ABR inc.
environmental research & services

15 December 2010

Ms. Robyn McGhee, Environmental Scientist
ConocoPhillips Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99503

Subject: **Data report for the Alpine Pipeline caribou surveys, 2010**

Dear Ms. McGhee:

This final letter report constitutes our primary deliverable for the 2010 project titled "Caribou Along The Alpine Pipelines." It summarizes data on caribou distribution in 2010 in a survey area encompassing the Alpine pipelines corridor, extending eastward from the Alpine project facilities on the central Colville River delta to the processing facilities at Kuparuk CPF-2.

Please contact either one of us with questions or requests for further information.

Thank you,

Brian E. Lawhead and Alexander K. Prichard
Senior Scientists
ABR, Inc.—Environmental Research & Services

Introduction

The State of Alaska's Right-of-Way Lease/Grant Stipulation 2.6.1 states that the pipeline systems carrying liquids between the Alpine Development Project and the Kuparuk Oilfield "… shall be maintained to avoid significant alteration of caribou and other ungulate movement patterns. The Commissioner may require additional measures to mitigate impacts to ungulate movements."

This report addresses that stipulation by summarizing data from 2010 (as well as additional telemetry data from 2007–2009) on caribou distribution and movements in the area crossed by the Alpine pipeline corridor, which comprises three adjacent pipelines sharing the same support structure, between the Colville River delta and Kuparuk Central Processing Facility 2 (CPF-2). The data used in this report were collected in concert with surveys conducted for two larger projects under contract to ConocoPhillips Alaska, Inc. (CPAI): the Greater Kuparuk Area (GKA) mammal study (Lawhead and Prichard 2010c) and the Alpine Satellite Development Program (ASDP) caribou monitoring study (Lawhead et al., in prep.).

Study Area

Constructed in the winter of 1998–1999, the Alpine pipelines extend 55 km (34 mi) from the processing facilities at the Alpine CD-1 pad to those at Kuparuk CPF-2. ABR conducted aerial surveys of caribou in the area of the pipeline corridor both before (1992–1998) and after construction (1999–2010) (Lawhead and Prichard 2007b, 2008b, 2009b, 2010b, 2010c).

The Colville East aerial survey area (Figure 1) encompasses most of the length of the pipeline corridor between the Colville River delta and Kuparuk CPF-2 and extends from the Beaufort Sea coast inland 48–56 km (30–35 mi) (Lawhead and Prichard 2006a). The area surveyed was expanded slightly following the calving surveys to provide broader coverage for the postcalving survey.

Methods

Two methods have been used to examine caribou distribution and movements in the area of the Alpine pipelines. Aerial transect surveys provide information on the general distribution of caribou and radio-telemetry provides information on the movements of individual caribou equipped with radio-collars.

A fixed-wing airplane (Cessna 206), carrying three observers in addition to the pilot, was used to survey systematically spaced strip transects (1.6-km spacing of 400-m strips, for 50% sampling coverage) once during the calving season, on June 9, 2010. The survey was timed to occur near the end of calving. An earlier calving survey scheduled for the week before had to be canceled due to persistent poor weather. Another survey was flown during the postcalving period (June 21) before insect harassment began, covering 800-m strips spaced at 3.2-km intervals to maintain 50% coverage, and using two observers plus the pilot. Detailed methods used for transect surveys were described previously (Lawhead and Prichard 2010b). The number of caribou observed within the transect strips was doubled to estimate the actual number present, based on the 50% sampling coverage. Densities of all caribou and of calves only were calculated for the entire survey area and within 2-km distance zones north and south of the Alpine pipelines for each of the two surveys.

To summarize calving distribution and abundance data from aerial transect surveys in mid-June (June 8–16) 1993 and 1995–2010, we used the inverse distance-weighted (IDW) interpolation technique of the *Spatial Analyst* extension of *ArcView* GIS software (Environmental Systems Research Institute, Inc. [ESRI], Redlands, CA) to map caribou densities in 2010 and over all years. This analysis used the total numbers of all caribou and of calves only, pooled in 3.2 × 0.8-km segments of the transect strips; mean values were calculated for segments over all years. The IDW interpolation technique calculated a density surface using each segment centroid and the distance-weighted values for the 14 nearest centroids (200-m grid cells, power = 1). This analysis produced color maps showing surface models of the density of all caribou (adults, yearlings, and calves) and of all calves observed over the entire survey area, to create an easily understood visual portrayal of the data.

