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

Subject: **Data Report for Alpine Pipeline Caribou Surveys, 2015**

Dear Ms. McGhee:

This data report constitutes our reporting deliverable for this project. It summarizes data on caribou distribution and movements in 2015 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

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Joseph H. Welch
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 June 2015 and radio telemetry during November 2014–October 2015 in the area crossed by the Alpine pipeline corridor, which comprises three adjacent pipelines sharing the same support structure, between the central Colville River delta and Kuparuk Central Processing Facility 2 (CPF-2). The data presented 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. 2015c). Previous reports have described the distribution and movements of caribou in relation to the Alpine pipeline corridor during 2004–2014 (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2010b, 2011a; Lawhead et al. 2012b, 2013b, 2014b).

STUDY AREA

Constructed in the winter of 1998–1999, the Alpine pipeline 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 (1999–2015) (Lawhead and Prichard 2006b, 2007b, 2008b, 2009b, 2010c, 2011b, 2012; Lawhead et al. 2013c, 2014c, 2015b).

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.

Two caribou herds—the Central Arctic Herd (CAH) and the Teshekpuk Herd (TH)—occur in the study area. The CAH consistently uses the area east of the Colville River delta, whereas the TH typically is distributed west of the delta (Lawhead et al. 2015a). The CAH typically calves in two areas on the coastal plain between the Colville and Canning rivers, uses coastal areas for insect relief, and winters in the central Brooks Range (primarily in the southern foothills in recent years; Arthur and Del Vecchio 2009, Lenart 2013). The TH calves near Teshekpuk Lake, ~130 km (80 mi) west of Kuparuk, and uses coastal habitats and areas around Teshekpuk Lake for relief from insect harassment. The TH generally winters on the Arctic Coastal Plain (Person et al. 2007). However, since the winter of 2004–2005, portions of the herd have shown a tendency to winter in the central Brooks Range, where they mix with CAH animals. Unusual wintering excursions by large portions of the herd occasionally have occurred into the ranges of the Porcupine Herd in 2003–2004 and the Western Arctic Herd (WAH) in 2008–2009 (Carroll 2007, Parrett 2009, Lawhead et al. 2010).

METHODS

Two methods—aerial transect surveys and radio telemetry—have been used to examine caribou distribution and movements in the vicinity 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 radio telemetry provides information on the annual movements of individual radio-collared caribou throughout each herd's range.

A fixed-wing airplane (Cessna 206), carrying three observers in addition to the pilot, was used to survey 400-m-wide strips on each side of the airplane as the pilot followed transects spaced systematically at intervals of 1.6 km (resulting in 50% sampling coverage) in the Colville East survey area during calving in 2015 (8–9 June 2015; Figure 1). An earlier calving survey in 2015 was canceled because prolonged inclement weather prevented the survey crew from reaching the survey area. Another survey was flown during the postcalving period (18–19 June 2015) 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 planned to be flown before the seasonal onset of mosquito harassment to minimize the influence on caribou distribution and movements, but mosquito emergence was early in 2015 and mosquito harassment began just before the postcalving survey was conducted.

Transect survey methods were described in detail previously (Lawhead et al. 2015c). 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 calving survey in 2015, sightability was good in all portions of the study area, so no estimated densities needed to adjusted using the sightability correction factor (SCF) developed previously for calving caribou in the Kuparuk area (Lawhead et al. 1994). The 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 pipeline corridor for the calving and postcalving surveys.

To summarize calving distribution and abundance for the period before (5 years: 1993 and 1995–1998; no surveys were flown in 1994) and after construction of the Alpine pipelines (17 years: 1999–2015), 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. We used data from calving surveys conducted during 8–9 June in 2015 and 6–16 June over the period of 1993–2015. This analysis used SCF-adjusted 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 transect 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 all caribou (adults, yearlings, and calves combined) and another map shows only calves.

During the period from 1 November 2014 through 31 October 2015, telemetry data were available from 20 GPS-collared CAH caribou, 36 GPS-collared TH caribou, and 17 satellite-collared caribou of both sexes (Table 1). The CAH collars were deployed by ADFG biologists in several locations. In recent years, most CAH caribou have been collared in the central Brooks Range during late winter (usually April). In all years, the TH collars were deployed by ADFG biologists in the area surrounding Teshekpuk Lake, >50 km west of the Alpine pipeline study area. Funding for these collars has been provided by CPAI, the North Slope Borough (NSB), ADFG, and the Bureau of Land Management (BLM).

Table 1. Number, type, and dates of radio-collars deployed on caribou of the Teshekpuk Herd (TH) and Central Arctic Herd (CAH) that were active during 1 November 2014–31 October 2015.

Herd	Collar Type	Funding Source(s)	Male	Female	Total
TH	Satellite	NSB, BLM, ADFG	15	2	17
	GPS	NSB, BLM, ADFG	0	36	36
CAH	Satellite	NSB, BLM, ADFG	0	0	0
	GPS	CPAI	0	20	20

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 upload five or six successive locations via a satellite link every two days during the spring, summer, and fall (15 April–15 November) and every eight days during winter (15 November–15 April).

RESULTS

AERIAL TRANSECT SURVEYS

CALVING SURVEY

Caribou distribution during the 2015 calving season (Figures 2 and 3) was similar to the distribution observed in the 1990s before construction of the Alpine pipelines, when the highest density of calving activity in the Greater Kuparuk Area occurred in the Kuparuk South survey area (Lawhead et al. 2015b). Within the Colville East survey area, a total of 533 caribou (including 113 calves) were observed on the calving survey transects (Table 2). After adjusting for 50% sampling coverage, we estimated that 1,066 caribou were present in the survey area during the calving survey. In comparison, the mean number of caribou estimated in the same survey area during the latter portion of the calving season during 2002–2014 was 4,884 caribou (Lawhead et al. 2015b).

