ABR inc.
environmental research & services

14 January 2010

Ms. Sally Rothwell, Environmental Scientist
ConocoPhillips Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99503

Subject: **Data report for Alpine Pipeline caribou surveys, 2009**

Dear Ms. Rothwell:

This letter report constitutes our primary deliverable for the 2009 project titled "Caribou Along The Alpine Pipelines." It summarizes data on caribou distribution in 2009 in a survey area encompassing the Alpine pipelines corridor, extending east 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 2009 (as well as additional telemetry data from 2007 and 2008) on caribou distribution and movements in the area crossed by the Alpine pipelines, comprising 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 carried out under contract to ConocoPhillips Alaska, Inc. (CPAI): the Greater Kuparuk Area (GKA) mammal study (Lawhead and Prichard 2010) and the Alpine Satellite Development Program (ASDP) caribou monitoring study (Lawhead et al., in prep.).

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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 (1999–2009) (Lawhead and Prichard 2007b, 2008b, 2009b, 2010).

The Colville East aerial survey area (Figure 1) encompasses most of the length of the pipeline corridor between the Colville River delta and the Kuparuk CPF-2 area 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 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) twice during the calving season in 2009 (2–4 June and 8–10 June). The early survey was timed to coincide with the approximate peak of calving in the first week of June and the later survey was near the end of calving. Another survey was flown during the postcalving period before insect harassment began (22–23 June), covering 800-m strips spaced at 3.2-km intervals and using two observers plus the pilot. Detailed methods used for transect surveys were described previously (Lawhead and Prichard 2009b). 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 were calculated for the entire survey area and within 2-km distance zones north and south of the Alpine pipelines for each of the three surveys.

To summarize calving distribution and abundance data from aerial transect surveys in early and mid-June (1–8 and 8–16 June) 1993 and 1995–2009, 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 2009 and over all years. This analysis used the total numbers of caribou and of calves 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 (large caribou + calves) and all calves observed over the entire survey area, to create an easily understood visual portrayal of the data.

Telemetry data were available for caribou of the two 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 delta. Alaska Department of Fish and Game (ADFG) biologists outfitted four female CAH caribou with Global Positioning System (GPS) collars provided by ConocoPhillips Alaska (CPAI) in early July 2008 and six female CAH caribou were collared in early July 2009 (a seventh caribou died soon after collaring); all CAH caribou were collared near the Prudhoe Bay oilfield.

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 both years, the TCH collars were deployed in the area around Teshekpuk Lake. In addition, satellite telemetry

data from the NSB, the U.S. Bureau of Land Management (BLM), and ADFG were available for 26 TCH caribou (21 females and 5 males) that had been outfitted with satellite collars before 2007 and still had functioning collars in 2008 (Table 1). One satellite-collared TCH caribou switched to the CAH in early 2007. At this writing, no satellite collar data for the TCH are available yet after September 2008 and no GPS collar data are available after June 2008 for the 20 caribou collared with NSB funds.

Table 1. Number, type, and dates of radio-collars transmitting on caribou of the Teshekpuk Herd (TCH) and Central Arctic Herd (CAH) between June 2007 and October 2009.

Herd	Collar Type	Funding Source	Deployment Date	Retrieval Date	Male	Female	Total [a]
TCH	Satellite	NSB, BLM, ADFG	<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	CPAI	June 2009	June 2011	0	6	6
CAH	Satellite [f]	NSB, BLM, ADFG	July 2006	–	0	1	1
	GPS	CPAI	June 2008	July 2009	0	4	4
	GPS	CPAI	July 2009	June 2011	0	6	6

[a] Some individual caribou were outfitted with more than one collar over several years.
[b] One died Oct. 2007, one died Jan. 2008, one died Feb. 2008, two died May 2008; five were retrieved June 2008; seven were active as of Sep. 2008 (no data after September 2008 are available yet).
[c] One caribou was not captured and the collar remained active in September 2008.
[d] One died in Feb. 2009.
[e] Data not yet available.
[f] Originally captured with the Teshekpuk Caribou Herd.