Telemetry data were available for small samples of both of the herds that occur in the vicinity of the study area: the Teshekpuk Herd (TCH) and Central Arctic Herd (CAH). The CAH is the herd that consistently uses the area between Alpine and Kuparuk, whereas the TCH typically is distributed west of the Colville River delta (Lawhead et al. 2010). In early July 2008, Alaska Department of Fish and Game (ADFG) biologists outfitted four female CAH caribou with Global Positioning System (GPS) collars purchased by ConocoPhillips Alaska (CPAI). Six female CAH caribou were collared in early July 2009 (a seventh caribou died soon after collaring) and 12 female CAH caribou were collared in June 2010. Most CAH caribou were collared near the Prudhoe Bay oilfield, but five of the collars were captured west of the Kuparuk River in 2010.

Twenty-seven female caribou in the TCH were outfitted with GPS collars in late June 2008 (Table 1) (Lawhead et al. 2009); 20 of those collars were provided by the North Slope Borough (NSB) and seven by CPAI. Six more GPS collars purchased by CPAI were deployed on TCH females in late June 2009. In June 2010, eight male TCH caribou were outfitted with satellite collars and 10 female caribou were outfitted with GPS collars funded by NSB, ADFG and the Bureau of Land Management (BLM). In all three years, the TCH collars were deployed in the area around Teshekpuk Lake. In addition, satellite telemetry data were available from the NSB, BLM, and ADFG for 26 TCH caribou (21 females and 5 males) that had been outfitted with satellite collars before 2007 and still had functioning transmitters in 2008 (Table 1). One satellite-collared TCH caribou switched to the CAH in early 2007. Telemetry data from the period prior to November 2009 are described in previous reports (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, and 2010a).

At the time of this writing, no satellite-collar data for the TCH are available after September 2008 and no GPS-collar data are available after June 2008 for the 30 caribou collared with NSB, ADFG, and BLM funds. GPS collars funded by CPAI and deployed in 2009 and 2010 are still active, so we do not have a complete data set available. A partial data set from satellite uplinks was available for this analysis, however. The GPS collars typically obtain five or six successive locations every two days.

Table 1. Number, type, and dates of radio-collars deployed on caribou of the Teshekpuk Herd (TCH) and Central Arctic Herd (CAH) between June 2006 and June 2010.

Herd	Collar Type	Funding Source	Deployment Date	Retrieval Date	Male	Female	Total [a]
TCH	Satellite	NSB, BLM, ADFG	Before 2007	Various [b]	5	20	25
	GPS	CPAI	June 2007	June 2008 [c]	0	11	11
	GPS	CPAI	June 2008	June 2009 [d]	0	7	7
	GPS [e]	NSB, BLM, ADFG	June 2008	Various	0	20	20
	GPS [f]	CPAI	June 2009	June 2011	0	6	6
	Satellite [e]	NSB, BLM, ADFG	June 2010	–	8	0	8
	GPS [e]	NSB, BLM, ADFG	June 2010	June 2012	0	10	10
CAH	Satellite [g]	NSB, BLM, ADFG	July 2006	–	0	1	1
	GPS	CPAI	June 2008	July 2009	0	4	4
	GPS [h]	CPAI	July 2009	June 2011	0	6	6
	GPS [i]	CPAI	June 2010	June 2012	0	12	12

[a] Some individual caribou were outfitted with more than one collar over several years.
[b] One died in Oct. 2007, one died in Jan. 2008, one died in Feb. 2008, two died in May 2008; five were retrieved in June 2008; seven were active as of Sep. 2008 (no data are yet available since then).
[c] One caribou was not captured and the collar remained active in Sep. 2008.
[d] One died in Feb. 2009.
[e] Data not yet available.
[f] One died in June 2010 and one died in Nov. 2010.
[g] Originally captured with the TCH.
[h] One collar stopped transmitting and one caribou died in June 2009 and one caribou died in Oct. 2009.
[i] One died in July 2010.

Results

Transect Surveys

Systematic aerial surveys of strip transects (Figure 1) provided snapshots of caribou distribution in the survey area during the calving and postcalving periods, before the summer insect-harassment season began. In 2010, the highest densities of calving caribou occurred south of the Alpine pipelines in the Colville East calving survey area (Figure 2). The areas of highest densities in 2010 generally were similar to the high-density distribution of calving activity in most years since 1993 (Lawhead and Prichard 2009b), albeit with a much higher concentration in the Colville East survey area and lower densities in the eastern portion of the surveyed area (Figure 2). In Colville East, the greatest density of calving activity typically occurs inland, south and southeast of the Alpine pipelines (Lawhead and Prichard 2006b, 2007b, 2008b, 2009b, 2010b). This inland/coastal gradient is reflected in the data on estimated density (Table 2), which showed greater numbers and densities south of the Alpine pipelines on both calving surveys in June 2010, as in 2005–2009 (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a). In 2010, a secondary area of relatively high-density calving also occurred north of the Alpine pipelines and south of DS-3S (Figure 2). About 35% of the Colville East calving survey area lies north of the Alpine pipelines, where 24% and 13% of the groups and total caribou, respectively, were found on the calving survey.

