cameron Hills, ranging from 71% to 91% since 2006.

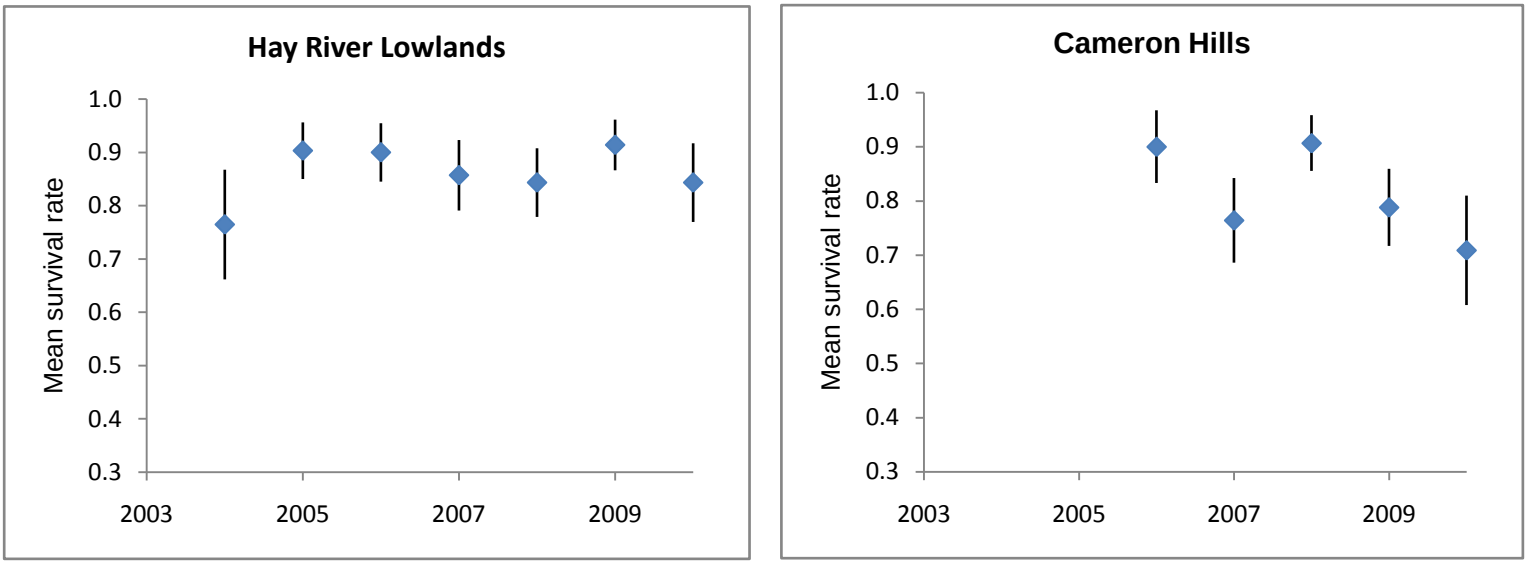


Figure 2. Mean adult female survival rates for boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2003-2010.

Calf recruitment

Calf recruitment is based on late winter composition surveys in February or March, when calves are 9 or 10 months old (most calves are born in May). A helicopter is used to count and classify all the cows, bulls and calves associated with collared cows (and any other caribou groups observed). Caribou are classified as calves or adults based on their size and body shape. Adults are sexed based on the presence of a black vulva patch (females) or lack of vulva patch (males). Recruitment is expressed as the ratio of calves per 100 adult cows. It is assumed that these 10-month old calves are recruited into the adult population. Detailed results and calculation methods are in Appendix 1, Table 2 at the end of this report.

Mean calf: cow ratios from late winter composition surveys are shown in Figure 3. As a general rule for boreal caribou, a calf:cow ratio of around 29 calves: 100 cows is associated with a stable population (Environment Canada 2008). This depends on a constant adult cow survival rate (around 85%). If adult cow survival decreases, higher calf recruitment is required for a stable population (Bergerud 1988). This data should be considered alongside other information about caribou in the study area.

In 2010, a high proportion of 10-month old calves were observed during the March composition survey of the Hay River Lowlands (50 calves: 100 cows). The adjacent Dehcho study area also

had a higher recruitment rate than in previous years at 35 calves: 100 cows (Larter and Allaire 2010). In the Cameron Hills there were 10 calves: 100 cows observed during the March survey. This is slightly lower than previous years.

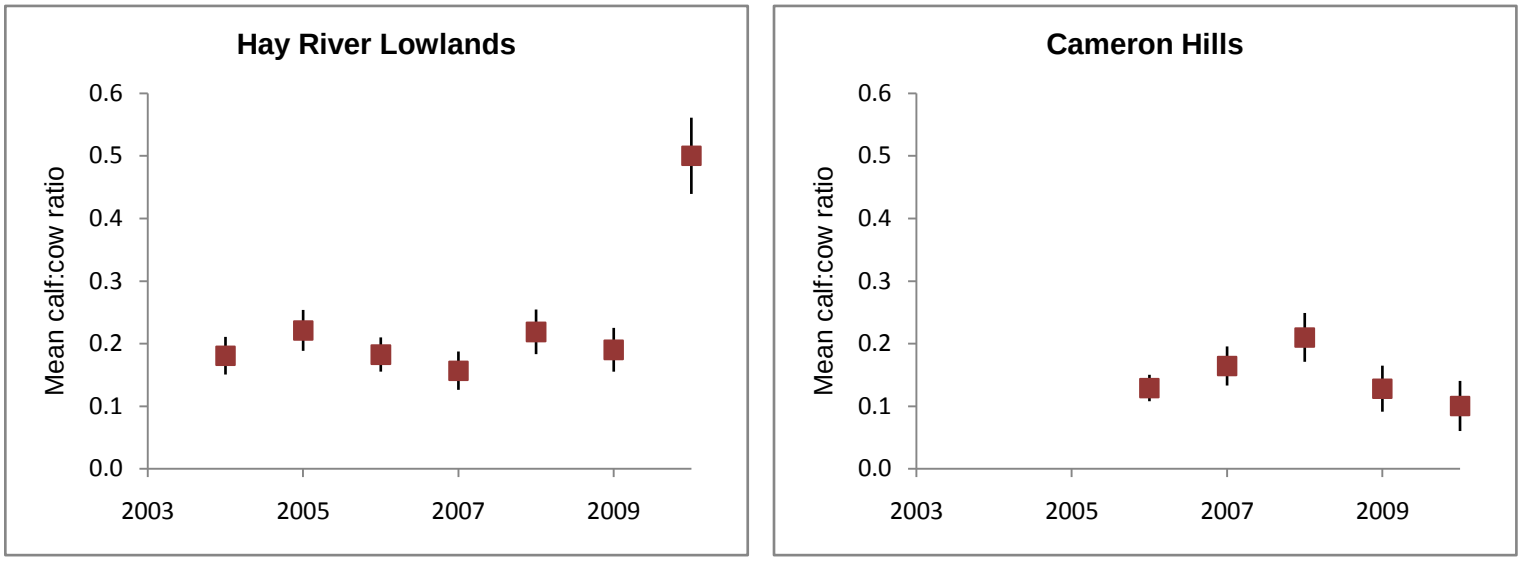


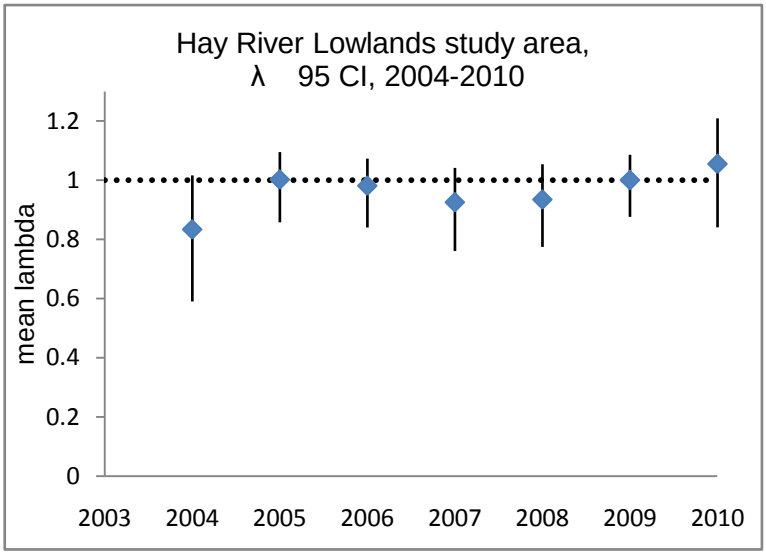
Figure 3. Mean calf:cow ratios for boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.

Population rate of increase (Is the population stable, increasing, or decreasing?)

Lambda (λ) is the estimated finite population rate of increase. A population is considered stable (lambda (λ) = 1) when the rate at which 1-year-old females are added to the population (recruited) is equal to the adult cow mortality rate. When lambda is less than 1, the population is decreasing. Lambda greater than 1 indicates an increasing population. Lambda only considers the mortality and recruitment rates for the year being calculated. Lambda values are shown in Figure 4. Detailed results and methods for calculating lambda are in Appendix 1, Table 3 and text.

Estimated realized population change (population trend)

Another way to look at overall trends is by estimating the relative change in population size since the beginning of the study. Note that trends are not based on the actual number of boreal caribou in the study areas. Instead, the population is considered to be 1 (100%) in the first year of the study, and changes in the population size relative to the first year of the study are estimated based on lambda each year. The estimated realized population change values are shown in Figure 5. Detailed results and methods for calculating the realized population change are in Appendix 1, Table 4 and text.



