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19 December 2014

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

Subject: **Data Report for Alpine Pipeline Caribou Surveys, 2014**

Dear Ms. McGhee:

This data report constitutes our final reporting deliverable for this 2014 project. It summarizes data on caribou distribution and movements in 2014 in a survey area encompassing the Alpine pipeline 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 Brian or Alex with questions or requests for further information.

Thank you,

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Senior Scientist	Senior Scientist	Research Biologist

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 on caribou distribution and movements from aerial surveys in 2014 and radio telemetry during 2007–2014 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 other caribou studies for ConocoPhillips Alaska, Inc. (CPAI): the Alpine Satellite Development Program (ASDP) caribou monitoring study (Lawhead et al., in prep.) and the Greater Kuparuk Area (GKA) mammal study (Lawhead et al. 2014a).

STUDY AREA

Constructed in the winter of 1998–1999, the Alpine pipelines corridor extends 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 (1993–1998, except 1994) and after construction (1999–2014) (Lawhead and Prichard 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b; Lawhead et al. 2013c, 2014b). Two herds, the Central Arctic Herd (CAH) and the Teshekpuk Herd (TH) occur in the study area. The CAH consistently uses the area between Alpine and Kuparuk, whereas the TH typically is distributed west of the Colville River delta (Lawhead et al. 2014c).

The Colville East aerial survey area (Figure 1) encompasses most of the length of the Alpine pipeline corridor between the Colville River delta and Kuparuk CPF-2. The survey area extends from the Beaufort Sea coast inland 48–56 km (30–35 mi) (Lawhead and Prichard 2006a). The postcalving survey area was slightly larger than the calving survey area because of the wider spacing of the postcalving transects (see below).

METHODS

Two methods—aerial transect surveys and radio telemetry—have been used to examine caribou distribution and movements in the area of the Alpine pipeline corridor in the last several decades. Aerial transect surveys provide information on the general distribution and abundance of all caribou in the survey area at specific times and telemetry provides information on the annual movements of individual radio-collared caribou throughout a herd's range.

A fixed-wing airplane (Cessna 206), carrying three observers in addition to the pilot, was used to survey 400-m-wide strip transects that were spaced systematically at intervals of 1.6 km (resulting in 50% sampling coverage) in the Colville East survey area during early and late calving in 2014 (4–5 June and 9–10 June 2014, respectively; Figure 1). Another survey was flown during the postcalving period (23 June 2014) using two observers plus the pilot, covering 800-m-wide strips spaced at 3.2-km intervals to maintain 50% sampling coverage (Figure 1). The postcalving survey was scheduled to occur before the seasonal onset of mosquito harassment to minimize the influence on caribou distribution and movements.

Transect survey methods were described in detail previously (Lawhead et al. 2014d). The number of caribou observed within the transect strips was doubled to estimate the actual number present, based on the 50% sampling coverage. During the early calving survey in 2014, sightability was low in the entire survey area due to patchy snow cover, whereas, during the late calving survey, sightability was low only in the southern portion of the Colville East survey area, so the estimated densities were adjusted in these areas using a sightability correction factor (SCF) developed previously for calving caribou in the Kuparuk area (Lawhead et al. 1994). The density of all caribou, as well as of calves only, was calculated for the entire survey area and within 2-km distance zones north and south of the Alpine pipeline corridor for the calving and postcalving surveys.

To summarize calving distribution and abundance for the period before construction of the Alpine pipelines (1993 and 1995–1998) and after construction (1999–2014), we used the inverse distance-weighted (IDW) interpolation technique of the *3D Analyst* extension of *ArcGIS* software (Environmental Systems Research Institute, Inc., Redlands, CA) to map caribou densities over all years for which we have comparable data. To provide a broader spatial context of calving densities in the GKA, we included data from the adjacent Kuparuk South and Kuparuk Field survey areas in these maps (Lawhead et al. 2014a). We used data from late calving surveys conducted during 8–10 June in 2014 and 6–16 June over the period of 1993–2014 (except 1994). This analysis used the SCF-corrected 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 observed over the entire survey area to create an easily understood visual portrayal of the data. One map was prepared to show adults, yearlings, and calves combined, and another map shows only calves.

From November 2013 through October 2014, telemetry data were available for some radio-collared caribou from both herds that occur in the vicinity of the study area. Twelve female TH caribou were outfitted with Global Positioning System (GPS) collars purchased by CPAI in June 2007 (Lawhead et al. 2008) (Table 1). Twenty-seven female caribou in the TH were outfitted with GPS collars in late June 2008; 20 of those collars were provided by the North Slope Borough (NSB) and seven by CPAI. In late June 2009, six more GPS collars purchased by CPAI were deployed on TH females and 14 Platform Transmitter Terminal (PTT) satellite collars (hereafter called satellite collars) purchased by NSB, ADFG, and the Bureau of Land Management (BLM) were deployed on 13 males and one female. In June 2010, four male TH caribou were outfitted with satellite collars and 13 female caribou were outfitted with GPS collars funded by NSB, ADFG, and BLM. In June 2011, four TH males and four TH females were outfitted with satellite collars and nine females were outfitted with GPS collars funded by NSB, ADFG, and BLM. In June 2012, seven male caribou were outfitted with satellite collars and 17 female caribou were outfitted with GPS collars. In June 2013, five satellite collars were deployed on TH males and 14 GPS collars were deployed on TH females. In June 2014, 11 female TH caribou were outfitted with GPS collars and six males and one female were outfitted with satellite collars, all funded by the NSB, ADFG, and BLM.

In all years, the TH collars were deployed in the area surrounding Teshekpuk Lake, >50 km west of the Alpine pipelines study area. In addition, satellite telemetry data were available from the NSB, BLM, and ADFG for 25 TH caribou (20 females and five males) that had been outfitted with satellite collars before 2007 and still had functioning transmitters in 2007 (Table 1). Telemetry data from the period before November 2013 are described in previous reports (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a; Lawhead et al. 2013b, 2014b).

In July 2008, Alaska Department of Fish and Game (ADFG) biologists outfitted four female CAH caribou with GPS collars purchased by CPAI (Table 1). Six female caribou were collared in July 2009 (a seventh caribou died soon after collaring). Twelve female caribou were collared in June 2010, seven of which were captured near the Prudhoe Bay oilfield and the other five of which were captured west of the Kuparuk River. Two of those 12 collared CAH caribou died during the summer of 2010 and the collars from the other 10 animals were retrieved in April 2012 (one animal died in April shortly before collar retrieval). Twelve additional GPS collars purchased by CPAI were deployed on CAH females in March 2013. Two of those caribou died in May and two died in August, so only eight collars were still active in October 2013. Twelve of the 13 GPS collars purchased by CPAI in 2014 were deployed on CAH females in late April 2014 and the other collar was deployed on a CAH female in June 2014.

A complete data set for the GPS collars that still are active is not yet available because those data must be downloaded from the collars after retrieval. 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 during the spring, summer, and fall (15 April–15 November).

RESULTS

AERIAL TRANSECT SURVEYS

CALVING SURVEYS

Caribou distribution and movements during the 2014 calving season appeared to have been affected by protracted snowmelt. After unseasonably warm weather in early May melted much of the snow in the survey area, the air temperatures subsequently cooled and patchy snow cover remained into the second week of June. Similar to 2013, much of the calving activity by radio-collared CAH females occurred south of our study area (E. Lenart, ADFG, pers. comm.), resulting in the second lowest calving density observed in the GKA since our surveys began in 1993 (Lawhead et al. 2014a). During the 2014 calving surveys, the highest densities of calving caribou in the GKA occurred south of the Kuparuk facilities and Alpine pipeline corridor (Figures 2–5), although at much lower densities than in most other years (Lawhead et al. 2014a). The highest density of calving caribou in the GKA occurred in the Colville East survey area, which has supported the highest density of calving activity in 12 of 21 years since 1993, including five of the past six years (Lawhead et al. 2014a).

Table 1. Number, type, and dates of radio-collars deployed on caribou of the Teshekpuk Herd (TH) and Central Arctic Herd (CAH) between 2006 and June 2014.