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, 2015.

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)
Calving	North	246	13	28	5	0.114	0.020
(8–9 June)	South	470	99	505	108	1.074	0.230
	Total	716	112	533	113	0.744	0.158
Postcalving	North	254	4	30	11	0.118	0.043
(18–19 June)	South	594	0	0	0	0	0
	Total	848	4	30	11	0.035	0.013

[a] Sample coverage was ~50% of the entire survey area.

As in previous years, caribou were not distributed proportionately throughout the survey area; 12% of groups and 5% of total caribou on the calving survey were north of the Alpine pipeline corridor (Table 2), an area that constituted 34% of the survey area. Reflecting the inland distribution of highest-density calving activity in 2015 (Figures 2 and 3), caribou density was low in all of the 2-km distance zones north and south of the Alpine pipelines except in the zone farthest to the south (Figure 4).

POSTCALVING SURVEY

By the time the postcalving survey was flown on 18–19 June (Figure 5), caribou had moved almost completely out of the Colville East survey area. Only four caribou groups, totaling 30 caribou (including 11 calves), were observed on the postcalving survey (Table 2, Figure 5). All but one of those caribou were along the Colville River or near the coast, more than 8 km north of the Alpine pipelines.

MOVEMENTS OF COLLARED CARIBOU

CAH GPS COLLARS

The movements of GPS-collared CAH caribou before November 2014 were described in previous reports (Lawhead et al. 2014b, 2015a). Of the 20 GPS collars that were active on female CAH caribou between November 2014 and October 2015, six animals moved into the Alpine pipelines study area (Figures 6 and 7). Five caribou crossed the Alpine pipeline corridor 27 times between 30 May and 8 September, with 20 (74.1%) of those crossings occurring during 2–20 July. Caribou C1439, C1426, C1007, C02120, and C1107 were all in the immediate vicinity of the Alpine pipeline corridor around the middle of July. During that time, Caribou C1107 and C02120 both crossed the pipelines heading north before crossing again on their way south a few days later. Caribou C02120 crossed multiple times between 10 July and 20 July. Caribou C1439 and C1426 crossed the pipeline multiple times between the first crossing to south on 8 July and the last crossing to the south on 17 July. Caribou C1426 returned to the area on 10 September and was just east of the pipelines near CPF-2, though it did not cross the Alpine pipelines at that time. C1330 remained near CPF-2 for a month (27 May–27 June) before moving northwest around 1 July; she moved south on 2 July, crossing the pipelines south of Alpine.

TH SATELLITE COLLARS

The movements of satellite-collared TH caribou before November 2014 were described in previous reports (Lawhead et al 2014b, 2015a). Seventeen TH caribou (15 males and 2 females) had functioning satellite collars for the period from November 2014 through October 2015. Four of those animals (Caribou 1520, Caribou 1514, Caribou C1007, and Caribou 1406; all males) entered the study area during that period (Figure 8), but were present there only for the last week of this reporting period (24–31 October). Those four collared bulls entered the study area from the west and either continued east or north once they crossed the Itkillik River. One collared bull (Caribou 1406) crossed the Alpine pipeline from south to north on 17 October. Caribou 1520 moved north near the end of September, but was about 8 km southwest of Nuiqsut at the time of the last available collar location (10 October). Caribou 1514 and 1521 both entered the study area on 28 September and continued moving east by 4 October, remaining south of Kuparuk DS-2P.

TH GPS COLLARS

The movements of GPS-collared TH caribou before November 2014 were described in previous reports (Lawhead et al. 2014b, 2015a). In 2015, 19 new GPS collars were deployed by ADFG biologists on TH females during 24–26 June. Location data for 36 female TH caribou outfitted with GPS collars were available for the period from November 2014 through October 2015. Consistent with the distribution of the TH to the west of the CAH, only two of those collared animals (Caribou 1516 and 1102) entered the area near the Alpine pipeline corridor, both in fall 2015 (Figure 9). Both caribou spent considerable time on the southern side of the pipelines in October 2015. All locations for Caribou 1516 were south of the pipeline, but many were consistently within a few dozen meters of the pipeline. Based on straight lines between successive locations, Caribou 1516 may have crossed the pipelines several times, but did not move away to the north, as Caribou 1406 did (Figure 8; described above). Caribou 1102 came from the west and used the area south of CPF-2 and near the Meltwater (DS-2P) road in early and mid-October, before moving west and north by the last week of October. As of the last GPS fix on 31 Oct, Caribou 1102 was within 2 km of the south side of the Alpine pipelines, but had not crossed them.

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 10). The highest preconstruction density along the Alpine pipeline corridor occurred near the eastern end; in contrast, the Colville River delta supports very low densities of caribou during calving (Lawhead et al. 2015a). The area along the Alpine pipeline corridor continued to host relatively low densities of caribou after construction (Figure 10). During the 2015 calving survey, caribou densities also were low along the pipeline corridor and north of the Alpine pipelines, with the highest density occurring >8 km to the south (Figures 2–3 and 10). The general pattern of lower caribou density adjacent to the Alpine pipeline corridor observed both before and after construction suggests that the Alpine pipeline corridor has had minimal effects on the calving distribution in the survey area.