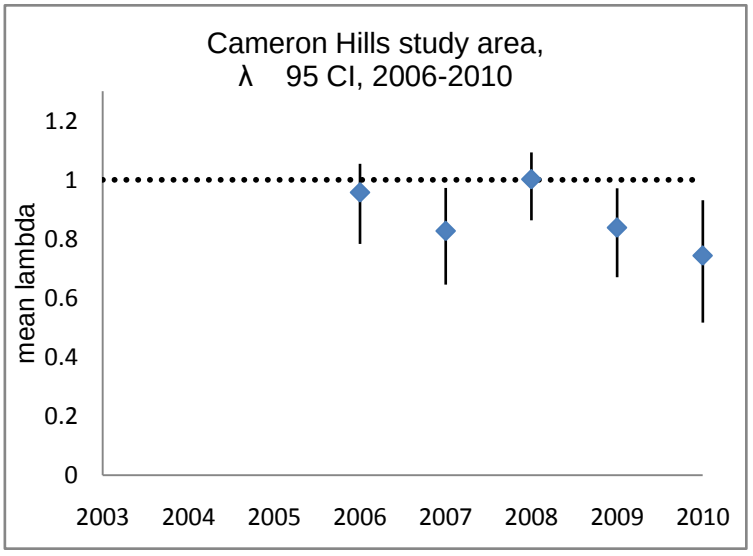
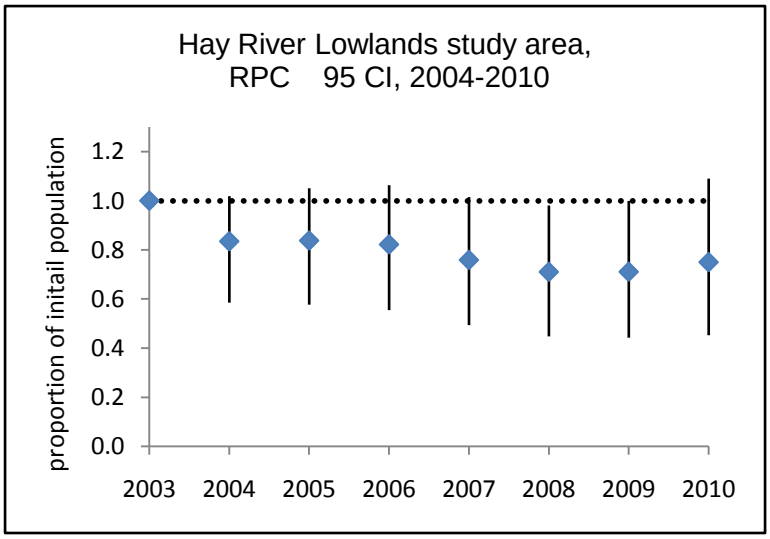


Figure 4. Estimated finite population rate of increase (lambda) with 95% confidence intervals for boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.



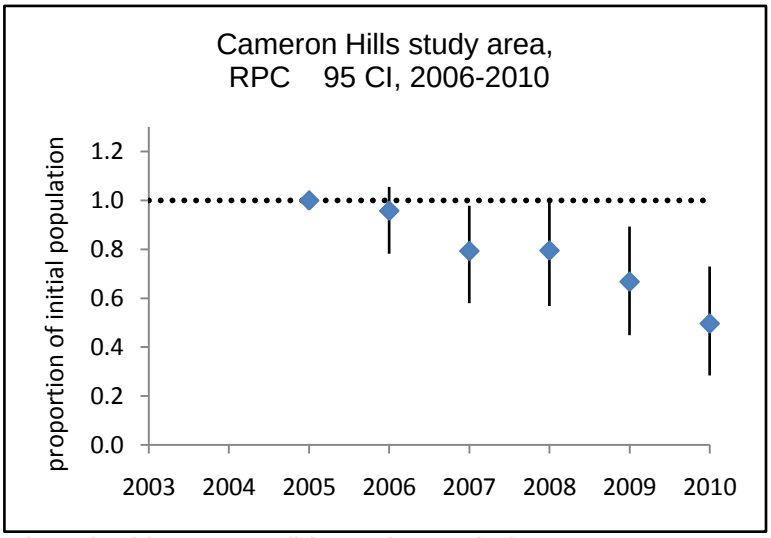


Figure 5. Estimates of realized population change (RPC) with 95% confidence intervals for boreal caribou in the South Slave region study areas (Hay River Lowlands, NWT, 2004-2010 and Cameron Hills, NWT/Alberta, 2006-2010).

The boreal caribou in the Hay River Lowlands may have declined since the study began (2003). The largest apparent decline is from 2003-2004; since 2004 the overall decline is approximately 10%. However, there is large overlap among the confidence intervals which indicates the recent population trend could be stable.

The boreal caribou population in the Cameron Hills area is declining (Figure 4). The 2010 population of boreal caribou in the Cameron Hills area is estimated to be about 50% of the initial

(2005) population, with a 95% confidence interval range from 27% to 71% of initial population size.

Mortalities

From 2003 until March 2008, regular survey flights were conducted to determine if collars were active or stationary (when a collar is motionless for more than 6 hours it transmits a unique signal). Aircraft and/or ATVs were then used to investigate potential mortality incidences of collared cows as soon as possible after they occurred to determine the probable cause of death (Table 2). Since March 2008, mortalities have not been investigated promptly enough to reliably determine the cause of mortality.

The majority (75%) of mortalities has occurred during the spring and summer (April to September) (Figure 6). This is consistent with higher mortality rates during the spring and summer in the Dehcho (Larter and Allaire 2010) and during the snow-free period in northern Alberta (McLoughlin et al. 2003). Wolves appear to be the main cause of mortality; this is also consistent with boreal caribou research in Alberta (McLoughlin et al. 2003).

Table 2. The number and probable cause of mortalities for collared female boreal caribou in the Hay River Lowlands, NT, and Cameron Hills, NT/Alberta, 2003-2010.

Hay River Lowlands

April to March	Maximum collars during year	**Total mortalities**	Suspected wolf predation	Suspected black bear predation	Suspect natural causes	Hunter harvest	Cause of mortality unknown
2003-2004	35	**4**	2	2			
2004-2005	33	**3**	3				
2005-2006	33	**3**	2			1	
2006-2007	37	**4**	2		1	1	
2007-2008	44	**5**	4			1	
2008-2009	37	**3**					3
2009-2010	31	**4**					4

Cameron Hills

April to March	Maximum collars during year	**Total mortalities**	Suspected wolf predation	Suspected black bear predation	Suspect natural causes	Hunter harvest	Cause of mortality unknown
2005-2006	32	**3**	2	1			
2006-2007	43	**7**	7				
2007-2008	40	**3**	3				
2008-2009	33	**7**					7
2009-2010	26	**6**				1	5

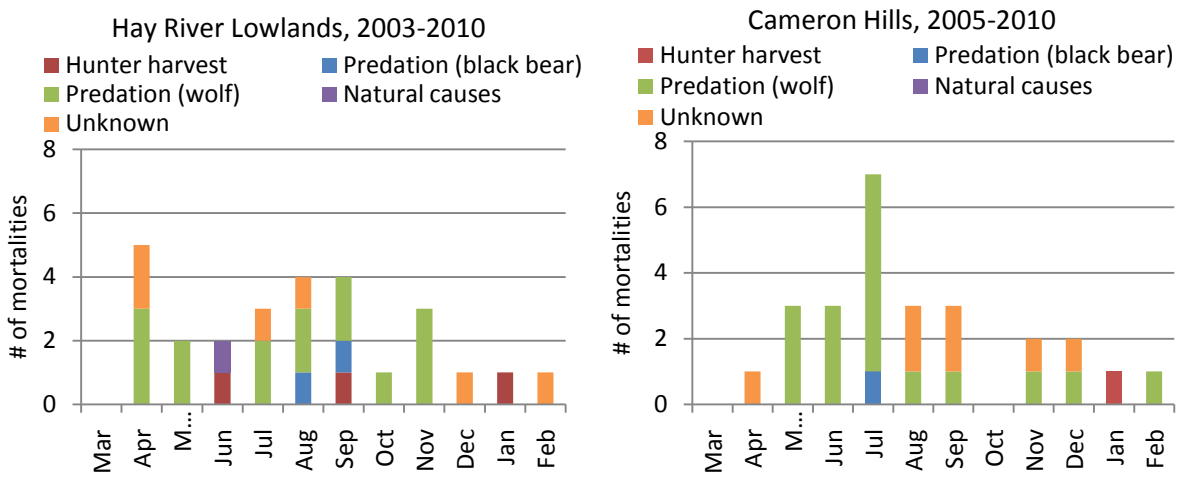


Figure 6. Mortalities of collared female boreal caribou classified by time of year and probable cause (Hay River Lowlands, NWT, 2004-2010 and Cameron Hills, NWT/Alberta, 2003-2010).

Calf Production

Boreal caribou cows space-out from other females during calving to reduce the risk of predation (Bergerud 1988). They remain alone or with their calves during the summer. In general boreal caribou in the NWT do not show fidelity to calving sites (Nagy et al. In prep. a).

The movements of GPS collars show that boreal caribou cows travel long distances just before the calving season. Cow movement rates decrease significantly a day or two before calving, the cow moves very little on the calving date, and movement rates are low on the days following calving. From this pattern we can determine the date and location of calving events by GPS-collared cows.