Herd	Collar Type	Funding Source	Deployment Date	Retrieval Date	Male	Female	Total[a]
TH	Satellite	NSB, BLM, ADFG	Before 2007	Various	5	20	25
	GPS	CPAI	June 2007	June 2008	0	12	12
	GPS	CPAI	June 2008	June 2009	0	7	7
	GPS	NSB, BLM, ADFG	June 2008	Various	0	20	20
	GPS	CPAI	June 2009	June 2011	0	6	6
	Satellite	NSB, BLM, ADFG	June 2009	Various	13	1	14
	GPS	NSB, BLM, ADFG	June 2009	June 2011	0	16	16
	Satellite	NSB, BLM, ADFG	June 2010	Various	4	0	4
	GPS	NSB, BLM, ADFG	June 2010	June 2012	0	12	12
	Satellite	NSB, BLM, ADFG	June 2011	Various	4	4	8
	GPS	NSB, BLM, ADFG	June 2011	June 2013	0	9	9
	Satellite	NSB, BLM, ADFG	June 2012	Various	7	0	7
	GPS	NSB, BLM, ADFG	June 2012	–	0	17	17
	Satellite	NSB, BLM, ADFG	June 2013	Various	5	0	5
	GPS	NSB, BLM, ADFG	June 2013	–	0	14	14
	Satellite	NSB, BLM, ADFG	June 2014	Various	6	1	7
	GPS	NSB, BLM, ADFG	June 2014	–	0	11	11
CAH	Satellite	NSB, BLM, ADFG	July 2006	June 2009	0	1	1
	GPS	CPAI	June 2008	July 2009	0	4	4
	GPS	CPAI	July 2009	June 2011	0	6	6
	GPS	CPAI	June 2010	April 2012	0	12	12
	GPS	CPAI	March 2013	Planned 2016	0	12	12
	GPS	ADFG	April 2012	Died 2012	0	4	4
	GPS	CPAI	April 2014	Planned 2017	0	12	12
	GPS	CPAI	June 2014	Planned 2017	0	1	1

[a] Some individuals were outfitted with more than one collar (sequentially) over a period of years.

Within the Colville East survey area, a total of 237 caribou (including 37 calves) were observed on transects during the early calving survey and a total of 364 caribou (including 71 calves) were observed on transects during the late calving survey (Table 2). After adjusting for the 50% sampling coverage and the low sightability in the survey area, we estimated that 891 caribou were present in the survey area during the early calving survey and 756 caribou were present in the survey area during the late calving survey. In comparison, the mean number of caribou estimated in the same survey area during the latter portion of the calving season during 2002–2013 was 5,228 caribou (Lawhead et al. 2014d).

Table 2. Number of groups and caribou observed, and caribou density estimated, to the north and south of the Alpine pipeline corridor during calving and postcalving surveys in the Colville East survey area, 2014.

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[b]	246	8	16	1	0.122	0.008
(4–5 June)	South[b]	470	81	221	36	0.884	0.144
	Total[b]	716	89	237	37	0.622	0.097
Late Calving	North	246	12	30	8	0.122	0.032
(9–10 June)	South[c]	470	88	334	63	0.740	0.140
	Total[c]	716	100	364	71	0.528	0.103
Postcalving	North	254	5	19	1	0.075	0.004
(23 June)	South	594	92	1583	370	2.664	0.623
	Total	848	97	1602	371	1.888	0.437

[a] Sample coverage was ~50% of the entire survey area.
[b] Sightability was low in the entire survey area due to patchy snow cover, so densities were multiplied by the SCF (1.88; see text).
[c] Sightability was low in southern portions of the survey area due to patchy snow cover, so densities in those portions were multiplied by the SCF (1.88; see text).

In Colville East, the highest density of calving activity typically occurs in the inland portion of the area, south and southeast of the Alpine pipeline corridor (Lawhead and Prichard 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b; Lawhead et al. 2013c, 2014d). In 2014, most caribou in the Colville East survey area were located south of the Alpine pipeline corridor during both calving surveys (Figure 6): 9% of groups and 7% of total caribou on the early survey and 12% of groups and 8% of total caribou on the late survey were north of the Alpine pipeline corridor, an area that constitutes 35% of the survey area.

POSTCALVING SURVEY

Caribou numbers increased after calving as large numbers of caribou moved into the Kuparuk area. During the postcalving survey on 23 June, the density of caribou had increased more than threefold since the calving surveys, with most of the caribou still being south of the Alpine pipeline corridor (Table 2, Figure 7). On 23 June, 1,602 total caribou (371 calves) were seen in the expanded Colville East survey area (Table 2), resulting in an estimate of 3,204 caribou after adjusting for the 50% sampling coverage. The portion of the survey area north of the Alpine pipeline corridor contained only 5% of groups and 1% of the individuals observed (Table 2).

Northward movement of CAH caribou typically occurs by late June as mosquitoes emerge in inland areas and begin to harass caribou there, forcing them northward to relief habitat near the Beaufort Sea coast. Average index values of mosquito activity in the second half of June 2014 were below the 32-year average (Lawhead et al. 2014a) and mosquito harassment had not yet begun at the time of the postcalving survey. ABR researchers working on avian studies just west of the Colville River delta reported that mosquito harassment in 2014 first began on 28 June, nearly a week after our postcalving survey was completed.

MOVEMENTS OF COLLARED CARIBOU

CAH GPS COLLARS

The movements of GPS-collared CAH caribou before November 2013 have been described in previous reports (e.g., Lawhead et al. 2014b, 2014c). In 2014, 13 new GPS collars purchased by CPAI were deployed by ADFG biologists on CAH females during 18–20 April and on 29 June 2014 (Table 1). Of the 21 GPS collars that were active on female CAH caribou between November 2013 and October 2014, seven were located near the Alpine pipelines study area (Figures 8 and 9). Caribou 0924 was located primarily south of the Alpine pipeline corridor from 21 May to 18 July, crossing the Alpine pipeline corridor six times during this period. Caribou C02120 was in the study area repeatedly during 28 May–28 June (no crossings of the Alpine pipeline corridor), 12–18 July (three crossings), and 15–27 September (two crossings). Caribou C1001 was located both north and south of the Alpine pipeline corridor from 27 May to 25 August, during which time she crossed the pipelines three times. Caribou C1006 was within the study area from 5 June to 14 July, crossing the Alpine pipeline corridor once. Caribou C1330 was located north and south of the Alpine pipeline corridor from 25 May to 21 July and south of the Alpine pipeline from 13 September to 8 October, but did not cross the Alpine pipeline corridor. Caribou C1426 was in the study area during 5–29 June and crossed the Alpine pipeline corridor once. Caribou C1439 was in the study area from 2 June to 13 October and crossed the Alpine pipeline corridor seven times.

TH SATELLITE COLLARS

The movements of satellite-collared TH caribou before November 2013 have been described in previous reports (Lawhead et al 2014b). Sixteen TH caribou (12 males and four females) had functioning satellite collars for the period from November 2013 through October 2014. Only two of those animals (Caribou 0812, a female, and Caribou 1310, a male) entered the study area during that period (Figure 10). Caribou 0812 was located near DS-2P on 23 June but did not appear to approach the Alpine pipeline corridor (there was a gap in locations around the time she was captured and recollared with a new GPS collar on 26 June 2014). After being recollared, she moved westward through the Kuparuk oilfield from 11 July to 17 July, when she departed the study area to the west. Caribou C1310 approached the Alpine pipeline corridor from the south on 25 June, crossed around 27 June, headed northeast to the Oliktok Point area until 5 July, moved west to the Colville River delta until 15 July, and then moved south, presumably crossing the Alpine pipeline corridor again (based on straight-line distances between locations 18 hours apart) on 15 July before departing the study area to the west on 17 July.

TH GPS COLLARS

The movements of GPS-collared TH caribou before November 2013 have been described in previous reports (e.g., Lawhead et al. 2014b, 2014c). Location data for 32 female TH caribou outfitted with GPS collars were available for the period from November 2013 through October 2014. Consistent with the more westerly distribution of the TH, only one of those 32 animals (Caribou 0812) entered the area near the Alpine pipeline corridor (Figure 10). The movements of Caribou 0812 were described in the preceding paragraph.