During the calving survey, 1,871 caribou were observed on transects (Table 2) and 3,742 caribou were estimated in the Colville East survey area. About two weeks later on June 21, 2,338 caribou were observed (4,676 estimated) in the expanded Colville East survey area (Figure 3). The increase in caribou numbers between those two surveys may have resulted from more caribou moving into the area from the south, more calves being born, and better sightability during the postcalving survey after all snow melted. On 21 June, the portion of the postcalving survey area north of the pipelines (30% of the survey area) contained 16% of the groups and 9% of the individuals seen that day (Table 2; Figure 3).

Northward movement of CAH caribou typically occurs by late June as mosquitoes emerge inland and begin to harass caribou there, forcing them northward to relief habitat near the Beaufort Sea coast. ABR biologists were not present in the field to record the onset of mosquito harassment in 2010, but the widespread distribution of caribou on 21 June indicated that mosquitoes had not yet emerged in numbers throughout the entire survey area. Late June was cooler than average, delaying mosquito emergence and activity and resulting in more caribou remaining inland (Lawhead and Prichard 2010c).

Table 2. Number of groups and caribou observed and estimated density of caribou north and south of the Alpine pipelines during calving and postcalving surveys, Colville East survey area, 2010.

Survey	Location	Area Surveyed (km²) [a]	No. of Groups Observed	Total No. of Caribou Observed	No. of Calves Observed	Total Density (no./km²)	Calf Density (no./km²)
Late Calving	North	248	93	244	77	0.98	0.31
(9 June)	South[b]	470	299	1,627	537	3.46	1.14
Postcalving	North	254	29	222	74	0.87	0.29
(21 June)	South	594	153	2,116	692	3.56	1.16

[a] Sampling coverage was 50% of the survey area.
[b] Sightability was low due to patchy snow cover.

During the calving survey, the highest densities of caribou occurred more than 6 km south of the Alpine pipelines, with moderately high densities also occurring in the zone 4–6 km north of the pipelines (Figure 4). Examination of caribou distribution during calving (Figure 2) suggests that the lower densities near the Alpine pipelines on the latter survey resulted from a localized area of high-density calving activity north of the pipelines and south of DS-3S, similar to that seen in some previous years. During the postcalving survey on June 21, caribou distribution and density were similar to the pattern seen during calving. The higher density of caribou relatively far inland on the postcalving survey and the similarity of the distribution on the calving and postcalving surveys was consistent with delayed emergence of mosquitoes, as expected from the cooler-than-average temperatures in late June.

Movements of Collared Caribou

GPS collars (TCH and CAH), November 2009–June 2010 — Movements before November 2009 were reported previously (Lawhead and Prichard 2010a). In June 2009, six female TCH and six female CAH caribou were outfitted with GPS collars provided by CPAI. One CAH collar stopped transmitting in July 2009. None of those collared caribou were near the Alpine pipelines during this period. Twenty GPS collars were deployed on TCH females for NSB, ADFG, and BLM in June–July 2008 and were removed in June 2010, but those data were not yet available for this report.

GPS collars (TCH and CAH), June–October 2010 — In June 2010, 12 female CAH caribou were successfully outfitted with GPS collars provided by CPAI; one animal died in mid-July, however. The TCH animals remained west of the Colville River and the CAH animals remained east of the Colville River. None of the collared TCH caribou was located near the Alpine pipelines during this period. The three CAH females described below all crossed the Alpine pipelines during July 2010 (Figure 5).

CAH caribou C04189 was south of Prudhoe Bay in late June 2010, then moved through the Prudhoe Bay oilfield to the coast in the first week of July. It moved west along the coast, crossing both the Milne Point and Oliktok Point roads by July 9, and was on the eastern Colville River delta on July 13. Between July 15 and 17, this caribou crossed the eastern portion of the Alpine pipelines (Figure 5) and moved inland until July 25, then moved south of Prudhoe Bay and continued farther east into the western portion of the Arctic National Wildlife Refuge (ANWR) by the end of July. It crossed the Dalton Highway in mid-August and again in late September and was in the Brooks Range east of the highway in November.

CAH caribou C04219 was collared east of the Sagavanirktok River in late June, then moved east near Kaktovik by July 3 before moving back to the west. It moved west along the southern edge of the Prudhoe Bay oilfield during July 9–11, crossed the Spine Road east of CPF-2 on July 13, and continued west near the Colville River delta. Between July 15 and 17, this caribou crossed the eastern portion of the Alpine pipelines (Figure 5) and continued inland until July 25, then moved south of the Prudhoe Bay field and farther east. It moved to the Point Thomson area by the end of July and later moved south. It was in the Brooks Range east of the Dalton Highway in November.