Results

Transect Surveys

Systematic surveys of strip transects (Figure 1) provided views of caribou distribution in the survey area at two points during the calving period and once in the postcalving period, before the summer insect-harassment season began. In 2009, the highest densities of calving caribou occurred south of the Alpine pipelines in the eastern Colville East and western Kuparuk South calving survey area (Figures 2 and 3). The areas of highest densities in 2009 were typical of the high-density distribution of calving activity in most years since 1993 (Lawhead and Prichard 2009b), albeit slightly farther west and with greater densities in the southernmost portion of the survey areas. In the Colville East survey area, the greatest density of calving activity typically occurs inland away from the coast, south and southeast of the Alpine pipelines (Lawhead and Prichard 2006b, 2007b, 2008b, 2009b). This inland/coastal gradient is reflected by the data on estimated density (Table 2), which showed greater numbers and densities south of the Alpine pipelines on both calving surveys in June 2009, as in 2005–2008 (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a). In 2009, a secondary area of relatively high-density calving also occurred north of the Alpine pipelines and south of DS-3S (Figures 2 and 3). About 35% of the calving survey area was located north of the Alpine pipelines, where 14% and 12% of the numbers of groups and total caribou, respectively, were found on the first calving survey; the comparable proportions on the second calving survey were 21% and 10%, respectively. The numbers throughout the entire survey area increased substantially between the two calving surveys as more calves were born and more caribou moved into the area from the south.

The greatest numbers of caribou among the three surveys were found on the second calving survey, when 3,519 caribou were observed on transects (Table 2) and 7,038 were estimated in the Colville East calving survey area. About two weeks later on 22–23 June, 2,621 caribou were observed (5,242 estimated) in the expanded Colville East survey area (Figure 4). The decrease in caribou numbers between those two surveys likely resulted from the movement of some caribou eastward out of the survey area. On 22–23 June, the portion of the postcalving survey area north of the pipelines (30% of the survey area) contained 17% of the groups and 6% of the individuals seen that day (Table 2; Figure 4).

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 2009, but the widespread distribution of caribou on 22–23 June suggested that mosquitoes had not yet emerged in numbers throughout the entire survey area. Late June was unusually cold in the Kuparuk area, which would have delayed mosquito harassment and resulted in more caribou remaining inland (Lawhead and Prichard, in prep.). CAH caribou subsequently moved eastward and remained far to the east of the Alpine pipelines for the remainder of the summer insect season.

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, 2009.

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)
Early Calving	North	248	55	120	32	0.48	0.13
(3–4 June)	South	470	335	895	152	1.90	0.32
Late Calving	North	248	103	342	70	1.38	0.28
(9–10 June)	South	470	397	3,177	851	6.76	1.81
Postcalving	North	254	26	146	12	0.57	0.05
(22–23 June)	South	594	131	2,475	598	4.17	1.01

[a] Sampling coverage was 50% of the survey area.

Caribou densities were relatively low in all distance zones during the first calving survey. During the second calving survey, the highest densities occurred more than 8 km south of the pipelines and in the zone 4–6 km north of the pipelines (Figure 5). Examination of caribou distribution during calving (Figures 2 and 3) 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 22–23, caribou density was highest more than 6 km south of the pipelines and was low in all other zones. The high density of caribou relatively far inland on that survey was consistent with the delayed emergence of mosquitoes expected from the unusually cold temperatures in late June.

Movements of Collared Caribou

GPS collars (TCH and CAH), November 2008–June 2009 — Movements prior to November 2008 were reported previously (Lawhead and Prichard 2009a). In late June–early July 2008, 11 female caribou were outfitted with GPS collars provided by CPAI; four were placed on CAH caribou and seven on TCH caribou. In addition, one TCH animal (Caribou 0624) collared in 2007 was moving with caribou of the Western Arctic Herd several hundred km away in late June 2008, so its collar could not be recovered. That caribou rejoined the TCH during fall 2008 and the collar was removed in March 2009. None of these collared caribou was near the Alpine pipelines during this period. Twenty GPS collars were deployed on TCH females for the NSB in June–July 2008 but those data were not yet available for this analysis.

GPS collars (TCH and CAH), June–October 2009 — In late June–early July 2009, 12 female caribou were successfully outfitted with GPS collars provided by CPAI; six were placed on CAH caribou and six on TCH caribou. An additional CAH female caribou died shortly after collaring and one of the CAH collars stopped working later in July. None of these collared caribou was located near the Alpine pipelines during this period. The TCH animals remained west of the Colville River and the CAH animals remained east of the Kuparuk River. By early winter 2009, the TCH collars all were located near the Chukchi Sea coast southwest of Barrow and the CAH caribou were south of the Brooks Range and east of the Dalton Highway.