CALVING DISTRIBUTION BEFORE AND AFTER ALPINE CONSTRUCTION

In survey years before construction of the Alpine pipeline corridor (1993 and 1995–1998), high densities of caribou were recorded both north and south of the Alpine pipeline corridor during the calving season, with lower densities occurring over much of the pipeline route (Figure 11); the highest preconstruction density along the Alpine pipeline corridor occurred near the eastern end. The area along the pipelines continued to host low densities of caribou after construction (Figure 11). In 2014, caribou densities were low north of the Alpine pipeline corridor on the calving and postcalving surveys, with higher densities occurring south of the pipeline, especially during the postcalving season (Figures 2–7). Densities were greater within 2 km on the south side of the Alpine pipeline corridor than they were 2–4 km south. However, the general pattern of low caribou density adjacent to the Alpine pipeline corridor was observed both before and after construction, suggesting that this pipeline corridor has had minimal impacts on the calving distribution in the survey area.

DISCUSSION AND CONCLUSIONS

The combined results of aerial transect surveys and radio telemetry provided both indirect and direct evidence, respectively, of crossings of the Alpine pipeline corridor by caribou in 2014. During the calving and postcalving surveys, caribou were distributed primarily on the south side of the Alpine pipeline corridor, where caribou densities were 6–36 times greater than north of the corridor (Table 2, Figure 6). The general pattern of caribou distribution during the 2014 calving season (Figures 2–5) is consistent with reports of reduced densities of calving caribou within 2–4 km of 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). Consistent displacement of caribou from areas near infrastructure without human activity, such as the Alpine pipeline corridor, has not been documented in arctic Alaska, however. Some studies in Scandinavia have reported that wild reindeer (in areas with heavy hunting pressure) avoided areas around powerlines (Nellemann et al. 2001, Vistnes et al. 2004), whereas other Scandinavian studies found no evidence of powerline avoidance (Reimers et al. 2007, Panzacchi et al. 2013). Although the density of caribou within 2 km of the Alpine pipeline corridor during calving in 2014 was lower than in some other distance zones to the south (Figure 9), the vicinity of the Alpine pipeline corridor did not support high-density calving activity in the years before construction of the Alpine pipelines either (Figure 11).

During the 2014 calving surveys, very few caribou were present in the Colville East survey area (Figures 2–5; Lawhead et al. 2014a). In 2014, like in 2013, caribou largely calved to the south of the survey area, possibly because of protracted snowmelt. Carroll et al. (2005) reported that TH females calved farther south in years of late snowmelt. As the 2014 season progressed, caribou densities in the Alpine pipelines study area more than tripled by the time of the postcalving survey, as caribou moved slowly northward toward the coast in advance of the onset of mosquito harassment in late June.

GPS telemetry has documented numerous crossings of the Alpine pipelines by collared CAH caribou in past years (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a; Lawhead et al. 2013b, 2014b). Pipeline crossings in the North Slope oilfields usually begin in May as caribou arrive from southern wintering areas; before calving, caribou commonly feed in areas of early snow melt adjacent to oilfield roads (often referred to as "dust shadows"; Lawhead and Cameron 1988), which result from decreased albedo due to fugitive dust fall-out. Additional crossings occur in June as more caribou move north during the calving and postcalving periods, but most crossings occur during the mosquito and oestrid-fly seasons between late June and early August, when highly dynamic movements occur in response to changing weather conditions and corresponding levels of insect activity (Curatolo and Murphy 1986, Cronin et al. 1994, Murphy and Lawhead 2000).

The movements of caribou during the mosquito and oestrid-fly seasons 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 that are affected by the previous locations of the caribou; changes in air temperature, wind speed, and wind direction; solar radiation and cloud cover; and the seasonal chronology of insect emergence and life spans. CAH caribou typically move to the coast, and occasionally onto the Colville River delta, when mosquito harassment occurs in late June and throughout July. Coastal areas provide good mosquito-relief habitat because they typically are cooler and windier than inland areas (Russell et al. 1993, Murphy and Lawhead 2000, Parrett 2007, Yokel et al. 2009). Caribou then move inland again to preferred foraging areas when mosquito harassment abates due to cooler temperatures or higher winds.

A prominent issue for petroleum development in northern Alaska 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 demonstrate that caribou frequently crossed the Alpine pipeline corridor during the insect season, often crossing and recrossing on the same day or successive days, suggesting that the Alpine pipeline corridor was not impeding caribou movements (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a; Lawhead et al. 2013b, 2014b). Since 2004, most collared CAH caribou have moved far east (some as far as the Alaska/Yukon border) during the insect season (Lenart 2011; Lawhead et al. 2011, 2012, 2013a), so they have had less contact with the Alpine pipeline corridor in that season than in previous years. In 2014, a sample of 21 GPS-collared CAH caribou was available to evaluate summer movement patterns. The movement data from those collared animals indicated that a substantial proportion of the CAH (33% of the collars) used the general area of the Alpine pipeline corridor and western Kuparuk oilfield in summer 2014.

Most movements by CAH caribou, which have experience negotiating oilfield infrastructure and thus are more likely to be habituated than are TH caribou, did not suggest delays in crossing of the Alpine pipelines corridor, based on our examination of GPS collar movements (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a; Lawhead et al. 2013b, 2014b). The limited data from TH animals, which have less exposure to and experience negotiating oilfield infrastructure, indicate that they were able to cross the Alpine pipeline corridor successfully on the few occasions when they encountered it. In interpreting pipeline-crossing behavior, however, it must be borne in mind that telemetry data are suggestive, rather than conclusive, because no one witnessed the encounters and other factors potentially affecting pipeline crossings (such as snow cover, weather conditions, insect activity, and intraspecific and interspecific behavioral interactions) were not documented. It is possible that telemetry locations spaced two hours to two 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 pipeline corridor were able to cross without substantial delays.

Based on the available data, therefore, we concluded that the Alpine pipeline corridor did not significantly alter caribou movements during periods in 2014 for which survey data were available (primarily spring and summer) and that the elevated design of the pipelines (stipulated minimum height of 1.5 m [5 ft] above ground level) provided effective mitigation to allow caribou to cross the pipeline corridor. This conclusion is consistent with previous research, which found that pipelines elevated to a minimum height of 1.5 m were high enough to allow caribou crossings during snow-free periods (Curatolo and Murphy 1986, Cronin et al. 1994, Lawhead et al. 2006).

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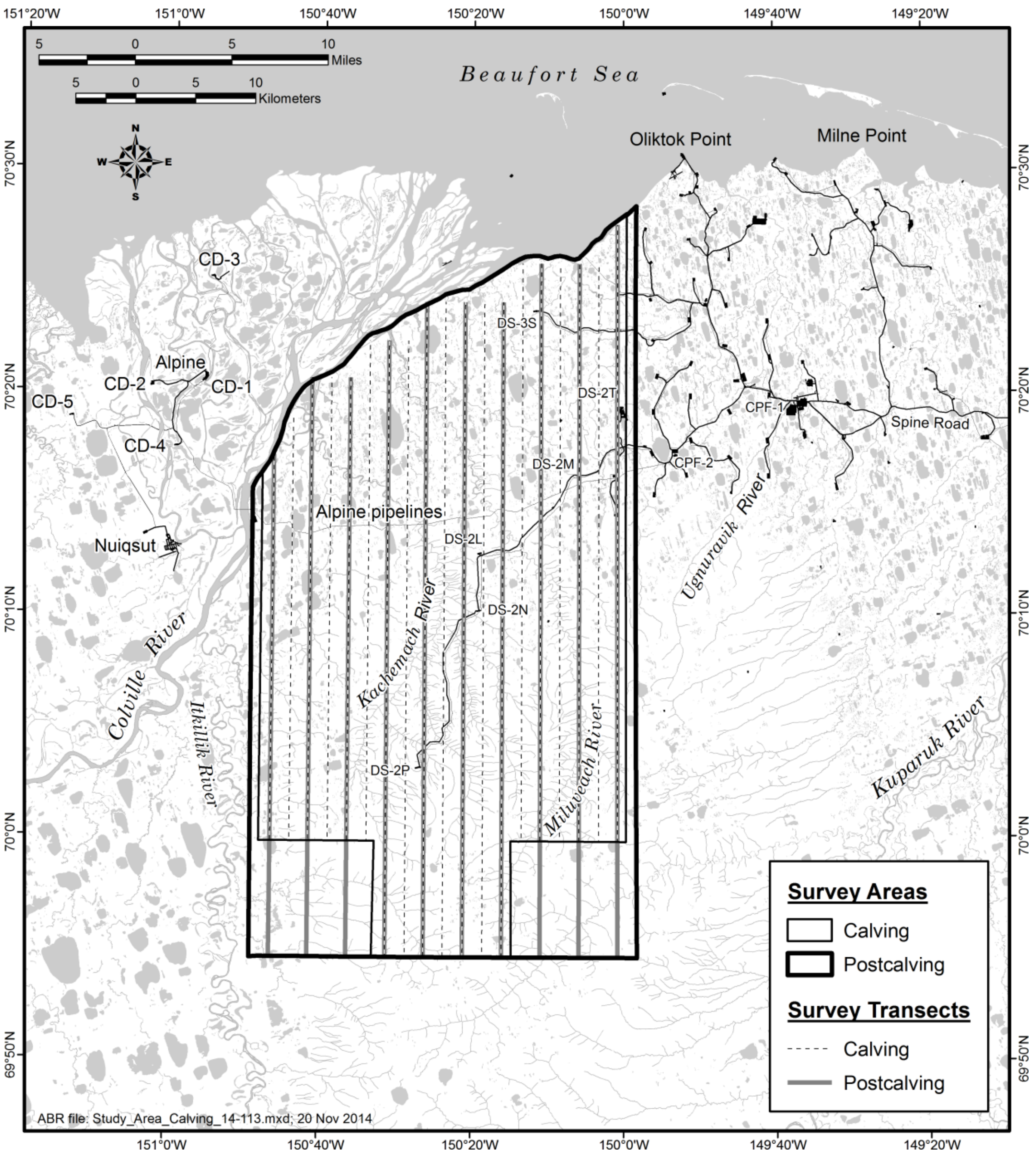