CAH caribou C0819 was in the southern portion of the Prudhoe Bay oilfield on July 10, then moved west, remaining south of the oilfields. Between July 12 and July 14, it crossed the eastern portion of the Alpine pipelines from south to north. Between July 16 and July 18, it crossed the central portion of the Alpine pipelines from north to south (Figure 5). This caribou was located near CPF-2 on July 24, near the Prudhoe Bay oilfield on July 26, and then moved southeast. In September, it moved south along the Sagavanirktok River and was in the Brooks Range east of the Dalton Highway in November.

In addition to the movements indicated by telemetry data, two large groups of caribou (>1,000 animals) were recorded on time-lapse cameras monitoring loon nests north of Alpine on the Colville River delta (J. Parrett, ABR, pers. comm.). The groups were moving west on the afternoon and evening of July 15. Those animals probably were from the CAH, judging from the proximity of several CAH collars east of the Colville delta and the location of all known TCH far to the west of the delta.

In November 2010, two of five GPS-collared TCH caribou were located south of Barrow, one was north of Umiat, and two were in the central Brooks Range. One of the caribou crossed the Brooks Range and died along the Alatna River in mid-November. All but one CAH caribou were in the Brooks Range and east of the Dalton Highway; the other one was just north of the Brooks Range and west of the highway.

Discussion and Conclusions

The combined results of aerial transect surveys and radio telemetry provided both indirect and direct evidence of crossings of the Alpine pipelines in 2010. Although caribou densities were higher south of the Alpine pipelines during the calving and postcalving surveys than they were north of the pipelines, caribou were distributed on both sides of the pipeline corridor. The general pattern of caribou distribution during the 2010 calving season supports previous reports of reduced densities of calving caribou within 2–4 km of active roads and other infrastructure with human activity (Dau and Cameron 1986, Lawhead 1988, Cameron et al. 1992, Cronin et al. 1994, Lawhead et al. 2004), but no indication of consistent displacement from areas near infrastructure without human activity, such as the Alpine pipelines, has been documented. During the 2010 postcalving survey, caribou were distributed throughout the survey area in a similar pattern to that seen during calving (Figure 3), although caribou were absent from one part of the southern portion of the survey area. No explanation for that localized absence was evident, but a female brown bear with three large young (2- or 3-year-olds) was observed about 10 miles west of the area several hours later, so it is possible that caribou groups had moved away to avoid those bears.

As previous movements of GPS-collared caribou have demonstrated, CAH caribou cross the Alpine pipelines frequently (Lawhead and Prichard 2006a, 2007a, 2008a). Northward crossings of the pipelines occur during May and June as caribou move toward the coast during the calving and postcalving periods, especially after the onset of mosquito harassment. Most crossings have occurred during the insect season between late June and early August, when highly dynamic movements occur in response to changing weather conditions and the resulting levels of insect activity (Curatolo and Murphy 1986, Cronin et al. 1994, Murphy and Lawhead 2000). The movements of caribou during the insect season are predictable in terms of general responses to the waxing and waning of insect harassment, but movements through specific areas are determined by complex interactions involving previous locations of the caribou; air temperature, wind speed, and wind direction; solar radiation; and the seasonal chronology of insect emergence and life spans. CAH caribou typically move to the coast, and occasionally onto the Colville delta, when mosquito harassment occurs in late June and July, then move inland again to preferred foraging areas when mosquito harassment abates due to cooler temperatures or higher winds. A prominent issue in oil and gas development has been the extent to which these north/south movements in response to changing weather and insect activity are affected by the presence of development infrastructure and associated activities (Murphy and Lawhead 2000). GPS-collar data for the CAH demonstrated that caribou frequently crossed the Alpine pipelines during the insect season, often crossing and recrossing on the same day or successive days and indicating that the Alpine pipelines were not impeding caribou movements (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a). In the past six years, CAH caribou have moved as far east as the Arctic National Wildlife Refuge during the insect season (Lenart 2009, Lawhead et al. 2010), so they have had less contact with the Alpine pipelines in that season than in previous years.

In 2004–2010, most movements by collared CAH caribou, which have experience negotiating oilfield infrastructure and thus are more likely to be habituated, did not suggest delays in crossing (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a). The limited data from TCH animals, which have less exposure to and experience negotiating oilfield infrastructure, suggest that they generally were able to cross the Alpine pipelines successfully. It must be borne in mind, however, that telemetry data are suggestive rather than conclusive in interpreting pipeline-crossing behavior, because no one witnessed the encounters and because other factors potentially affecting pipeline crossings (such as snow cover, weather conditions, insect activity, intraspecific behavioral interactions) were not documented. It is possible that telemetry locations spaced 2 hr to 2 days apart could obscure delays or aborted crossings, but the multiple documented crossings and analysis of movement rates (ABR, Inc., unpublished data) indicate that caribou that approached the Alpine pipelines were able to cross with little or no delay.