Discussion and Conclusions

The combined results of aerial transect surveys and telemetry tracking of GPS- and satellite-collared caribou provided indirect and direct evidence of crossings of the Alpine pipelines in 2009. Caribou densities were higher south of the Alpine pipelines during calving and postcalving surveys than north of the pipelines, but caribou were distributed on both sides of the pipeline corridor. During the 2009 postcalving survey, caribou were distributed throughout the survey area, with the largest groups observed in the southeastern part of the survey area. The general pattern of caribou distribution during the 2009 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.

As the 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 have occurred during May and June as caribou moved toward the coast during the calving and postcalving periods, especially after the onset of mosquito harassment. Most crossings have occurred during the insect season, a highly dynamic period between late June and early August when caribou movements are affected primarily by changing weather conditions and the resulting levels of insect activity (Curatolo and Murphy 1986, 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 the Colville River 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 whether these north/south movements in response to changing weather and insect activity are limited by the presence of development infrastructure or activity (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). In the past five years, CAH caribou have moved as far east as the Arctic National Wildlife Refuge during the insect season (Lenart 2009, Lawhead et al. 2009), so they have had less contact with the Alpine pipelines than in previous years.

In 2004–2009, 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). The limited data from TCH animals, which have less exposure and experience negotiating oilfield infrastructure, suggest that they generally were able to cross the Alpine pipelines successfully. It must be borne in mind that telemetry data are suggestive rather than conclusive in interpreting pipeline-crossing behavior, however, 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 a day 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 raised to a minimum height of 1.5 m (5 ft) were elevated sufficiently to allow caribou crossings during snow-free periods.

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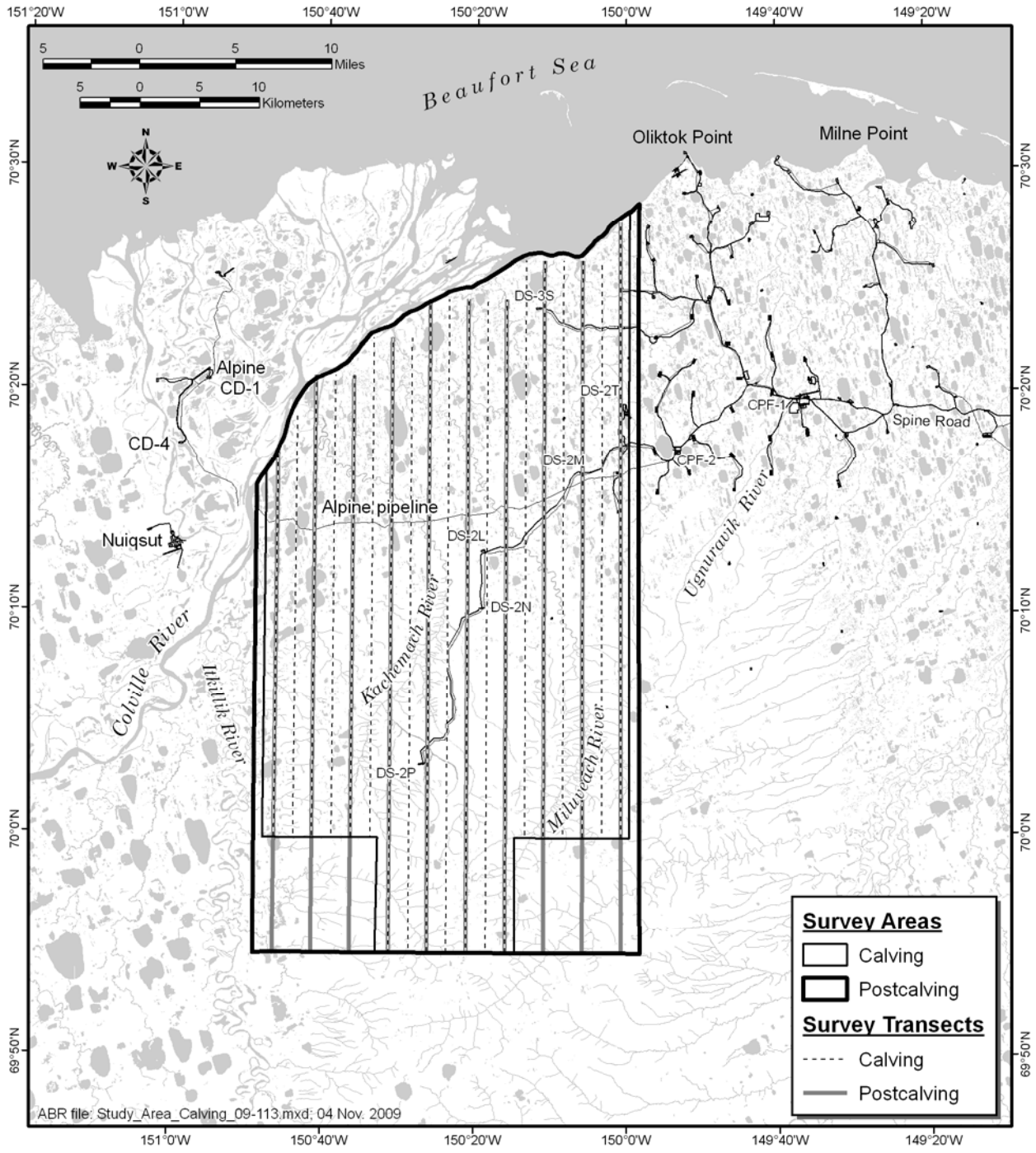