Figure 1. Colville East survey area for systematic aerial strip-transect surveys of caribou, June 2014.

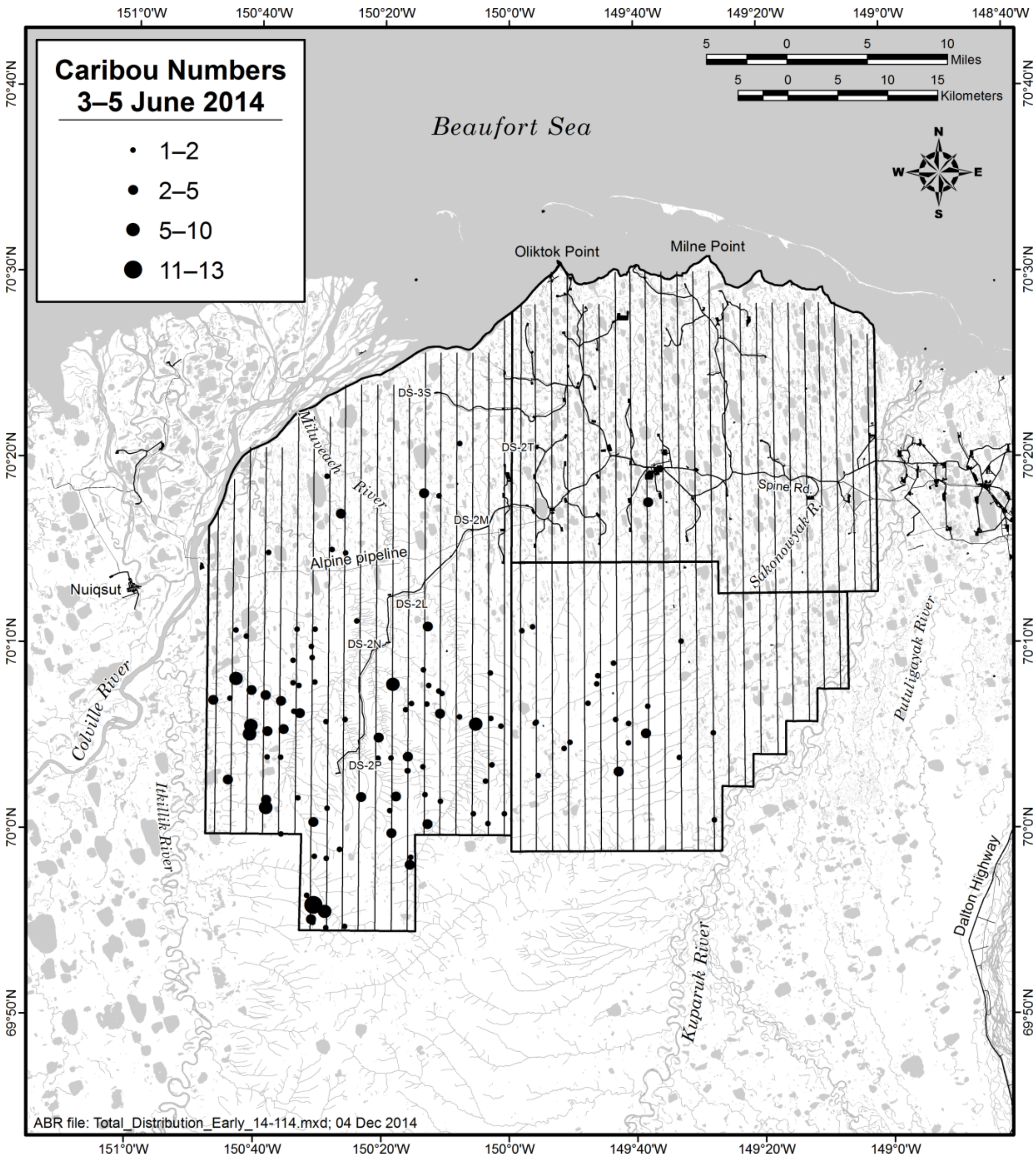

Figure 2. Distribution of all caribou in the Kuparuk–Colville calving survey areas during the early calving survey, 3–5 June 2014.