DISCUSSION AND CONCLUSIONS

Radio telemetry has documented numerous crossings of the Alpine pipelines by collared CAH caribou in past years (Lawhead et al. 2014b and references therein). Because the CAH typically winters on the southern slopes of the Brooks Range, few pipeline crossings by caribou occur in the North Slope oilfields in winter. Although the TH typically winters on the North Slope, few TH animals winter east of the Colville River (Person et al. 2007, Parrett 2013).

Telemetry data show that pipeline crossings in the survey area usually begin in May as female caribou begin to arrive from wintering areas farther south. Crossings increase in June as more caribou move north during the calving and postcalving periods, but most crossings occur during the mosquito and oestrid fly seasons (late June to 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 during periods of westerly winds, 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 move inland again to preferred foraging areas when mosquito harassment abates due to cooler temperatures or higher winds. Since 2004, most collared CAH caribou have moved east of the Sagavanirktok River (some as far as the Alaska/Yukon border) during the insect season (Lenart 2013; Lawhead et al. 2011, 2012a, 2013a, 2014a, 2015a), so they have had less contact with the Alpine pipeline corridor in that season than in previous years. Some CAH caribou returned to the Kuparuk area later in the summer in most of those years.

Caribou distribution and movements in 2015 were notable in several respects: (1) significant numbers of caribou calved in the GKA area, unlike the previous two years when caribou were distributed farther inland, evidently due to late snow melt in 2013; (2) the warm spring resulted in unusually early mosquito emergence in mid-June, resulting in caribou movement out of the survey area sooner than expected; (3) much of the western segment of the CAH remained in the Kuparuk area during midsummer, instead of moving toward the Alaska/Yukon border, as has been observed in most years since 2004; and (4) an unusual number of collared CAH and TH caribou were still in the vicinity of the North Slope oilfields as of late fall 2015.

In 2013 and 2014, the western segment of the CAH calved farther south of the survey area than usual, resulting in low densities of caribou in the survey area during the calving period (Lawhead et al. 2014c, 2015b). TH females are known to calve farther south in years of late snow melt (Carroll et al. 2005). The spring of 2013 was colder than normal with much-delayed snow melt, but the timing of snow melt was near average in 2014, suggesting that other factors may have been responsible for the more southerly calving distribution that year. In 2015, spring temperatures were warmer than average, resulting in early snow melt and a larger proportion of the western segment of the CAH calving in the survey area.

In 2015, the calving distribution of caribou in the Colville East survey area and adjacent survey areas was similar to previous years of average or early snow melt. The Kuparuk South survey area, located east of the Colville East survey area, contained the highest density of caribou among the three survey areas examined for this study and the GKA study in 2015 (Figures 2 and 3; Lawhead et al. 2015c). The Kuparuk South survey area supported the highest density of calving activity in 11 of the 20 years since 1996, but the Colville East area hosted the highest calving densities in most of the past 10 years (Lawhead et al. 2015c). Caribou were distributed primarily on the south side of the Alpine pipeline corridor during calving in 2015, where caribou densities were up to nine times greater than north of the corridor (Table 2, Figures 2–4).

Postcalving movements toward the coast typically occur by late June as mosquitoes emerge farther inland, forcing caribou to move to insect-relief habitat near the Beaufort Sea coast. Warmer than average temperatures in May and June 2015 resulted in early mosquito emergence and predicted mosquito harassment levels based on temperature and wind speed were well above the 32-year average in June 2015 (Lawhead et al. 2015c). ABR biologists conducting ground work for other studies west of the Colville River delta reported that a few mosquitoes had emerged by 14 June and mild to moderate harassment began on 16 June. Moderate to severe mosquito harassment before the postcalving survey could be flown on 18–19 June, which accounted for the small number of caribou recorded on that survey because nearly all caribou already had exited the Colville East survey area to the northeast. This transition from postcalving to the first mosquito harassment is the period when many CAH caribou interact with and cross the Alpine pipeline corridor.

A prominent issue for petroleum development in northern Alaska has been the extent to which north/south-oriented 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 et al. 2014b, 2015a, and references therein). 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 et al. 2014b, 2015a, and references therein).

In fall 2015, a large number of collared caribou from the TH and a few collared CAH caribou were in the GKA area and as far east as Deadhorse until at least late October. CAH caribou rarely winter on the North Slope (Arthur and Del Vecchio 2009, Lenart 2013, Lawhead et al. 2015a). While many TH caribou often winter on the North Slope, it is very unusual for them to move east of the Colville River in winter (Person et al. 2007, Parrett 2013, Lawhead et al. 2015a). The fall 2015 data from two GPS-collared TH animals, which have less exposure to and experience negotiating oilfield infrastructure than do CAH animals, suggest that some of their movements may have been affected by the Alpine pipelines during a season in which the motivation to cross infrastructure is less than during the summer insect season (Figure 9).

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, which are spaced two hours to two days apart (depending on the collar), could obscure delays or aborted crossings, but the multiple documented crossings and analysis of movement rates indicate that most caribou that approached the Alpine pipeline corridor were able to cross without substantial delays.