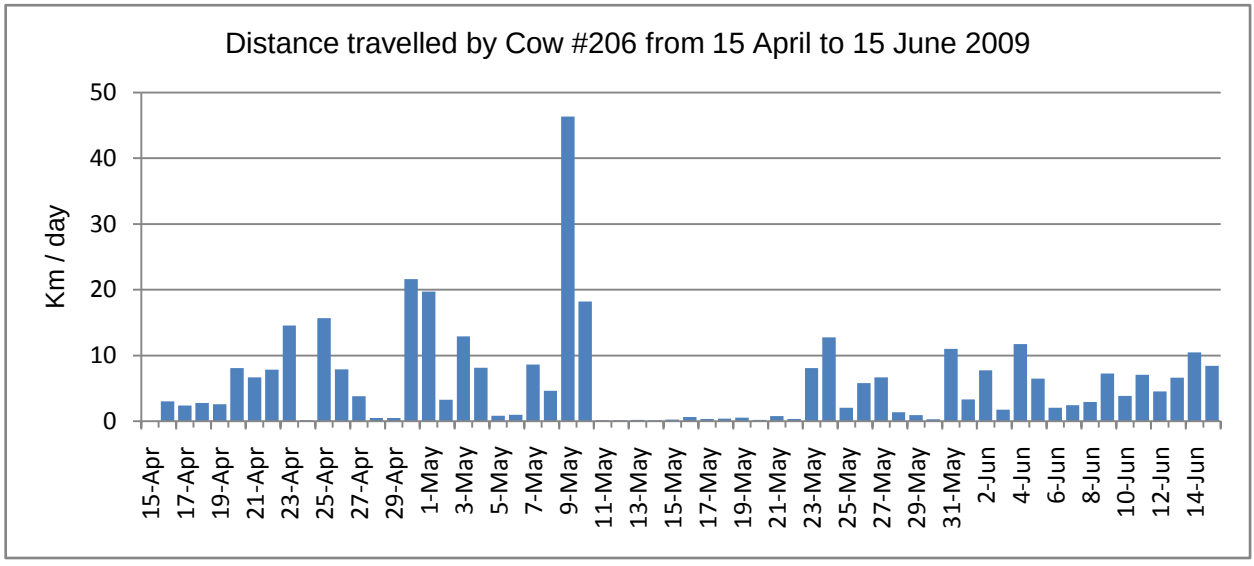


Figure 7. Example of the movement pattern of GPS-collared cows indicative of calving; in this case calving occurred on or near May 11.

In 2008 and 2009 visual surveys were also used to determine calf production by VHF-collared cows). A Husky-Aviat aircraft was used to locate collared cows due to its slow speed and ability to fly over caribou without disturbing them. Flights were conducted four times throughout May. The calf production rate of VHF-collared cows should be considered a minimum rate because even when no calves are observed on visual surveys, it is possible that a calf was born but not observed, for example, if it died shortly after birth, was born after the visual flights were complete, or remained well hidden on all surveys.

The calf production rate for collared cows in 2008 was between 85-97% in the Hay River Lowlands and between 91-97% in the Cameron Hills. The calf production rate of GPS-collared cows was 92% (11/12 cows) in the Hay River Lowlands and 96% (25/26 cows) in the Cameron Hills. The minimum calf production rate for VHF-collared cows was 81% (17/21 cows) in the Hay River Lowlands and 60% (3/5 cows) in the Cameron Hills.

The calf production rate for collared cows in 2009 was between 86-100% in the Hay River Lowlands and between 79-83% in the Cameron Hills. The calf production rate of GPS-collared cows was 100% (10/10 cows) in the Hay River Lowlands and 80% (16/20 cows) in the Cameron Hills. The minimum calf production rate for VHF-collared cows was 75% (9/12 cows) in the Hay River Lowlands and 75% (3/4) in the Cameron Hills.

At the beginning of this study (from 2003 to 2007) the calf production rate for collared cows was determined from progesterone levels in blood serum (blood samples were taken during collaring to test for pregnancy) and from visual surveys during the calving season. The calf production rate ranged from 87% to 95% in the Hay River Lowlands (2003-2007), and from 79% to 90% in the Cameron Hills (2005-2007).

Based on GPS-collared caribou throughout the NWT boreal caribou range, we know that on average, caribou in the southern NWT calve about 5 days earlier than caribou in northern NWT (Nagy et al. In prep. b).

Results II: Diseases and parasites

Baseline health data collected from boreal caribou in the South Slave and Dehcho regions between 2003 and 2007 show that boreal caribou in the southern NWT are healthy. Only low numbers of parasites and antibodies were found in samples taken. Although some parasites and diseases found in this study have not been reported in boreal caribou before, none of the diseases or parasites detected is a cause for concern. The most common parasite identified was a *Trypanosome* species; it occurred at a rate similar to Alberta boreal caribou (about 80%). Trypanosomes are parasites that are found around the world in almost all vertebrates but have never been known to cause any type of disease in deer like caribou. All the boreal caribou samples tested negative for Johne's disease, bovine viral diarrhea virus (BVDV), parainfluenza (PI3), and *Brucella* (diseases that are found in other deer species or other places in Canada). These results have been published (Johnson et al. 2010) and a plain-language summary of the baseline health data is available from the South Slave Regional Biologist (867-872-6408).

Results III: Habitat use and movement patterns

Annual and cumulative home ranges

We mapped home ranges as 100% minimum convex polygons (MCPs), which is a line drawn around all of the location points from one collar. Annual home range size was calculated for all GPS-collared caribou that provided a complete year of data (1 April to 31 March) for 2008-09 and 2009-10 (Table 3). We also calculated the cumulative home range size for GPS-collared caribou that had more than one complete year of data (Table 3). Figure 8 shows two home ranges of different sizes. The cumulative home range of caribou #115 in the Hay River Lowlands over 2.4 years was 858 km^2. The cumulative home range of caribou # 218 in the Cameron Hills over 1.4 years was 9103 km^2. In some cases, using MCPs to map home ranges may overestimate the area used by an individual caribou, such as caribou #218 that did not use the area east of Bistcho Lake during the period it was tracked (Figure 8).

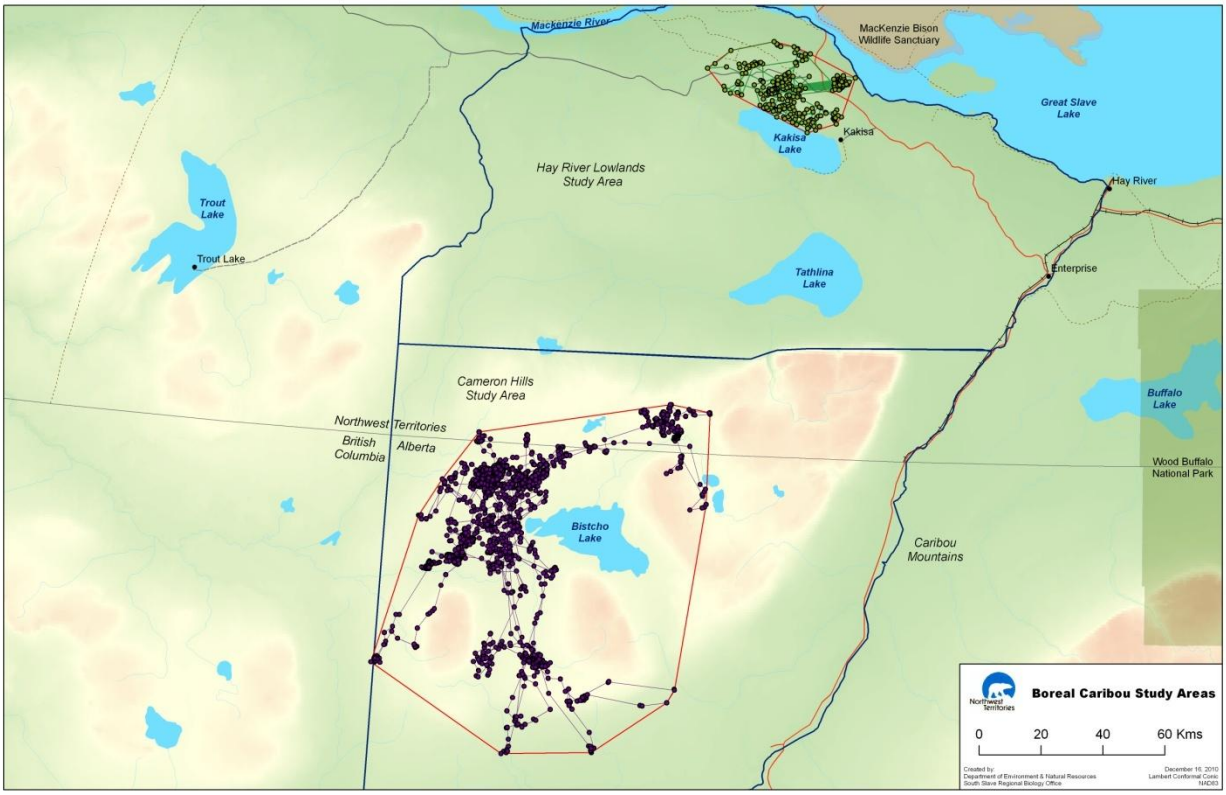


Figure 8. Caribou locations (dots) and pathways (lines) compared with that cow's home range (red line) for two GPS collared caribou. The home ranges are mapped as 100% minimum convex polygons (MCPs), which is a line drawn around all of the location points from one collar.

Table 3. Annual (2008-09 and 2009-10) and cumulative home range sizes (MCPs) for GPS-collared caribou in the Hay River Lowlands and Cameron Hills study areas.