Figure 1. Colville East survey area for systematic aerial strip-transect surveys of caribou, June 2009.

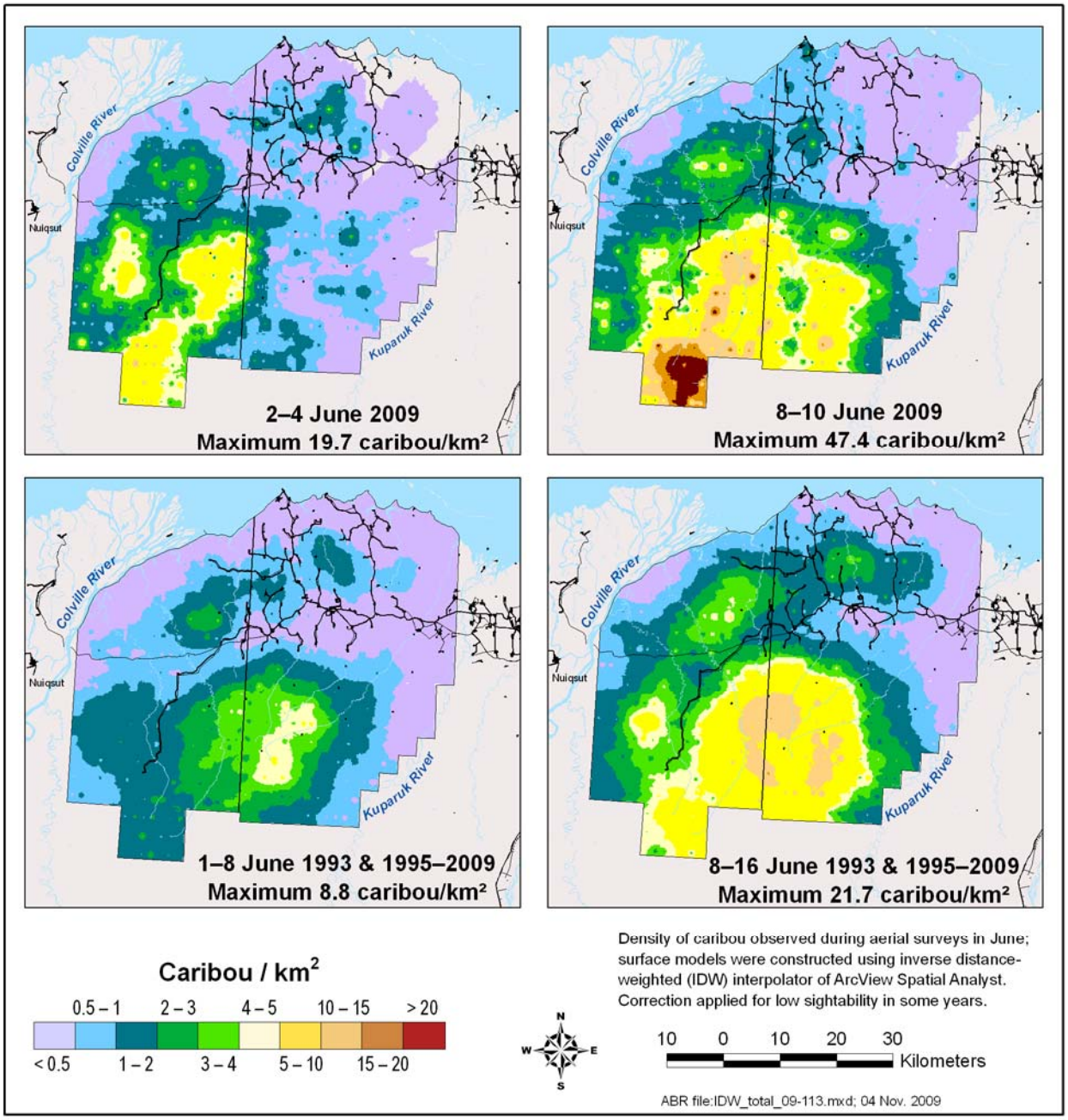

Figure 2. Distribution and density of all caribou in the Kuparuk–Colville calving survey areas during 2–4 June and 8–10 June 2009 (top) and distribution and mean density of all caribou during early June and mid-June in the Kuparuk–Colville calving survey areas, 1993 and 1995–2009 (bottom).