On the basis of the available data, therefore, we concluded that the Alpine pipelines were not significantly altering caribou movements during periods for which survey data were available (spring and early summer) and that no additional mitigation is necessary beyond the elevated design of the pipelines (minimum height 1.5 m [5 ft] above ground level). This conclusion is consistent with previous research (Curatolo and Murphy 1986, Cronin et al. 1994, Lawhead et al. 2006), which found that pipelines elevated to a minimum height of 1.5 m (5 ft) were high enough to allow caribou crossings during snow-free periods.

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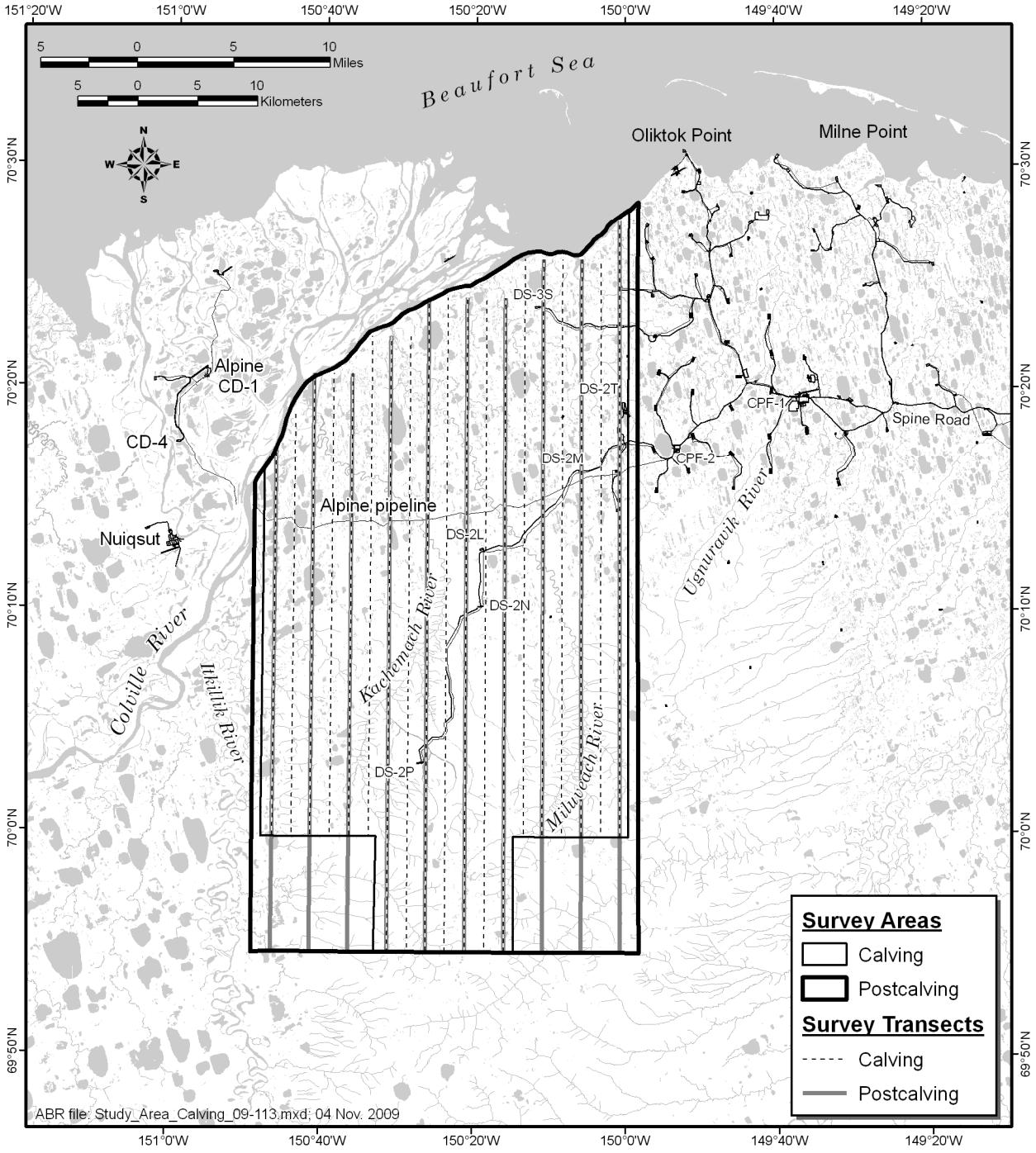

Figure 1. Colville East survey area for systematic aerial strip-transect surveys of caribou, June 2010.