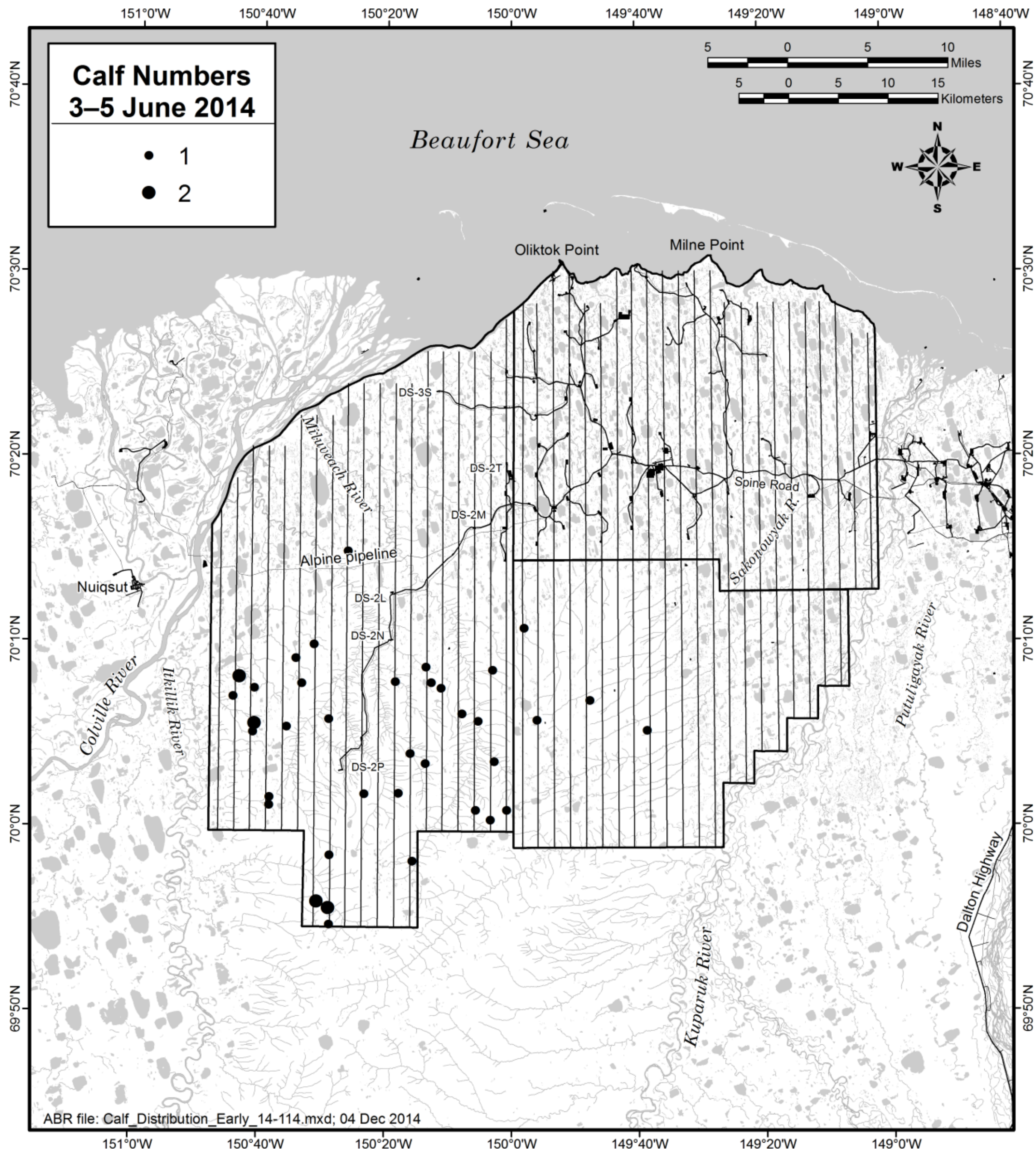

Figure 3. Distribution of calf caribou in the Kuparuk–Colville calving survey areas during the early calving survey, 3–5 June 2014.

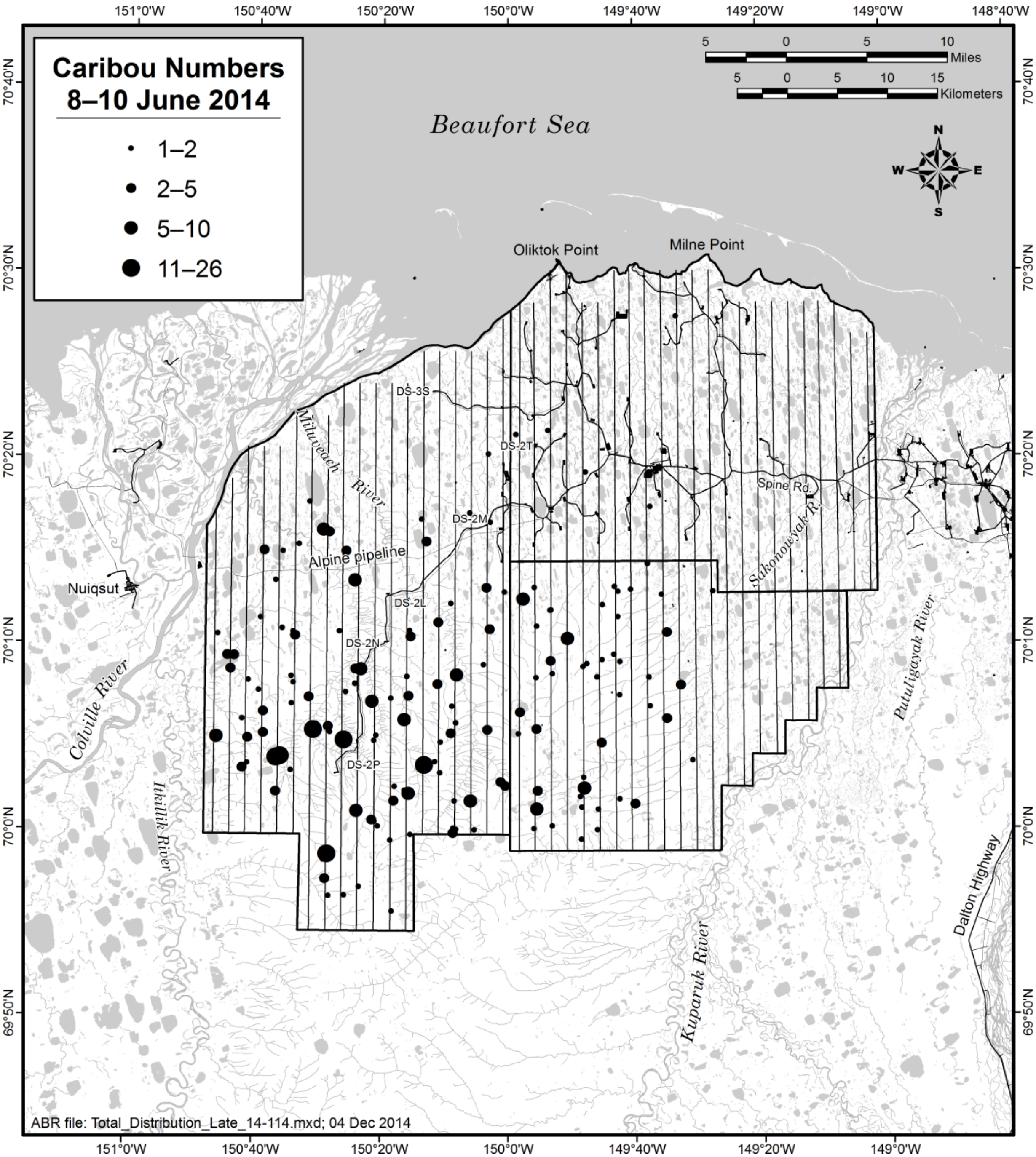

Figure 4. Distribution of all caribou in the Kuparuk–Colville calving survey areas during the late calving survey, 8–10 June 2014.