Hay River Lowlands	Annual home range size of GPS-collared caribou with complete year of data				
April to March	Mean (km^2)	Range (km^2)	Median (km^2)	SD	# collars
2008-2009	1581	783 - 4049	1350	847	12
2009-2010	2038	569 - 5872	1248	1838	7

Cameron Hills	Annual home range of GPS-collared caribou with complete year of data				
April to March	Mean (km^2)	Range (km^2)	Median (km^2)	SD	# collars
2008-2009	2291	391 - 5074	2497	1186	21
2009-2010	3225	1634-4115	3453	757	9

Cumulative home range size of GPS-collared caribou with min. 365 days of data, from the entire study					
	Mean (km^2)	Range (km^2)	Median (km^2)	SD	# collars
Hay River Lowlands [a]	2847	858 - 6057	2008	1885	10
Cameron Hills [b]	4140	1163 - 9204	3817	2091	37

[a] Total home range sizes are based on a min of 1.0 and max of 2.4 yrs of data (mean 2.0 yrs, SD=0.5).
[b] Total home range sizes are based on a min of 1.1 and a max of 3.4 yrs of data (mean 2.4 yrs, SD=0.7).

In 2007-08 the average home range in the Hay River Lowlands was based on 3 satellite collars and was 2309 km^2. From 2003 to 2007 minimum home range sizes were calculated using conventional VHF collars, however these areas likely underestimate the home range size because a maximum of 12 locations per caribou were available each year (see Johnson 2008a). The average annual home range size in the Cameron Hills (GPS collars only) was 2198 km^2, 3219 km^2, and 2735 km^2 in 2006, 2007, and 2008 respectively (see details in Johnson 2008b).

The 2008-09 and 2009-10 annual home ranges are mapped in Figures 9 and 10, respectively. Cumulative home ranges are shown in Figure 11. Home ranges are mapped as 100% minimum convex polygons (MCPs), which is a line drawn around all of the location points from one collar

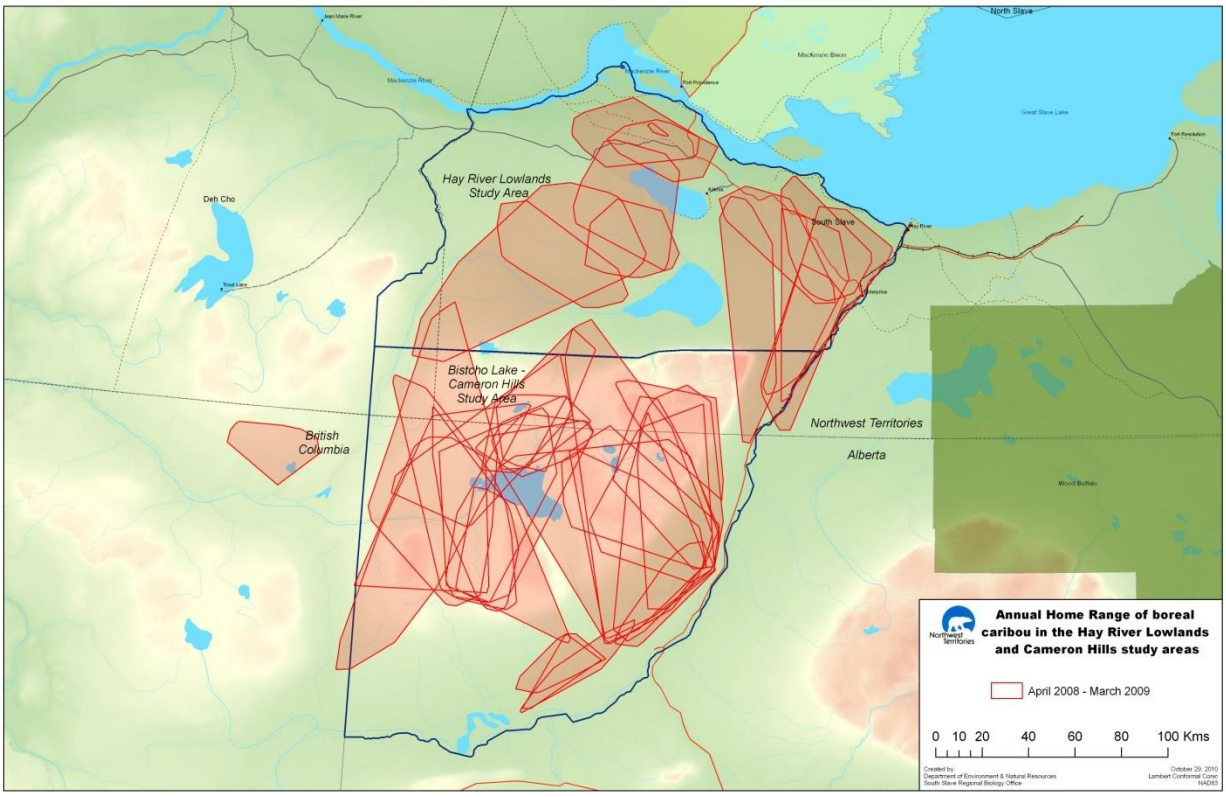


Figure 9. April 2008-March 2009 annual home ranges for GPS-collared boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas. Home ranges are mapped as 100% minimum convex polygons (MCPs).

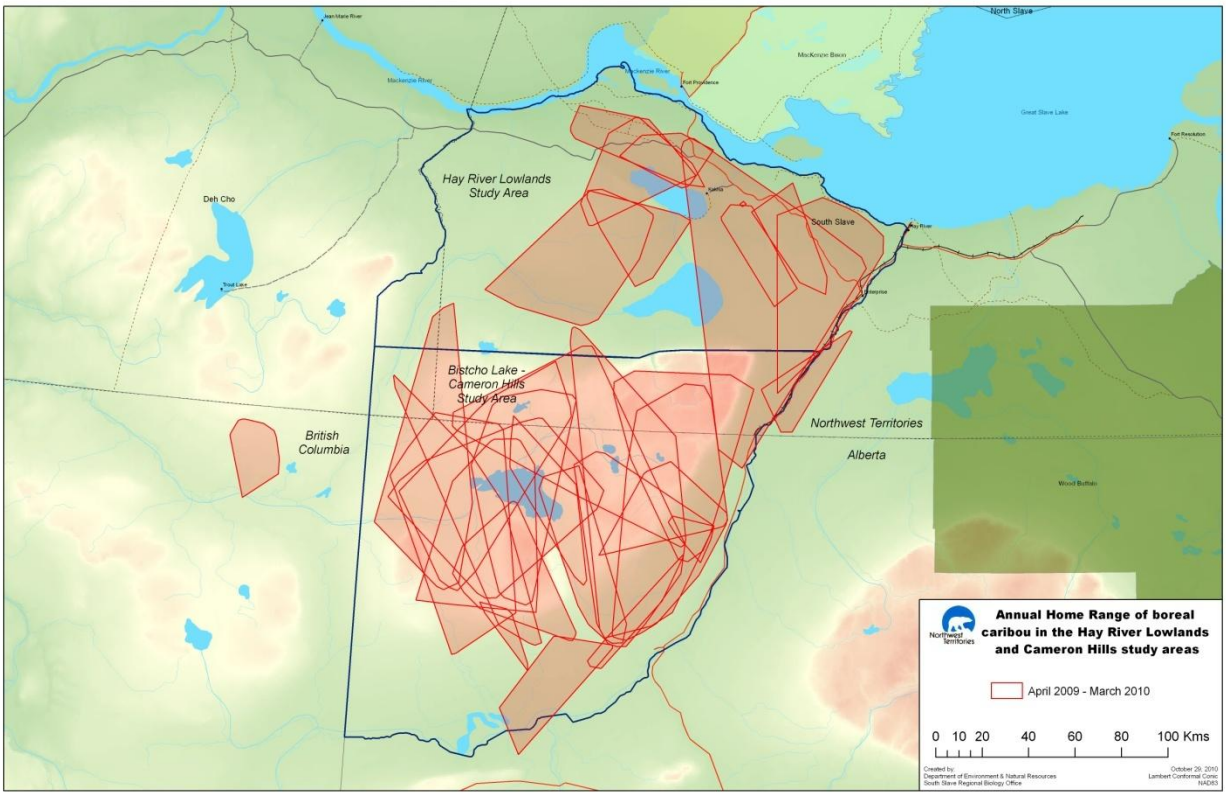


Figure 10. April 2009-March 2010 annual home ranges for GPS-collared boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas. Home ranges are mapped as 100% minimum convex polygons (MCPs).