Based on the available data, therefore, we concluded that, although the Alpine pipeline corridor may have influenced the movements of some TH animals with little previous experience navigating oilfield infrastructure, it did not significantly alter caribou movements during periods in 2015 for which data were available (primarily spring, summer, and fall migration) 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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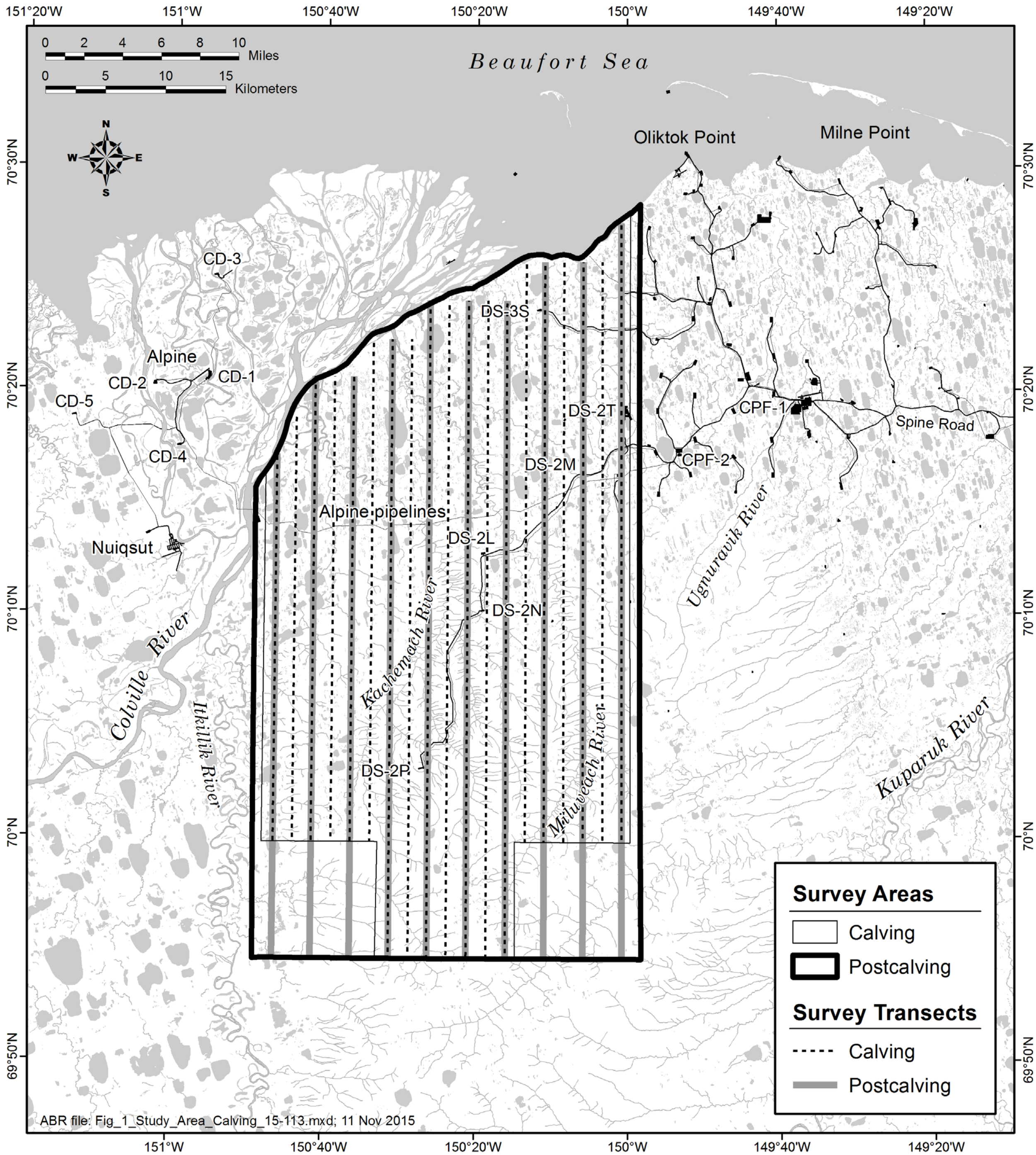

Figure 1. Colville East survey area for systematic aerial strip-transect surveys of caribou, June 2015.