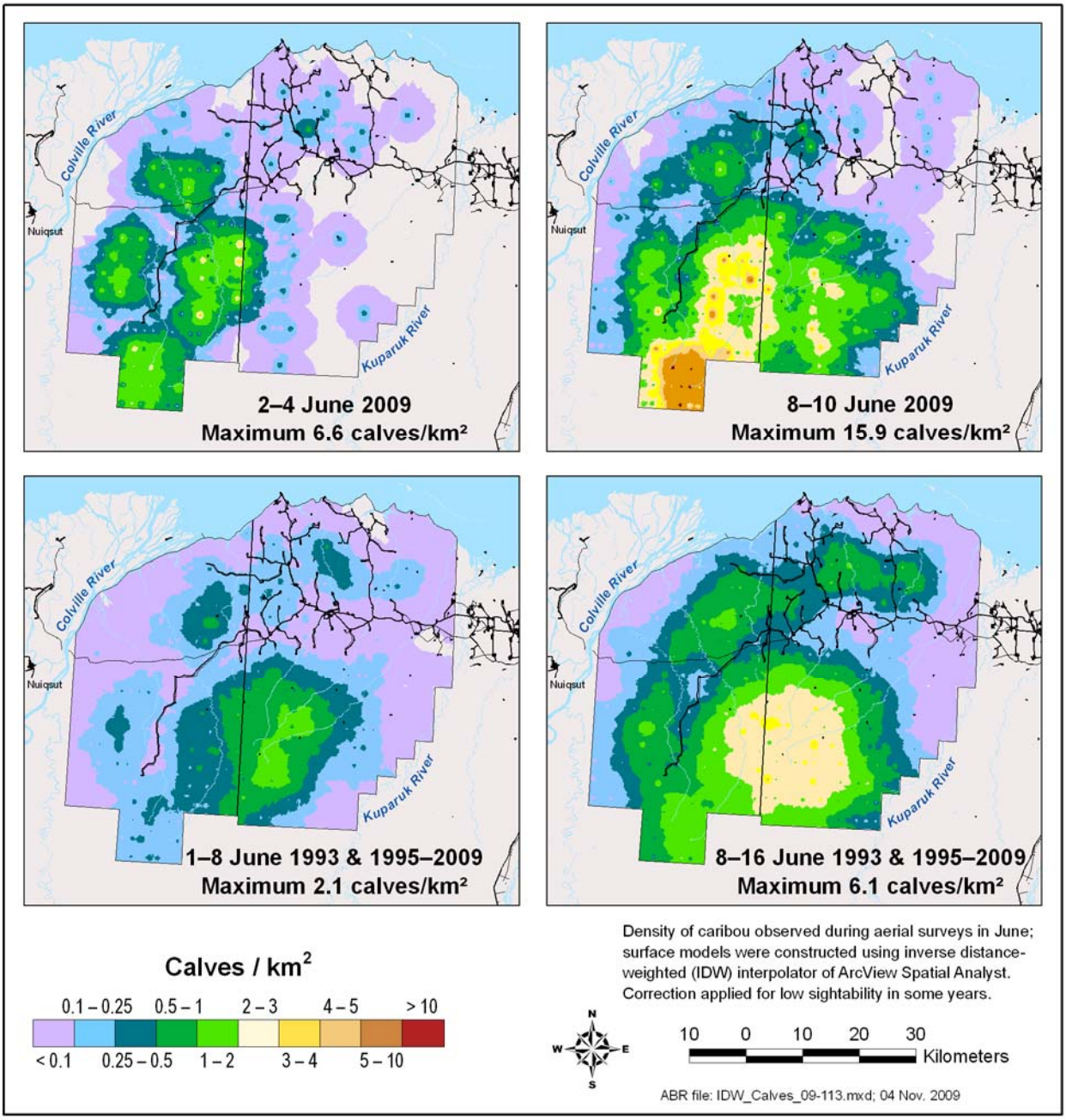

Figure 3. Distribution and density of calf caribou in the Kuparuk–Colville calving survey areas during 2–4 June and 8–10 June 2009 (top) and distribution and mean density of calf caribou during early June and mid-June in the Kuparuk–Colville calving survey areas, 1993 and 1995–2009 (bottom).