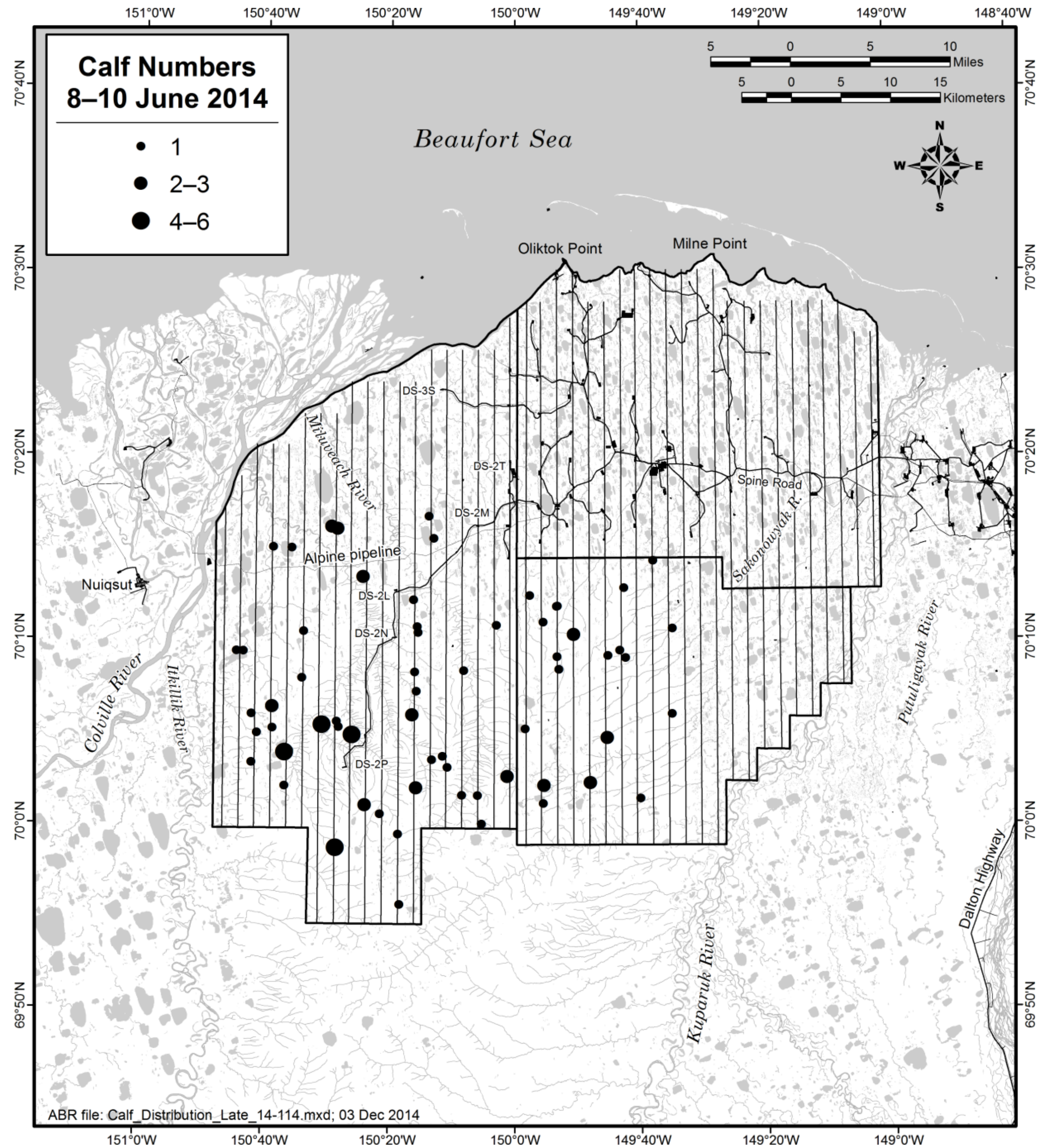

Figure 5. Distribution of calf caribou in the Kuparuk–Colville calving survey areas during the late calving survey, 8–10 June 2014.

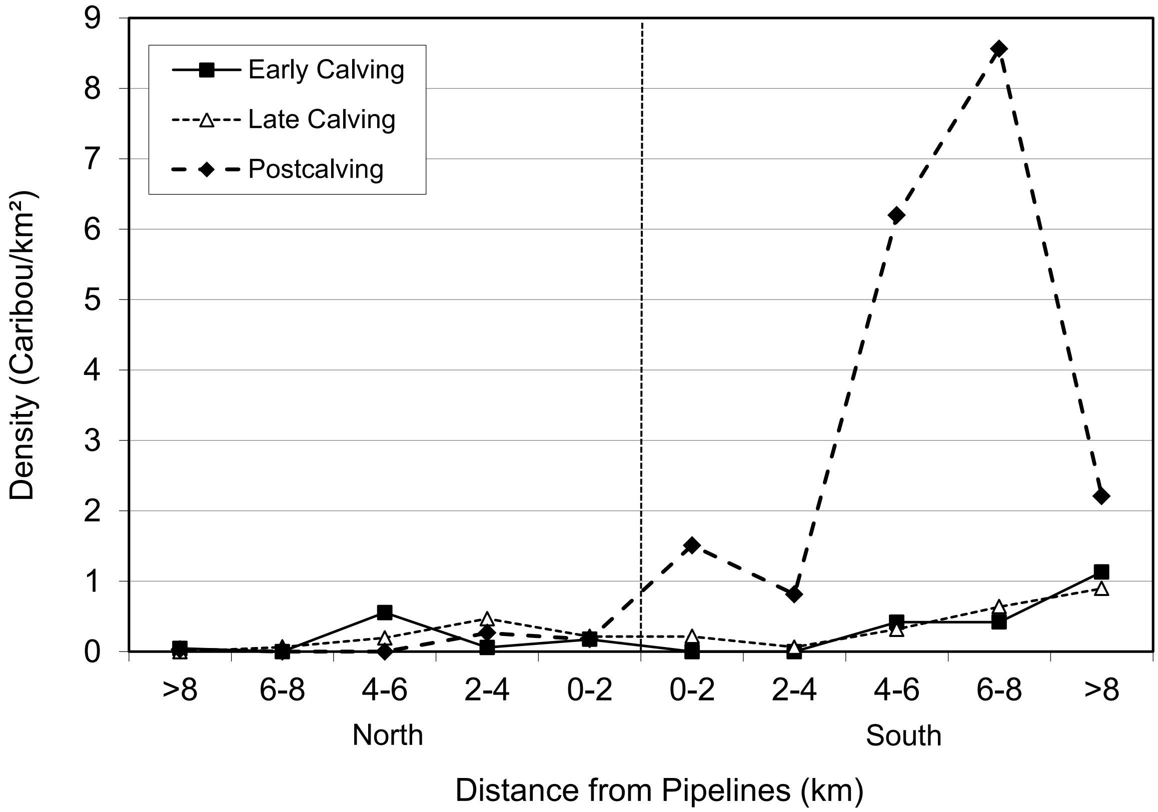

Figure 6. Densities of caribou in different distance zones around the Alpine pipeline corridor during calving and postcalving surveys in the Colville East survey area, June 2014. Caribou numbers were multiplied by 1.88 to adjust for low sightability due to patchy snow cover during the early calving survey and in portions of the survey area during the late calving survey (see text).

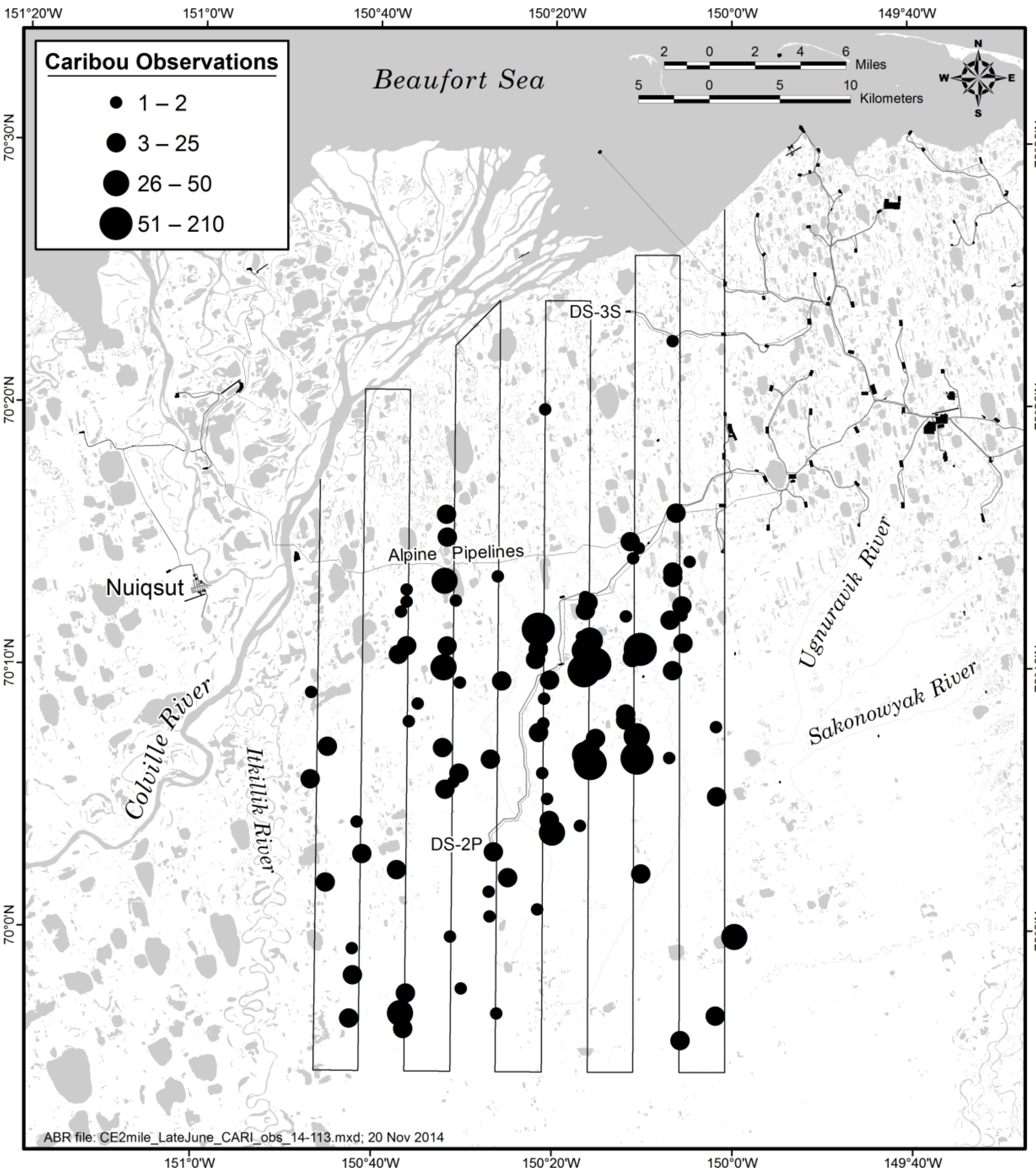

Figure 7. Distribution and size of caribou groups in the Colville East survey area during the postcalving survey on 23 June 2014.