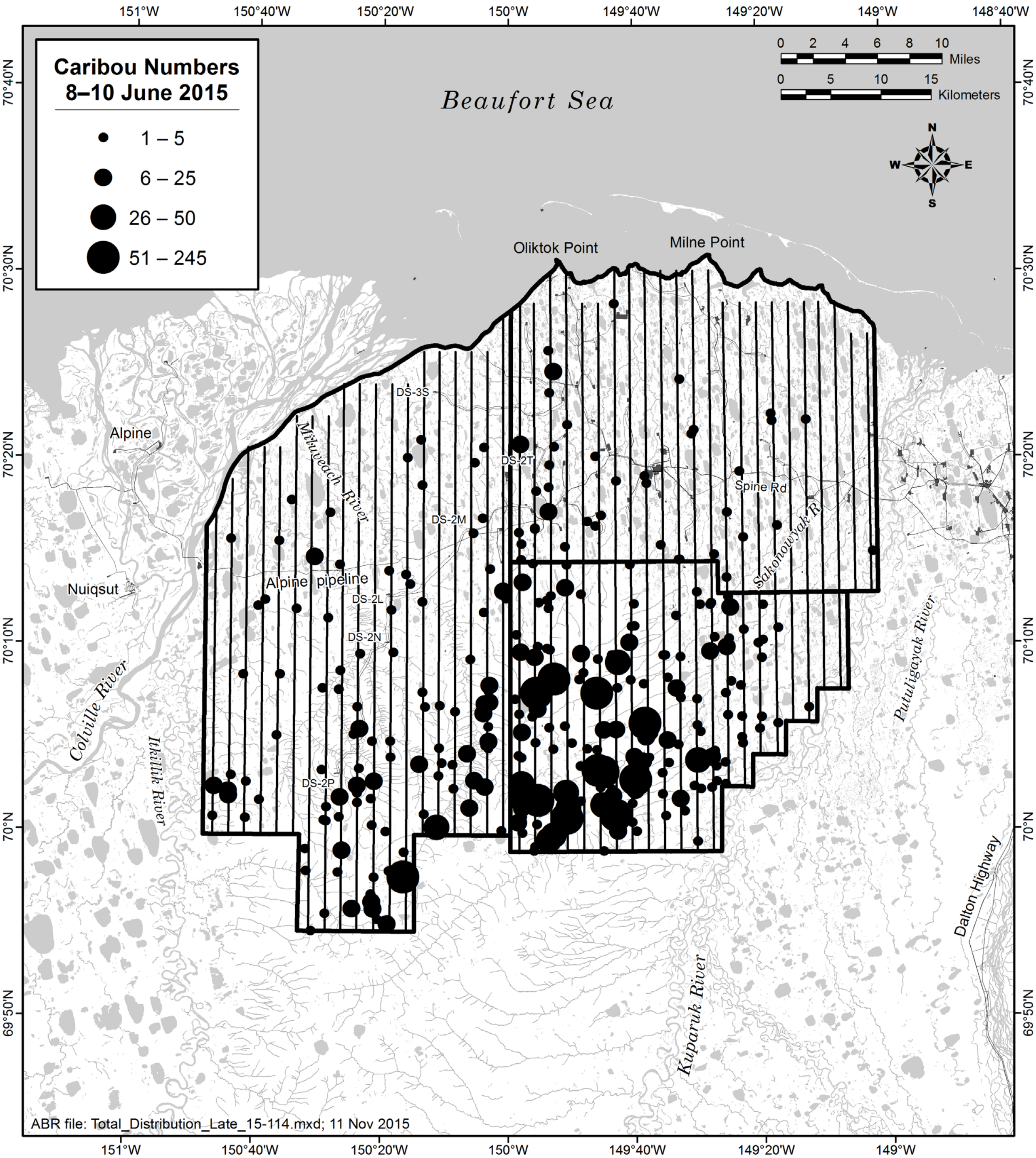

Figure 2. Distribution of all caribou in the Kuparuk–Colville calving survey areas during the calving survey, 8–10 June 2015.