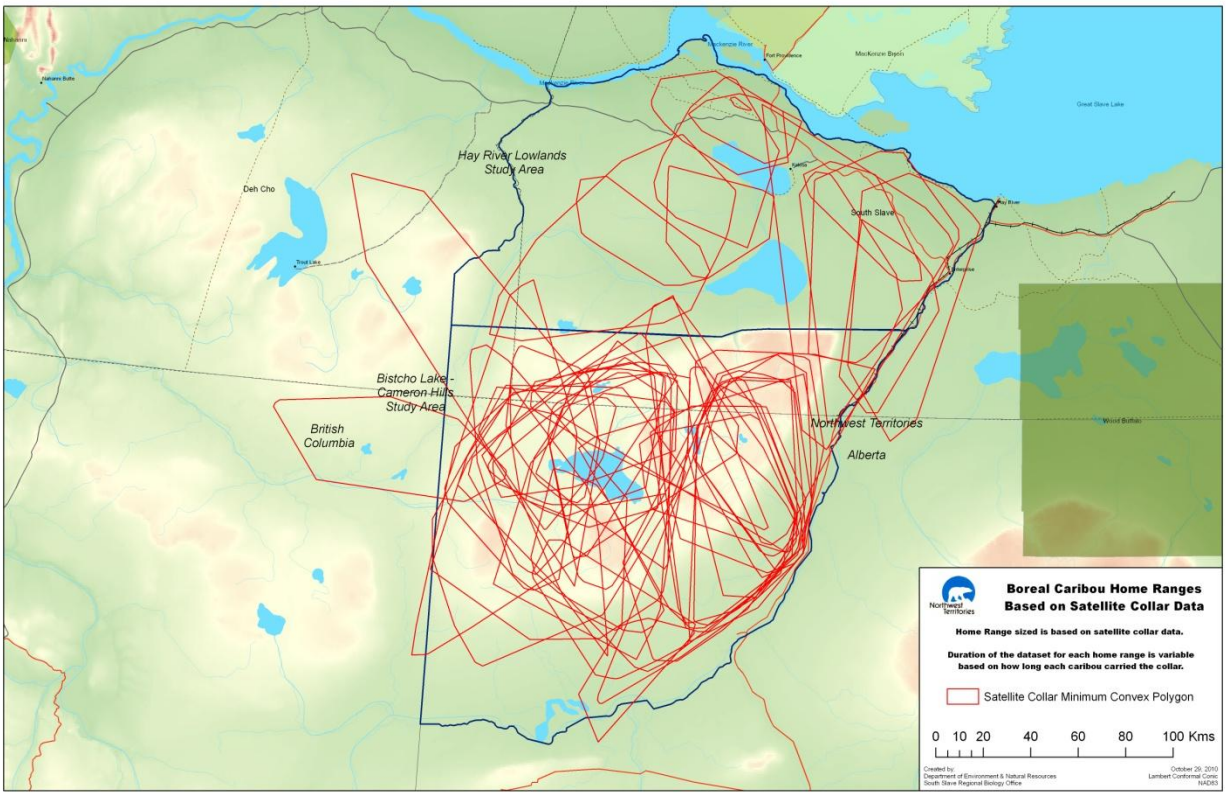


Figure 11. Cumulative home ranges of GPS-collared boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas that had at least one complete year of data.

Preliminary Results: boreal caribou data analysis

The South Slave Region has worked collaboratively with John Nagy (Ph.D. student at the University of Alberta and former ENR biologist) to analyze collar location data obtained in the South Slave Region and other areas of the range of boreal caribou in the NWT. This has provided information about how boreal caribou cows behave. The preliminary results of this work were presented to communities at the 2008 and 2010 Dehcho regional wildlife workshops and the 2009 South Slave regional wildlife workshop. All caribou locations in these analyses are from adult cows (bulls may have different movement rates or patterns of habitat use).

The results of these analyses will be submitted for scientific review and publication. Plain language summaries will be provided to First Nations partners and the public. Preliminary results are reported here.

Activity periods

Based on changes in caribou travel rates we identified eight distinct activity periods during the year. Cows must stop moving to give birth to their calves so we so we examined the travel rates of collared cows to find out when they stopped moving during the calving period (see Calf Production section). Cows are pregnant for about 228 days before giving birth to their calves. We estimated the date when calves were conceived (rut) by backdating 228 day the estimated date when cows gave birth (Nagy et al. In prep. b).

Collar locations for 2008-09 and 2009-10 are mapped in Appendices 2 and 3 respectively. Locations are mapped by these activity periods.

Habitat selection and site fidelity

Caribou use areas within all land cover and burn classes; however, during all seasons they select forest stands that are 100 years or older, and areas that have open conifer land cover (J. Nagy *unpublished data*).

Boreal caribou generally show the highest degree of fidelity to summer ranges and not to calving sites (Nagy et al. In prep. a).

Response to seismic lines

Boreal caribou in the Hay River Lowlands and Cameron Hills study areas avoid seismic lines during pre-calving, calving and summer. This "avoidance period" coincides with the time of year when cows and calves are most vulnerable to predators. In the Cameron Hills caribou avoid areas within 100 m of seismic lines, but in other study areas with fewer seismic lines (including the Hay River Lowlands) caribou avoid areas within 400 m of seismic lines. In general, caribou use areas near seismic lines less than expected and they also cross seismic lines less than expected. When caribou do cross seismic lines, they travel faster compared to when they are not crossing any seismic lines. Faster travel can be considered another type of avoidance that requires caribou to use more energy to respond to seismic lines. (Nagy et al. In prep. c).

Secure habitat

Together with data on cow survival and calf recruitment, these analyses suggest that the best habitat for boreal caribou are unburned habitats that are at least 400 meters from any seismic lines or other linear features. We classified areas > 400 m from linear features such as seismic lines, roads, and pipelines, as "secure boreal caribou habitat". Boreal caribou in study areas containing more patches of secure habitat that are at least 500 km^2 in size have better survival and recruitment than caribou in study areas with fewer or no large patches of secure habitat. (Nagy et al. In prep. d). This indicates that preserving large patches of secure habitat is important if we hope to maintain sustainable boreal caribou populations in the NWT.

The industrial footprint in the Cameron Hills is extensive and has decreased the quality of boreal caribou habitat. Currently in the Cameron Hills study area only 16% of the area is 'secure habitat' (farther than 400 m from a seismic line), and ¼ of that 16% 'secure boreal caribou habitat' is comprised of very small patches that are less than 2.5 square km in size (e.g., 500 m x 500 m). There are no patches of 'secure habitat' in the Cameron Hills that are larger than 500 km^2. The boreal caribou population in the Cameron Hills is declining (see Figure 4).

In the Hay River Lowlands study area, 52% of the area is 'secure habitat', or farther than 400 m from a seismic line. Approximately 15% of the area is 'secure habitat' that occurs in patches that are 500 km^2 or larger. Use of secure habitat patches larger than 500 km^2 by caribou in the Hay River Lowlands is 92% greater than expected by chance alone.

This information can be used in management decisions, for example, when deciding the boundaries of protected areas. Open conifer land cover and older, unburned forests provide the best habitat for boreal caribou. Moreover, the quantity of contiguous habitat may matter in addition to the quality: sufficient large patches of secure habitat are critical for cows and calves to be able to avoid predators during the period when they are most likely to be killed by predators. Maintaining large patches of secure habitat for boreal caribou should be a part of the strategy for managing boreal caribou habitat to ensure that we have healthy populations in the NWT.

Next Steps

This baseline study will continue until March 2011 with existing collars. 2010/2011 is the final year of this phase of the boreal caribou program in the South Slave region. After March 2011, a report will be produced.

The boreal caribou research and monitoring needs in the South Slave region will be evaluated in 2010/2011. A new program will be developed based on the Boreal Caribou Action Plan, community consultation, monitoring requirements and information gaps.

Acknowledgements

Deborah Johnson initiated this South Slave boreal caribou program and led the program until August 2008. Jan Adamczewski (ENR Wildlife) assisted with the 2009 Hay River Lowlands composition survey. Nic Larter and Danny Allaire (ENR Fort Simpson) provide comparative data, and assisted with the 2010 Hay River Lowlands composition survey. Collared boreal caribou sometimes move between our adjacent study areas and we cooperate to manage and survey these animals. Nicole McCutchen provided valuable advice and reviewed this report and calculations. John Nagy (University of Alberta, formerly ENR Inuvik) has done numerous analyses of the boreal caribou data together with the Dehcho and Gwich'in programs and has greatly increased our knowledge of how boreal caribou behave in the NWT.

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Appendix 1: Boreal caribou population demographics in the Hay River Lowlands and Cameron Hills study area: calculation methods and numerical data.

Adult Female Survival

Adult female survival is calculated based on Pollock et al.'s (1989) staggered-entry modification of Kaplan and Meier's (1958) survivorship model.

Table 1. Adult female survival of boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.

Hay River Lowlands

April to March	Year	mean survival	SE	CV	n
2003-2004	2004	0.76	0.10	0.13	35
2004-2005	2005	0.90	0.05	0.06	33
2005-2006	2006	0.90	0.05	0.06	33
2006-2007	2007	0.86	0.07	0.08	37
2007-2008	2008	0.84	0.06	0.08	44
2008-2009	2009	0.91	0.05	0.05	37
2009-2010	2010	0.84	0.07	0.09	31

n is maximum number of collars during the year

Cameron Hills

April to March	Year	mean survival	SE	CV	n
2005-2006	2006	0.90	0.07	0.07	32
2006-2007	2007	0.76	0.08	0.10	43
2007-2008	2008	0.91	0.05	0.06	40
2008-2009	2009	0.79	0.07	0.09	33
2009-2010	2010	0.71	0.10	0.14	26

n is maximum number of collars during the year

Calf Recruitment

Recruitment is calculated using the means of ratio calculation described in Krebs (1989), assuming a 50:50 sex ratio for unknown adults.

Table 2. Recruitment ratios from late winter composition surveys of boreal caribou in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.

Hay River Lowlands

April to March	Year	mean calf:cow ratio	SE	CV	n
2003-2004	2004	0.18	0.03	0.17	33
2004-2005	2005	0.22	0.03	0.15	46
2005-2006	2006	0.18	0.03	0.15	44
2006-2007	2007	0.16	0.03	0.20	33
2007-2008	2008	0.22	0.04	0.16	38
2008-2009	2009	0.19	0.03	0.18	38
2009-2010	2010	0.50	0.06	0.12	19

n is the number of groups classified

Cameron Hills

April to March	Year	mean calf:cow ratio	SE	CV	n
2005-2006	2006	0.13	0.02	0.16	32
2006-2007	2007	0.16	0.03	0.19	47
2007-2008	2008	0.21	0.04	0.19	51
2008-2009	2009	0.13	0.04	0.29	23
2009-2010	2010	0.10	0.04	0.40	18

n is the number of groups classified

Estimated population rate of increase (lambda)

Lambda (λ) is estimated using a stochastic version of Hatter and Bergerud's 1991 equation (λ =adult female survival/(1-female calf recruitment) following Latham et al. (2010). The stochastic version of λ is the mean of 10,000 iterations calculating λ. Female recruitment assumes a 50:50 sex ratio in calf production and equal survival of sexes to time of census. Error estimates around λ are generated using Excel Pop Tools (Monte Carlo analysis) which randomly draws from the annual female survival distribution and annual female recruitment distribution 10,000 times (see Latham et al. 2010).