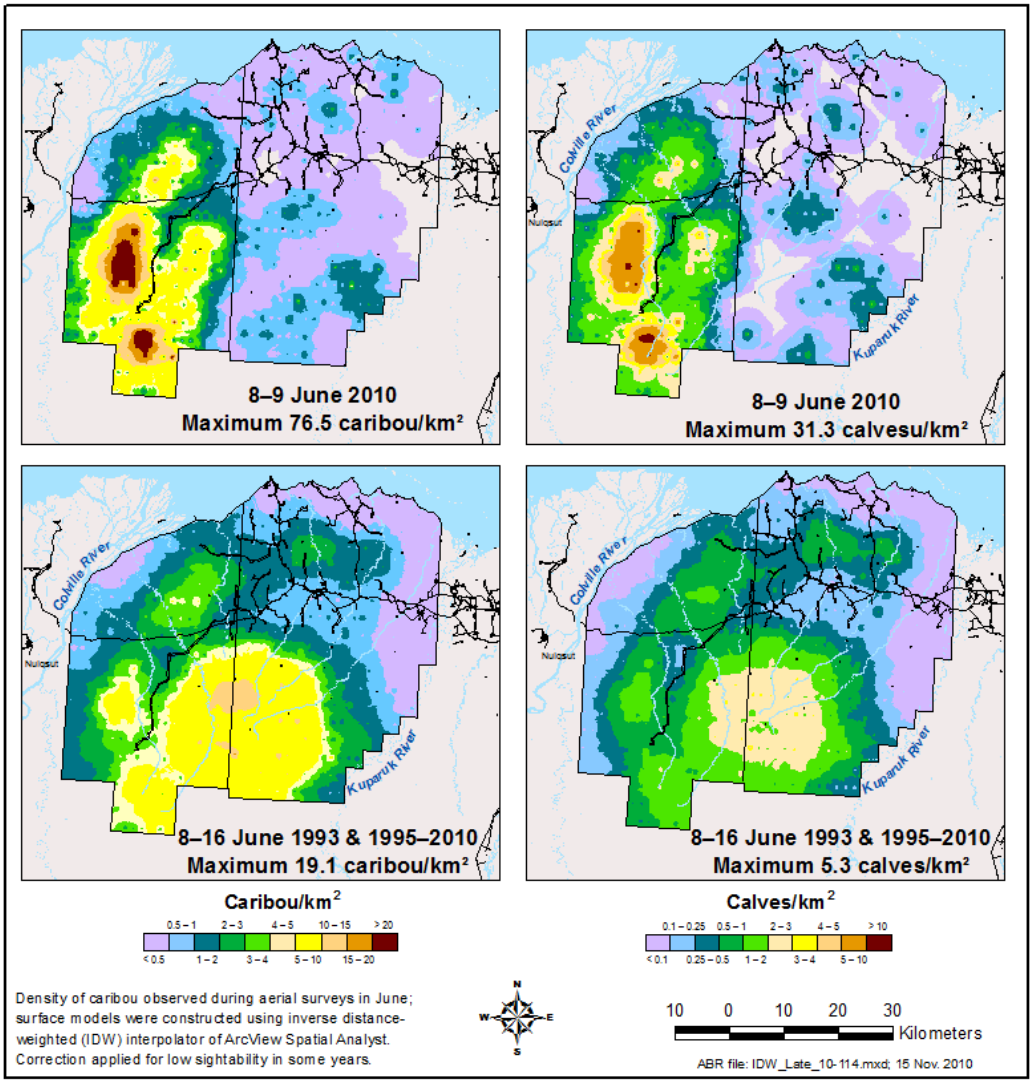

Figure 2. Distribution and density of all caribou and caribou calves in the Kuparuk–Colville calving survey areas during 8–9 June 2010 (top) and distribution and mean density of all caribou and caribou calves during mid-June in the Kuparuk–Colville calving survey areas, 1993 and 1995–2010 (bottom).