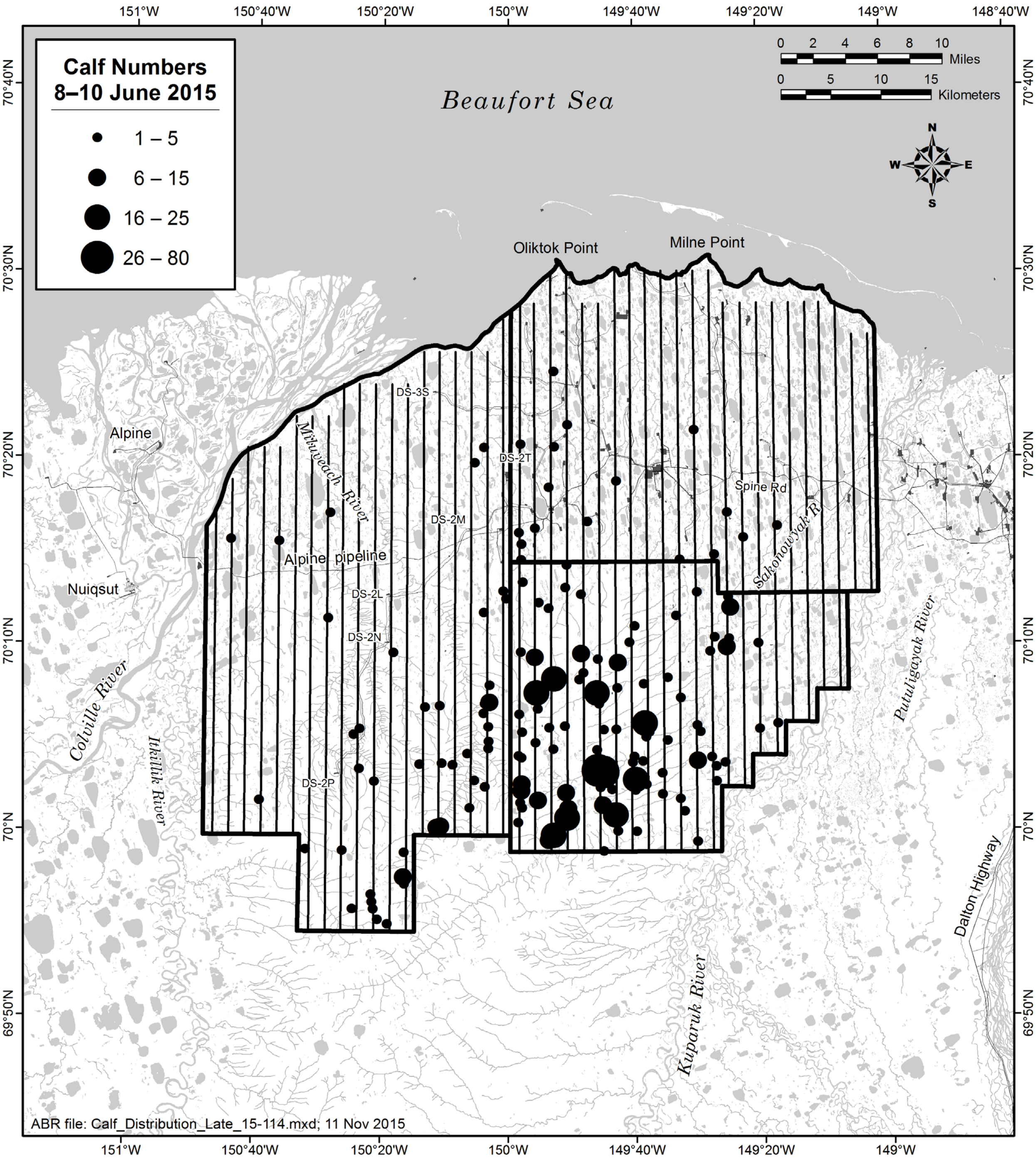

Figure 3. Distribution of calf caribou in the Kuparuk–Colville calving survey areas during the calving survey, 8–10 June 2015.

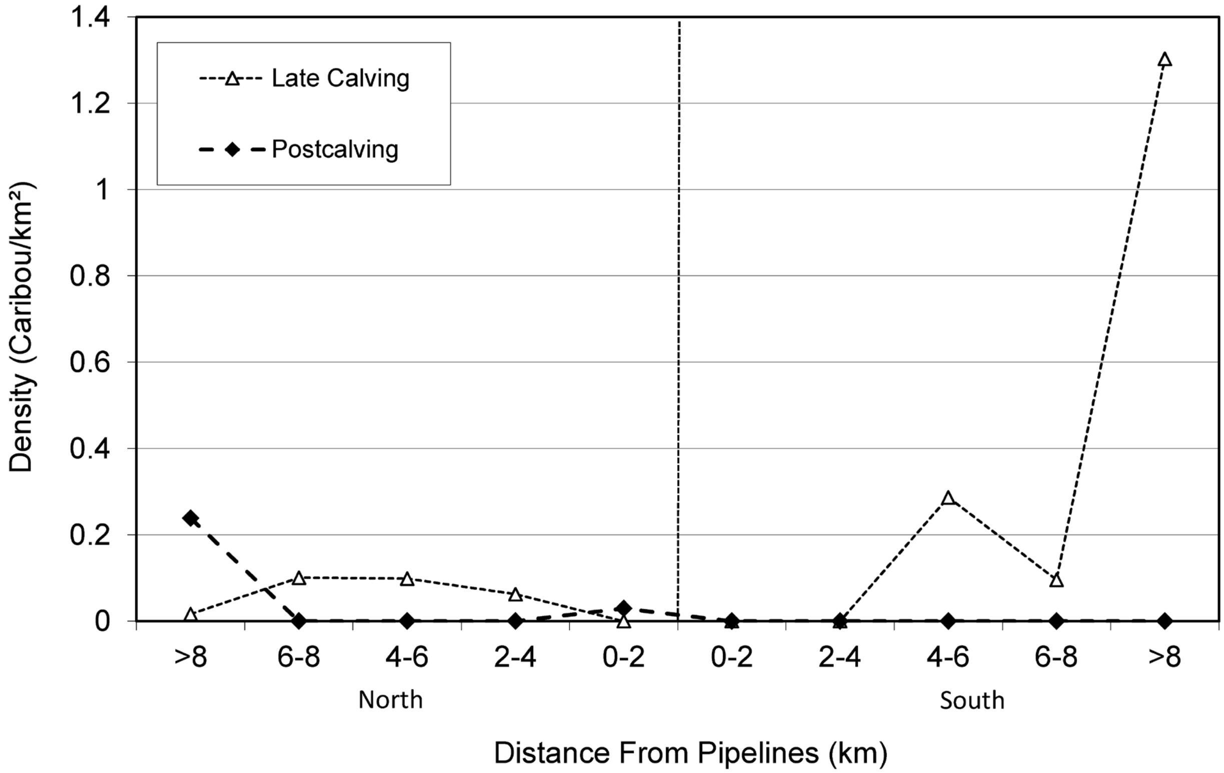

Figure 4. Densities of caribou in different distance zones around the Alpine pipeline corridor during late calving and postcalving surveys in the Colville East survey area, June 2015.