Table 3. Estimated population rate of increase (lambda) for boreal caribou populations in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.

Hay River Lowlands

April to March	Year	mean lambda	Variance	LowerCL	UppperCL	n
2003-2004	2004	0.83	0.10	1.02	0.59	35
2004-2005	2005	1.00	0.05	1.09	0.86	33
2005-2006	2006	0.98	0.05	1.07	0.84	33
2006-2007	2007	0.93	0.07	1.04	0.76	37
2007-2008	2008	0.93	0.06	1.05	0.77	44
2008-2009	2009	1.00	0.05	1.09	0.88	37
2009-2010	2010	1.06	0.07	1.21	0.84	31

n is maximum number of collars during the year

Cameron Hills

April to March	Year	mean lambda	Variance	LowerCL	UppperCL	n
2005-2006	2006	0.96	0.01	1.05	0.78	32
2006-2007	2007	0.83	0.01	0.97	0.65	43
2007-2008	2008	1.00	0.00	1.09	0.86	40
2008-2009	2009	0.84	0.01	0.97	0.67	33
2009-2010	2010	0.74	0.01	0.93	0.52	26

n is maximum number of collars during the year

Estimated realized population change

The estimated realized population change (proportion of initial population) is based on estimates of lambda following Anthony et al (2003). Confidence intervals are generated using Excel Pop Tools (Monte Carlo analysis) which randomly draws from the annual distribution of lambda 10,000 times (see Latham et al. 2010).

Table 4. Estimated realized population change (RPC) for boreal caribou populations in the Hay River Lowlands, NT and Cameron Hills, NT/Alberta study areas, 2004-2010.

Hay River Lowlands

April to March	Year	mean RPC	Variance	LowerCL	UppperCL	n
2003-2004	2004	0.83	0.01	1.02	0.59	35
2004-2005	2005	0.84	0.02	1.05	0.58	33
2005-2006	2006	0.82	0.02	1.06	0.55	33
2006-2007	2007	0.76	0.02	1.02	0.49	37
2007-2008	2008	0.71	0.02	0.98	0.45	44
2008-2009	2009	0.71	0.02	1.00	0.44	37
2009-2010	2010	0.75	0.03	1.09	0.45	31

n is maximum number of collars during the year

Cameron Hills

April to March	Year	mean RPC	Variance	LowerCL	UppperCL	n
2005-2006	2006	0.96	0.01	1.06	0.78	32
2006-2007	2007	0.79	0.01	0.98	0.58	43
2007-2008	2008	0.80	0.01	1.01	0.57	40
2008-2009	2009	0.67	0.01	0.89	0.45	33
2009-2010	2010	0.50	0.01	0.73	0.28	26

n is maximum number of collars during the year

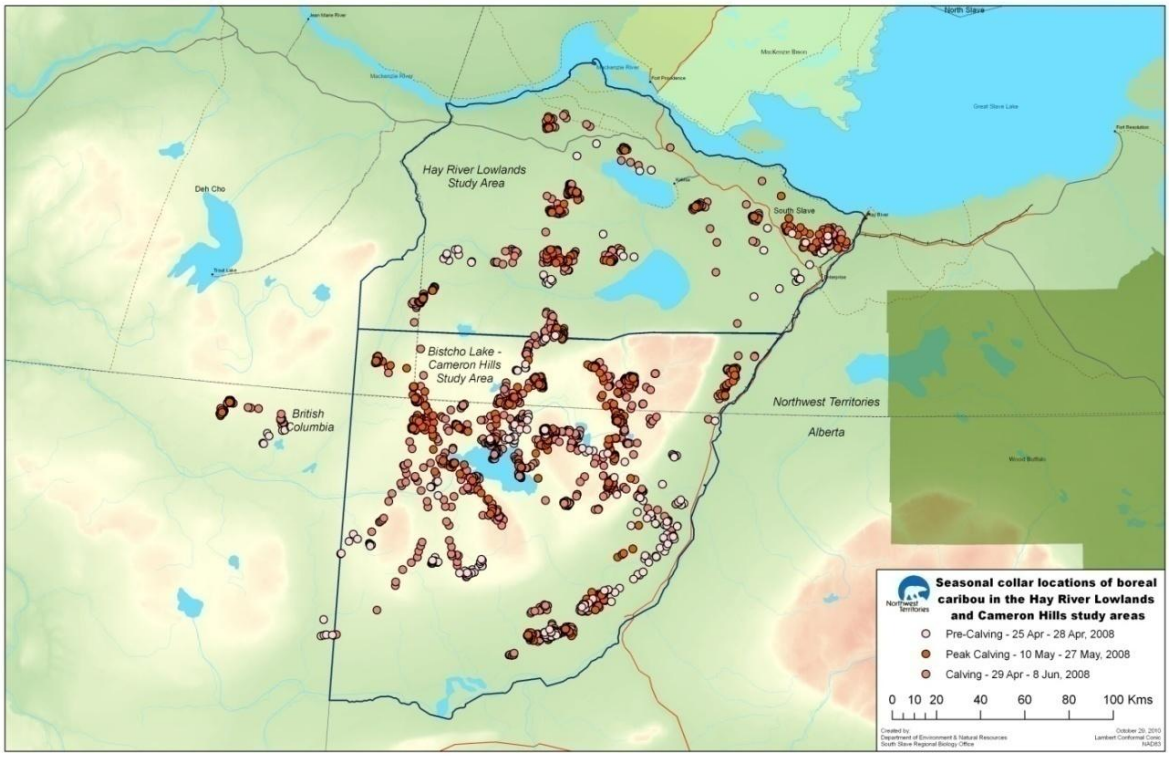
Comparison of deterministic and stochastic lambda and RPC calculations

Table 5. Comparison of deterministic and stochastic calculations for lambda (all same to 2 decimal places) and RPC with stochastic versions (all same to one decimal place). Deterministic calculation uses Hatter and Bergerud's 1991 equation. Stochastic calculation as above; may change slightly with a different 10,000 iterations.

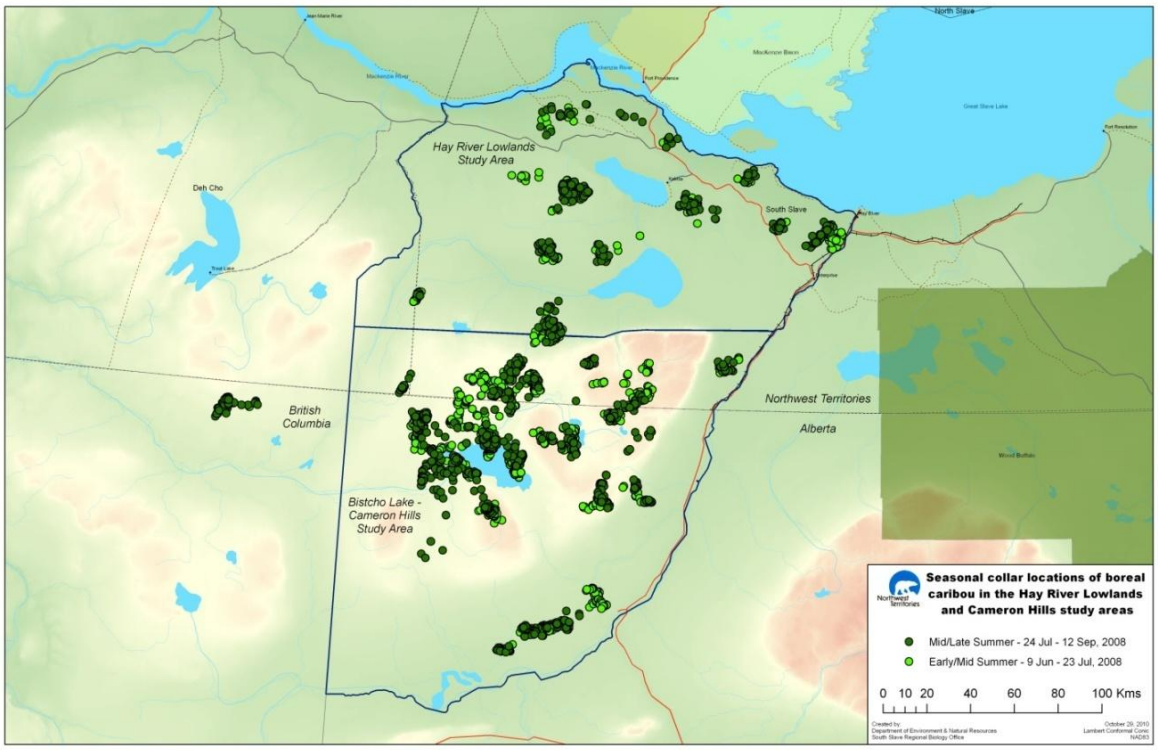
	Lambda		**Realized population change**	
Hay River Lowlands	**Deterministic**	**Stochastic**	**Deterministic**	**Stochastic**
2004	0.834	0.834	0.834	0.835
2005	1.003	1.002	0.836	0.838
2006	0.982	0.981	0.821	0.822
2007	0.924	0.926	0.759	0.759
2008	0.936	0.935	0.710	0.710
2009	1.001	1.001	0.711	0.711
2010	1.054	1.056	0.749	0.750