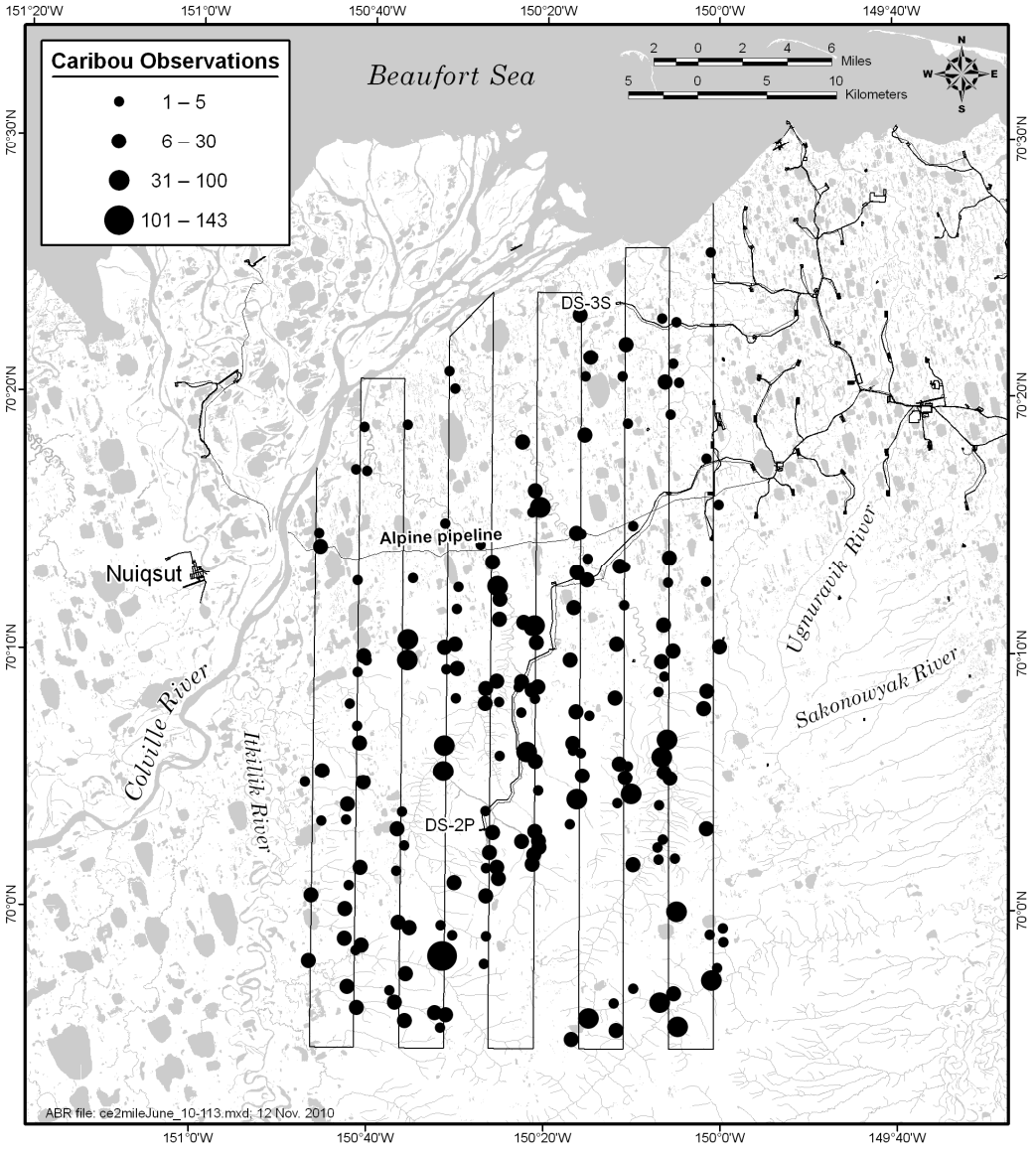

Figure 3. Distribution and sizes of caribou groups in the Colville East survey area during the postcalving survey on 21 June 2010.