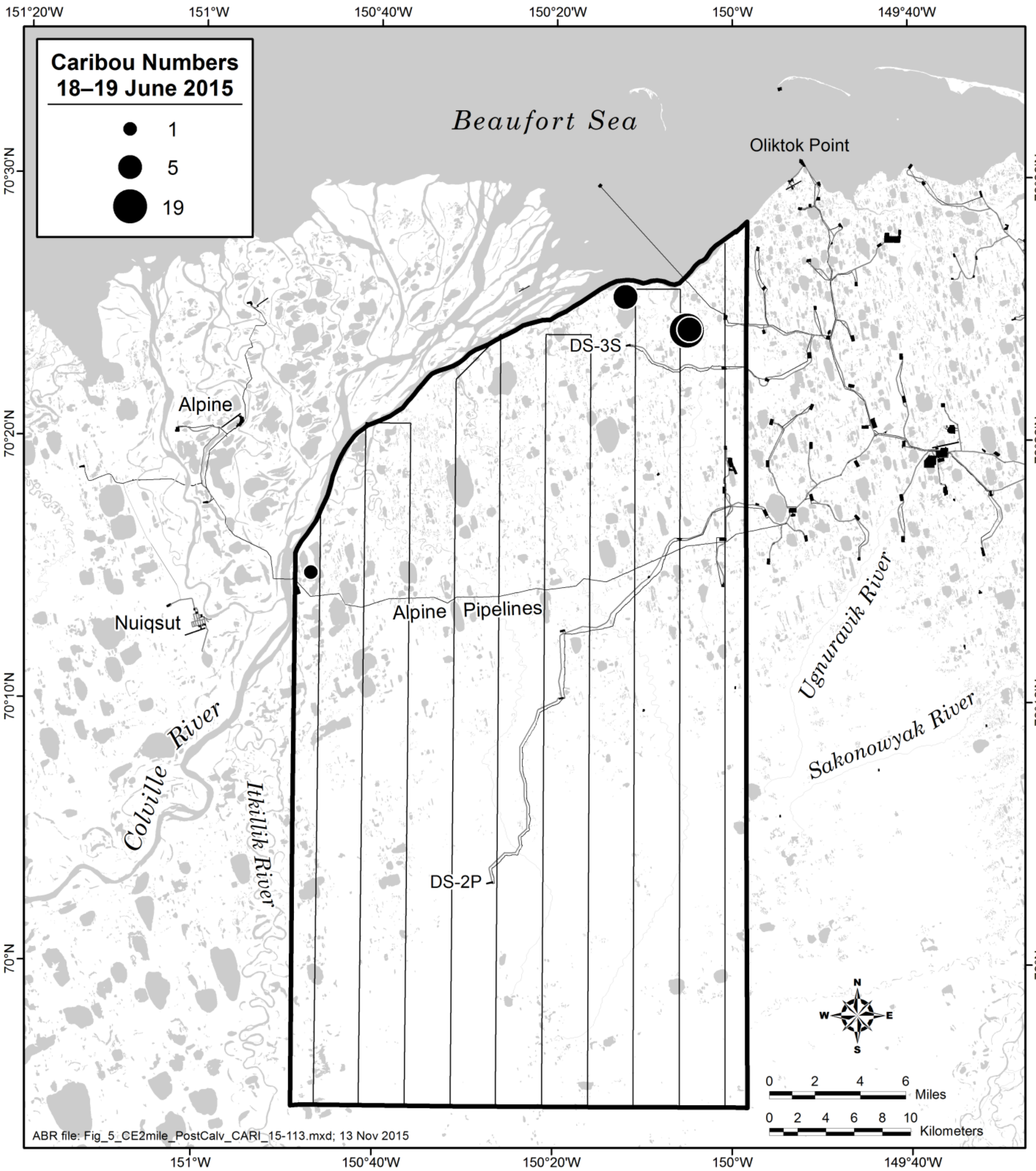

Figure 5. Distribution and size of caribou groups in the Colville East survey area during the postcalving survey on 18–19 June 2015.