	Lambda		**Realized population change**	
Cameron Hills	**Deterministic**	**Stochastic**	**Deterministic**	**Stochastic**
2006	0.958	0.957	0.958	0.958
2007	0.827	0.827	0.792	0.793
2008	1.002	1.002	0.793	0.795
2009	0.838	0.838	0.665	0.668
2010	0.744	0.743	0.495	0.496

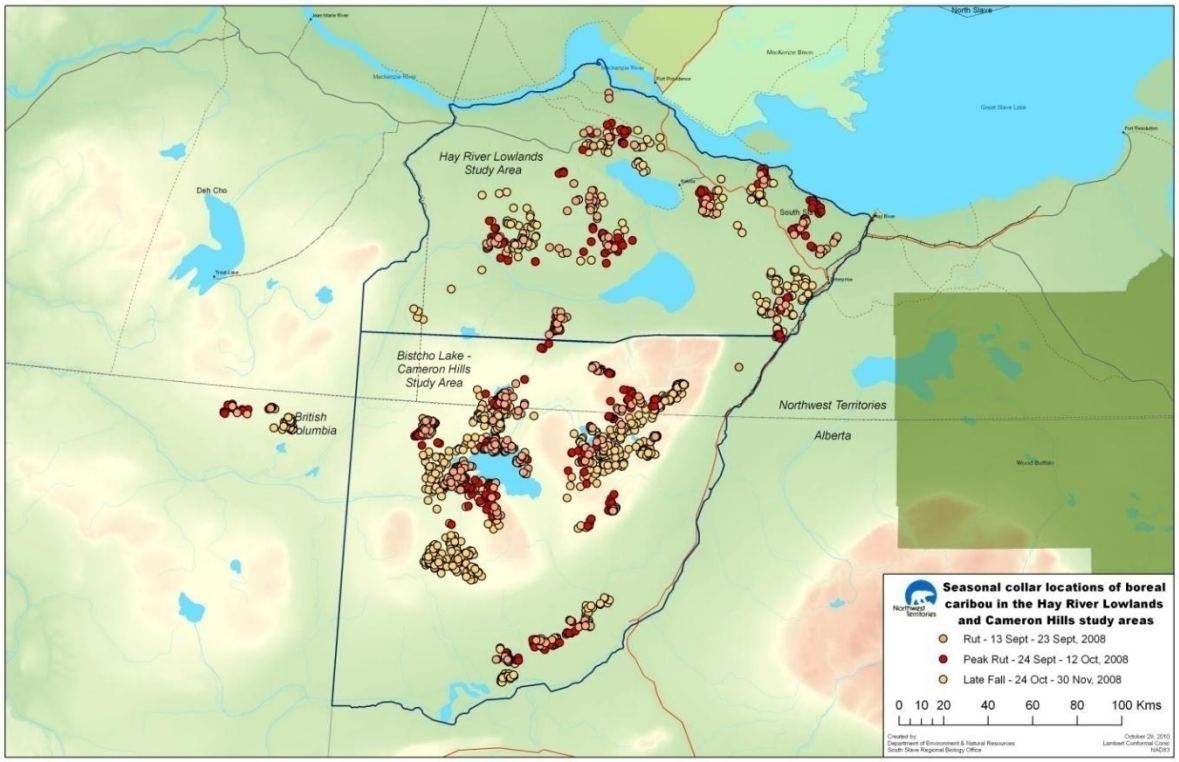
Appendix 2: 4 Maps showing seasonal locations of collared boreal caribou cows in the Hay River Lowlands and Cameron Hills study areas from April 2008 to March 2009.



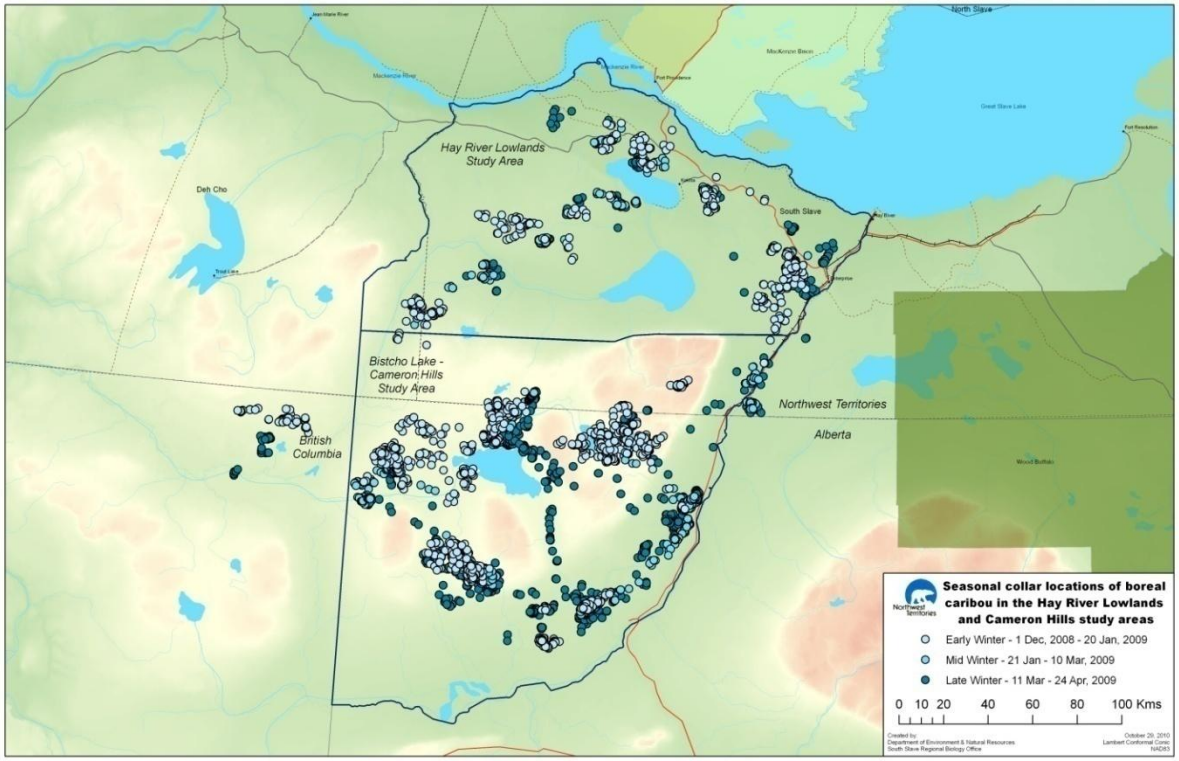
(a) Pre-calving, Calving and Post-calving