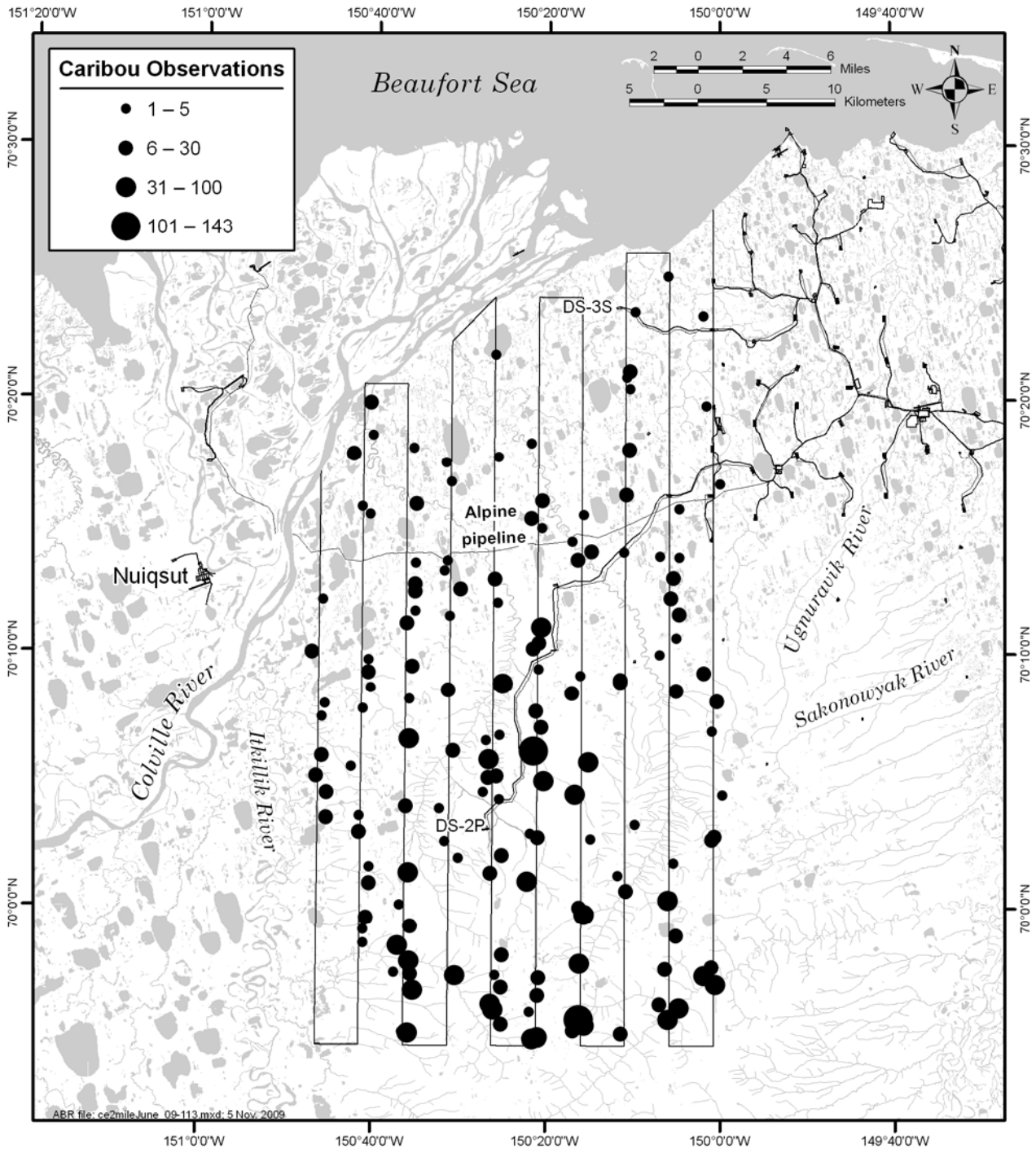

Figure 4. Distribution and sizes of caribou groups in the Colville East survey area during the postcalving survey on 22–23 June 2009.