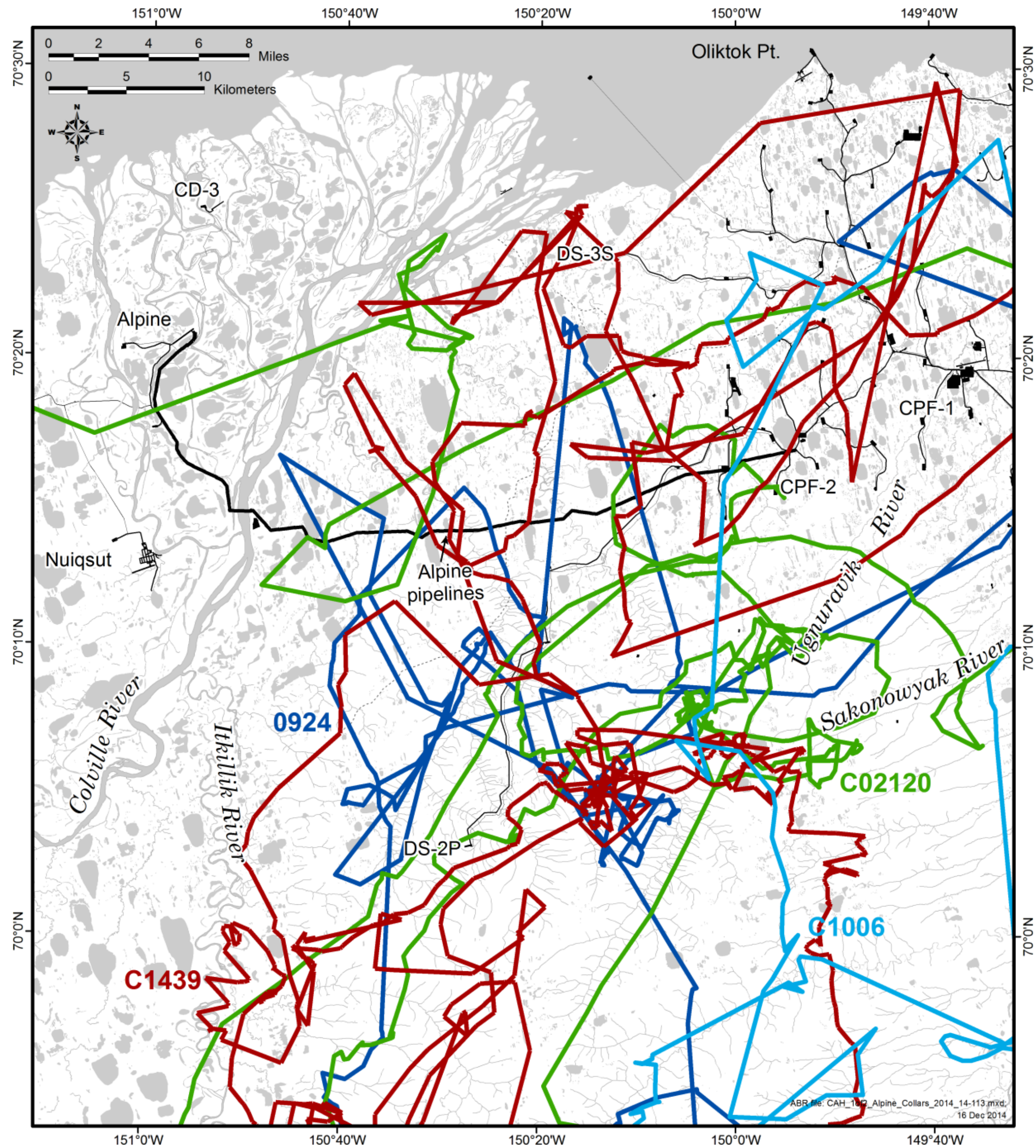

Figure 8. Movements of four GPS-collared CAH caribou (numbers 0924, C1006, C1439, and C02120) during November 2013–October 2014 in the area encompassing the Alpine pipeline corridor (see text for details).

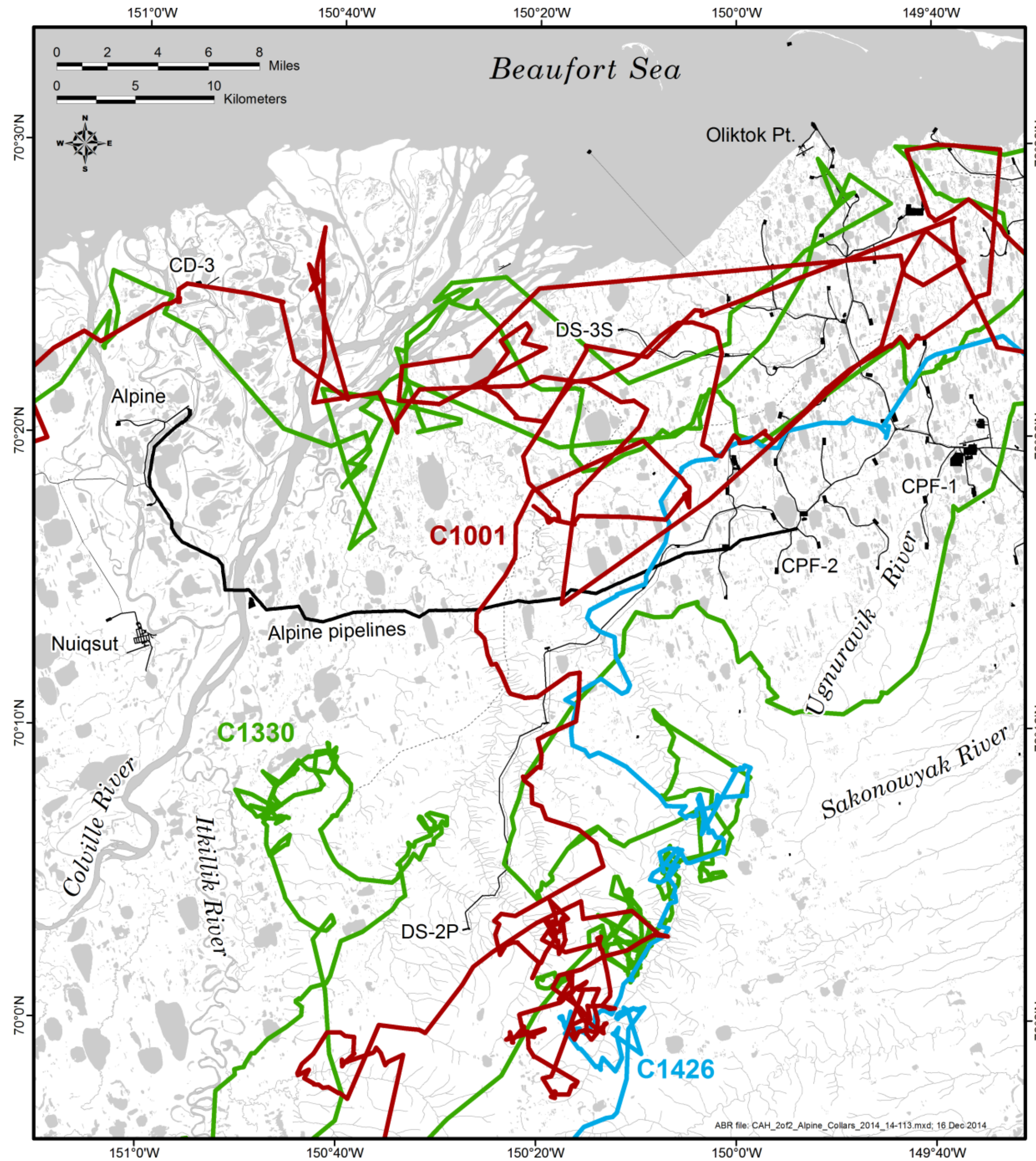

Figure 9. Movements of three GPS-collared CAH caribou (numbers C1001, C1330, and C1426) during November 2013–October 2014 in the area encompassing the Alpine pipeline corridor (see text for details).