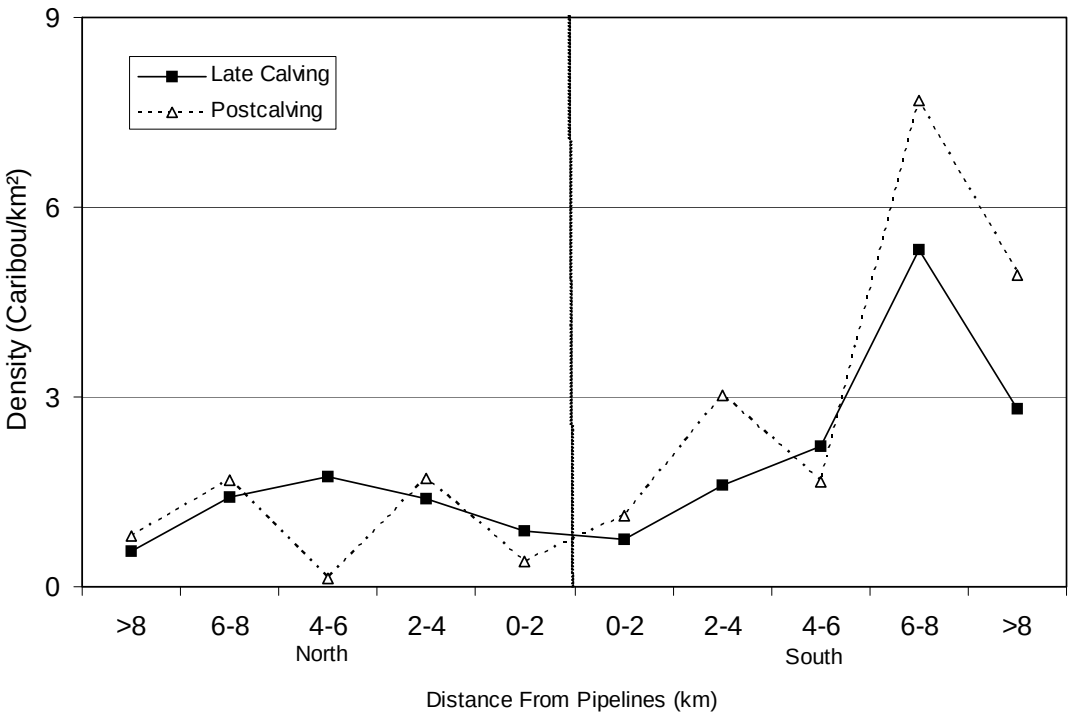

Figure 4. Densities of caribou in different distance zones from the Alpine pipelines during calving and postcalving surveys in the Colville East survey area, June 2010.

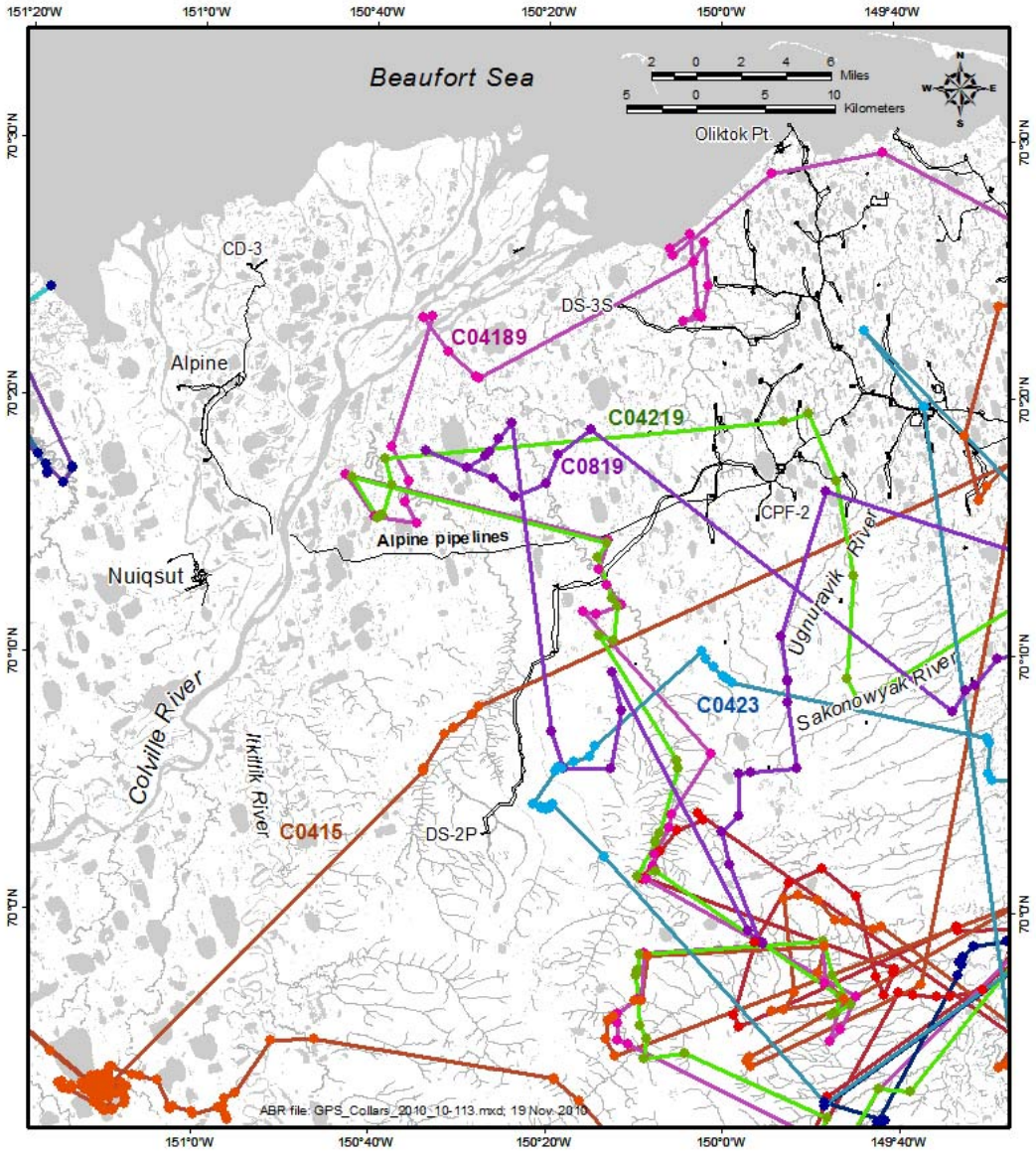

Figure 5. Locations of 15 CAH and 5 TCH caribou outfitted with GPS collars, June–November 2010.