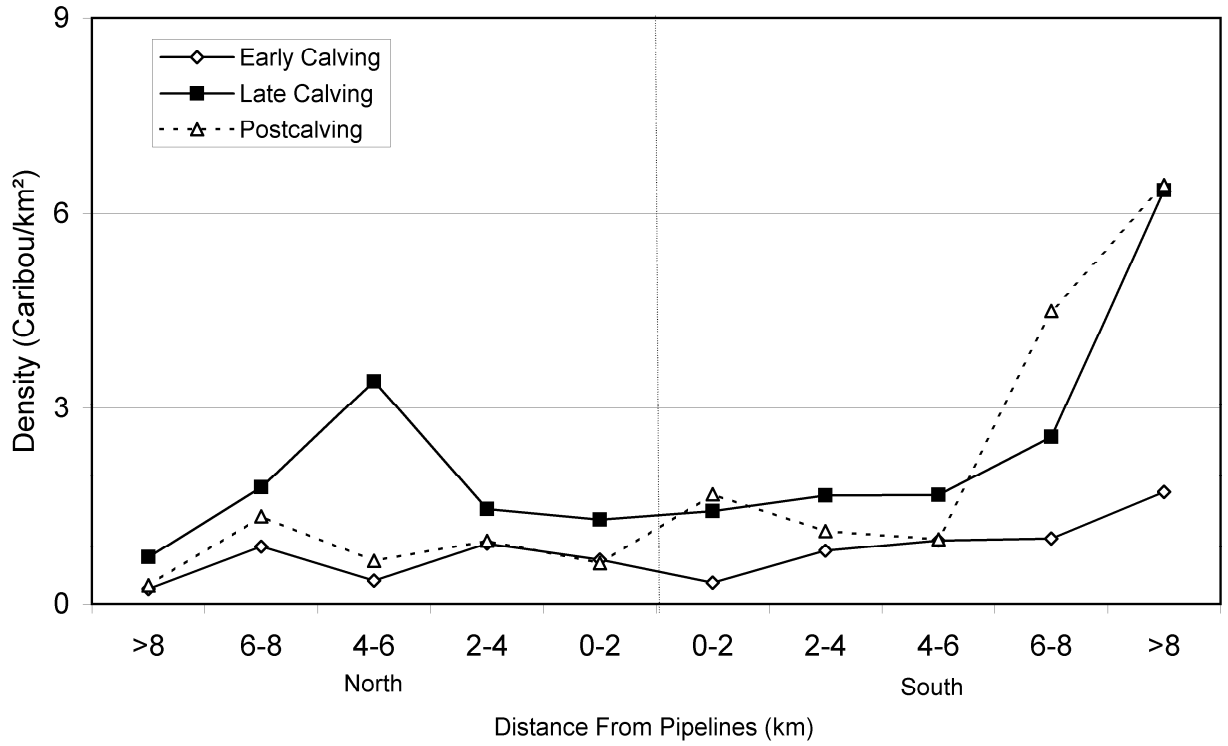

Figure 5. Densities of caribou in different distance zones from the Alpine pipelines during calving and postcalving surveys in the Colville East survey area, June 2009.