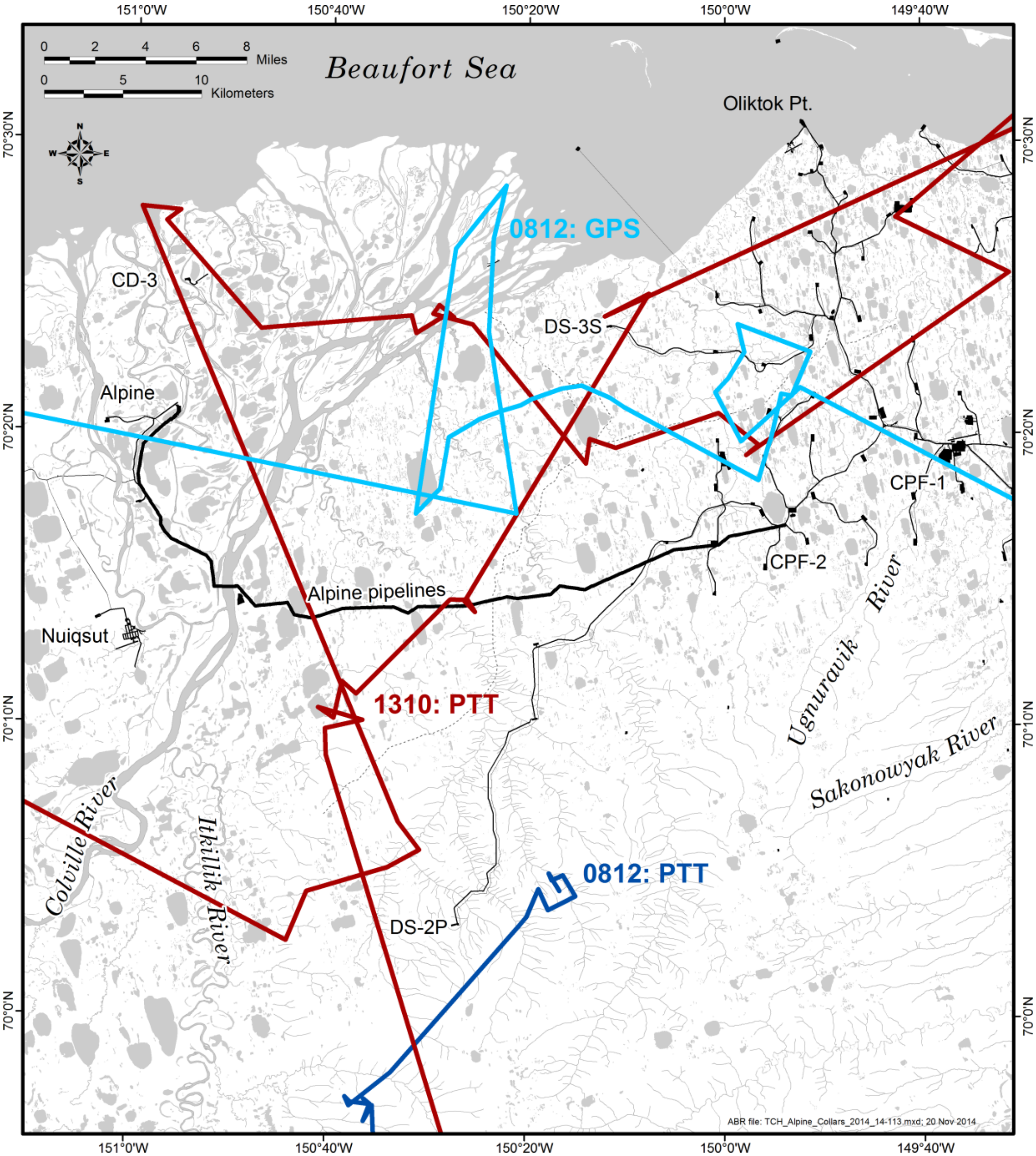

Figure 10. Movements of two TH caribou, 1310 (PTT satellite collar) and 0812 (switched from PTT satellite collar to GPS collar on 26 June 2014) during November 2013–October 2014 in the area encompassing the Alpine pipeline corridor (see text for details).

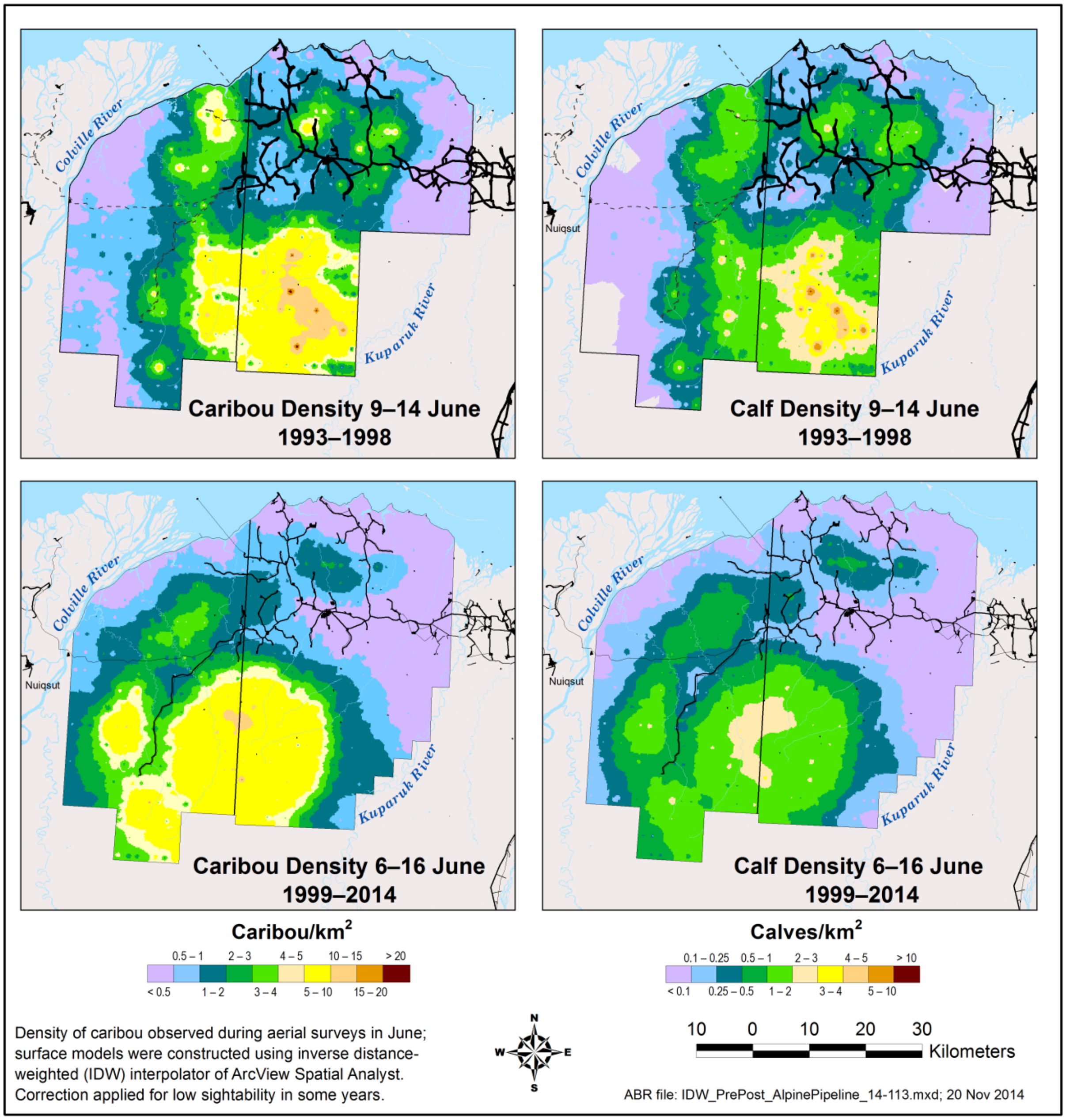

Figure 11. Distribution and density of all caribou (left) and calves only (right) in the Kuparuk–Colville calving survey areas in early and mid-June before construction of the Alpine pipeline corridor (top) and after construction (bottom). Dashed lines denote infrastructure not yet constructed.