(b) Early/mid Summer and Mid/late Summer

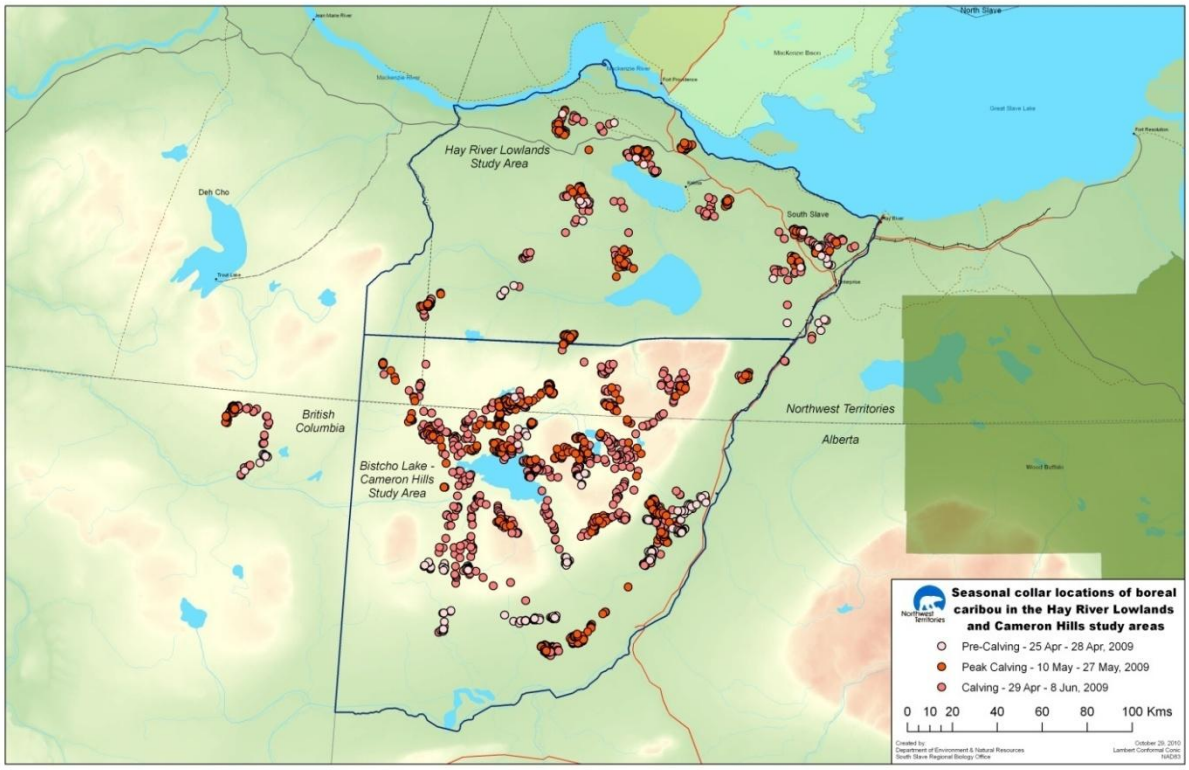


(c) Rut, Peak Rut and Late Fall

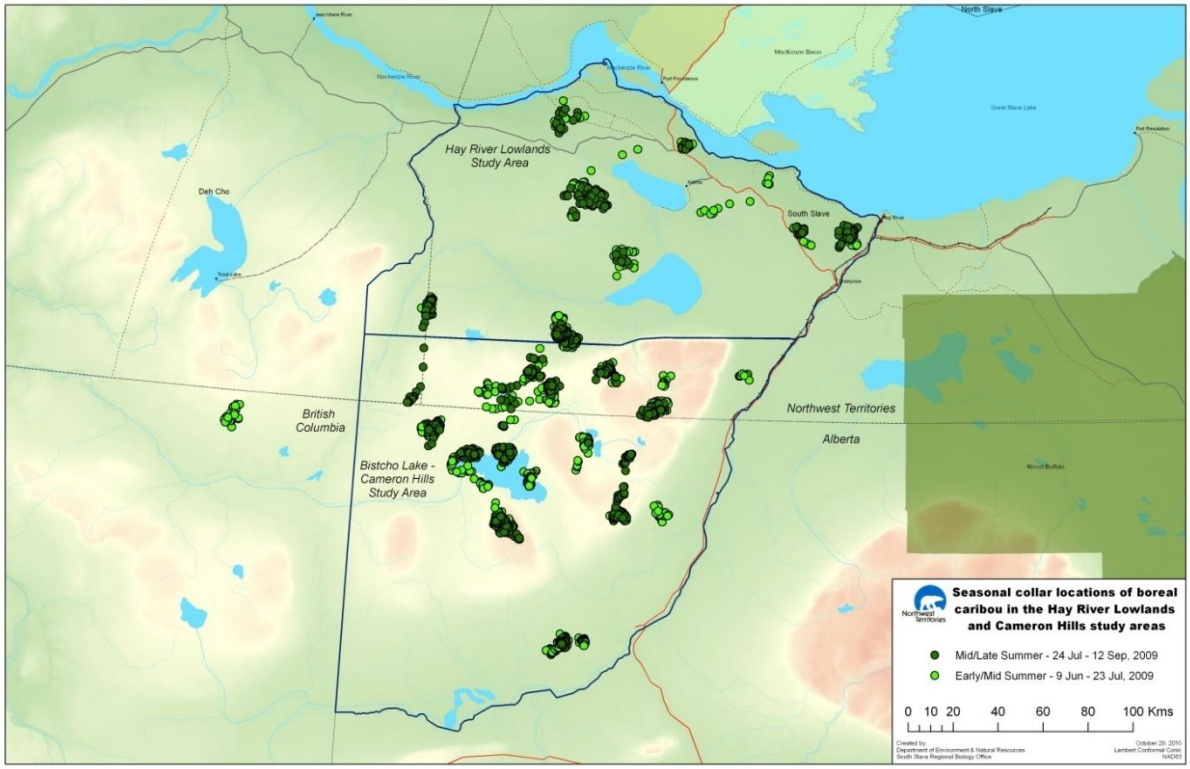


(d) Early Winter, Mid Winter and Late Winter

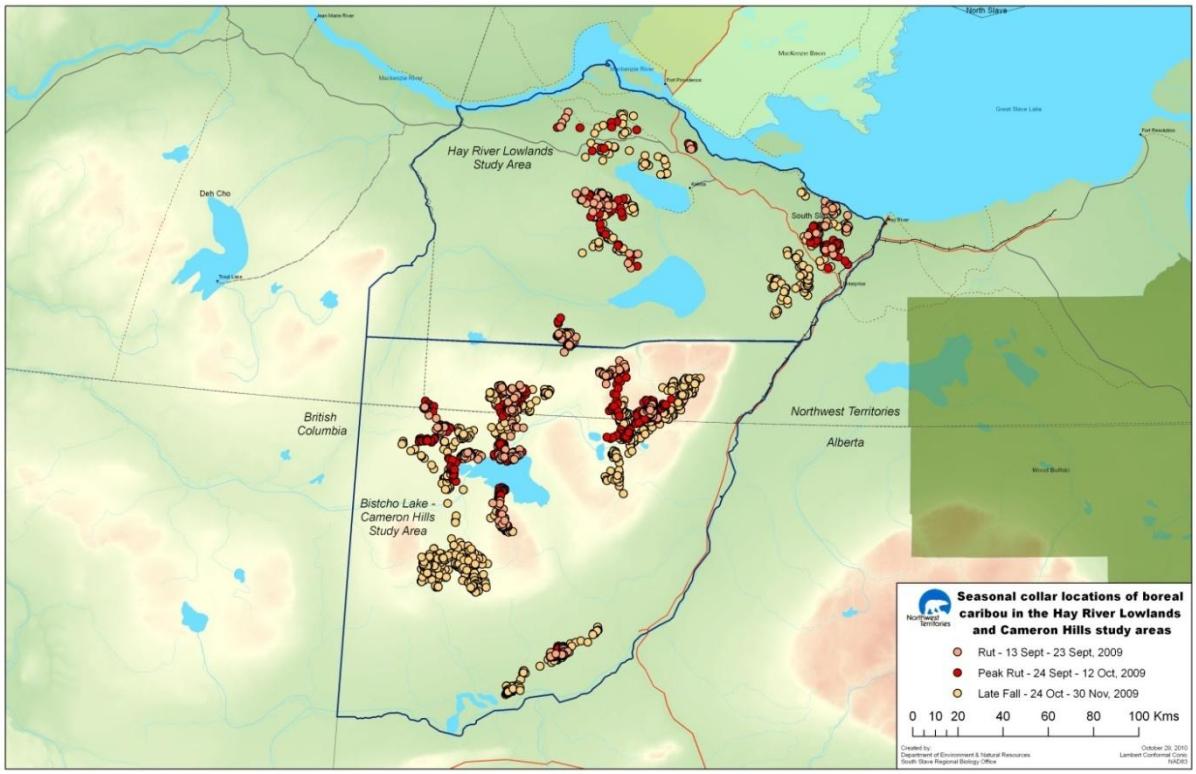
Appendix 3: 4 Maps showing seasonal locations of collared boreal caribou cows in the Hay River Lowlands and Cameron Hills study areas from April 2009 to March 2010.



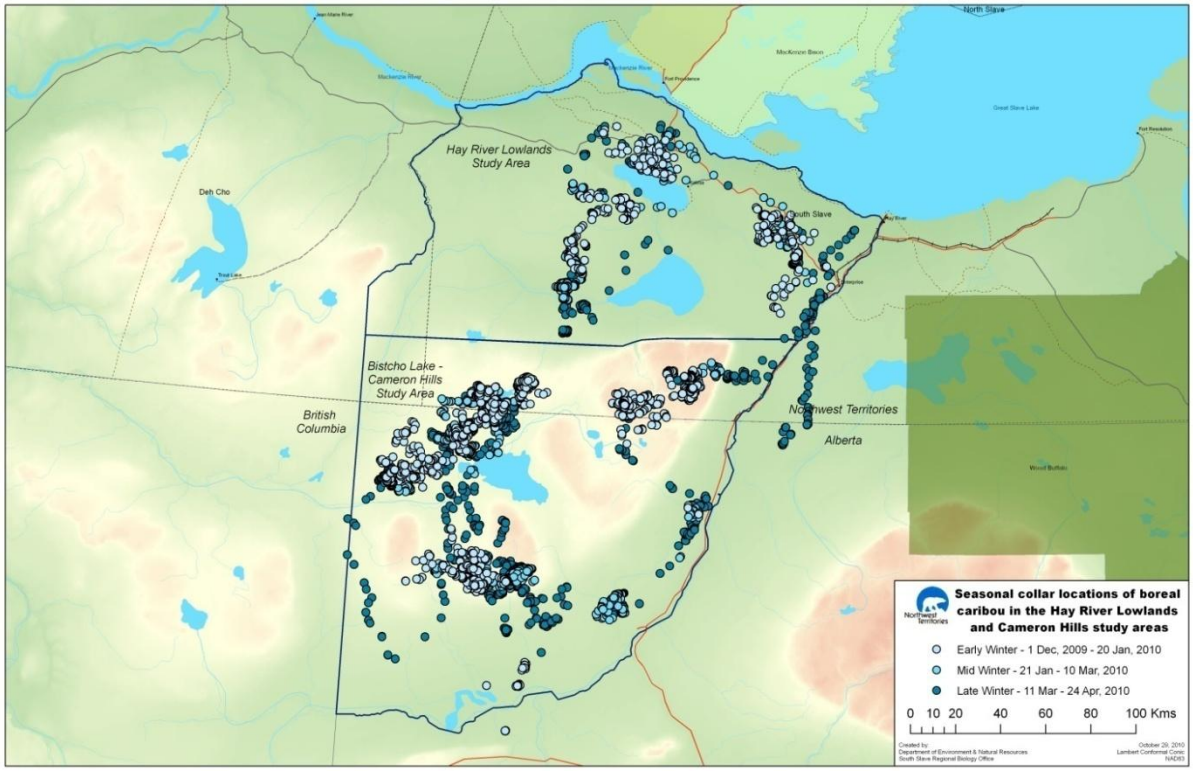
(a) Pre-calving, Calving and Post-calving



(b) Early/mid Summer and Mid/late Summer



(c) Rut, Peak Rut and Late Fall



(d) Early Winter, Mid Winter and Late Winter