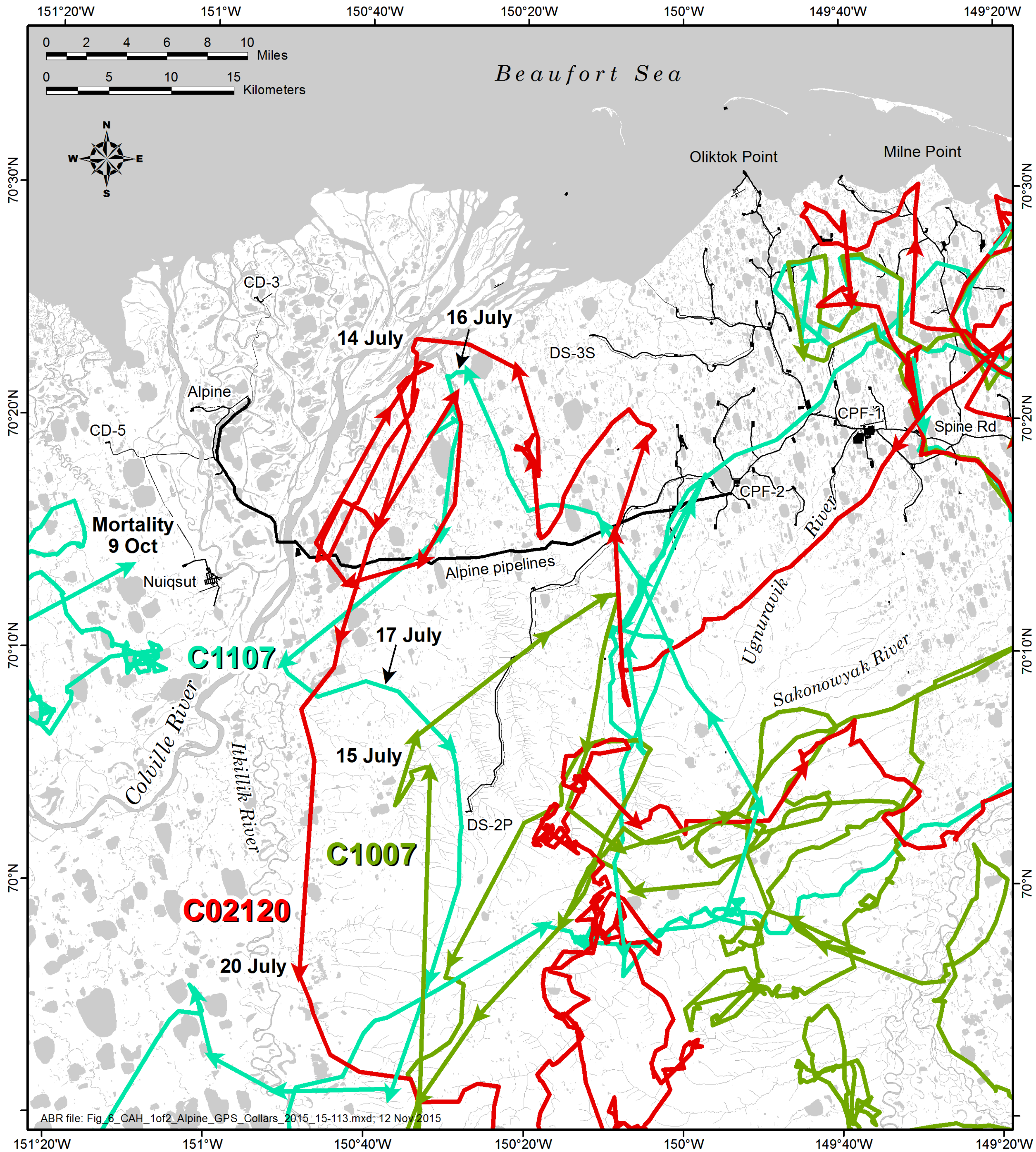

Figure 6. Movements of three GPS-collared CAH caribou (C1107, C1007, and C02120) during November 2014–October 2015 in the area encompassing the Alpine pipeline corridor (see text for details).

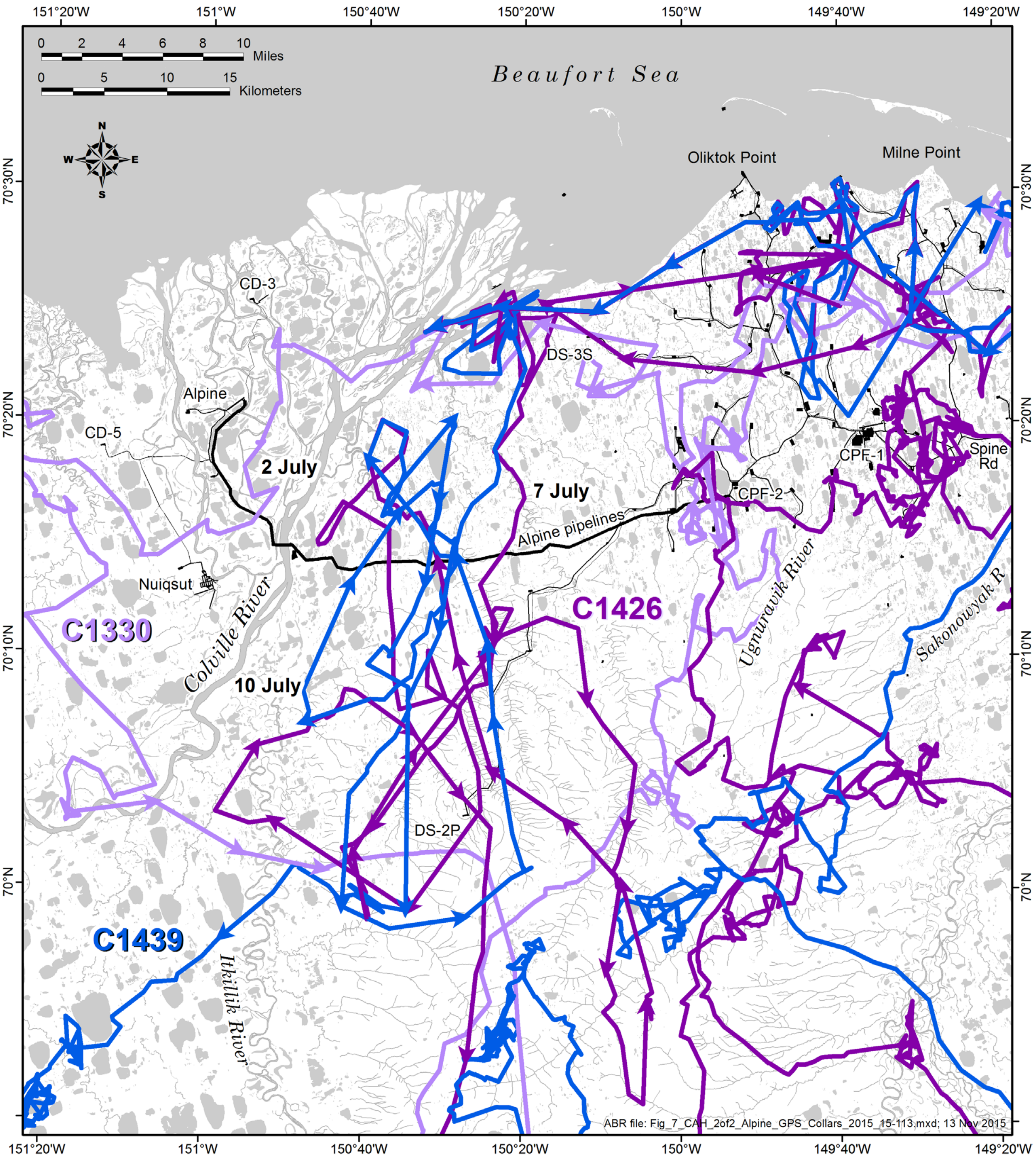

Figure 7. Movements of three GPS-collared CAH caribou (C1330, C1439, and C1426) during November 2014–October 2015 in the area encompassing the Alpine pipeline corridor (see text for details).

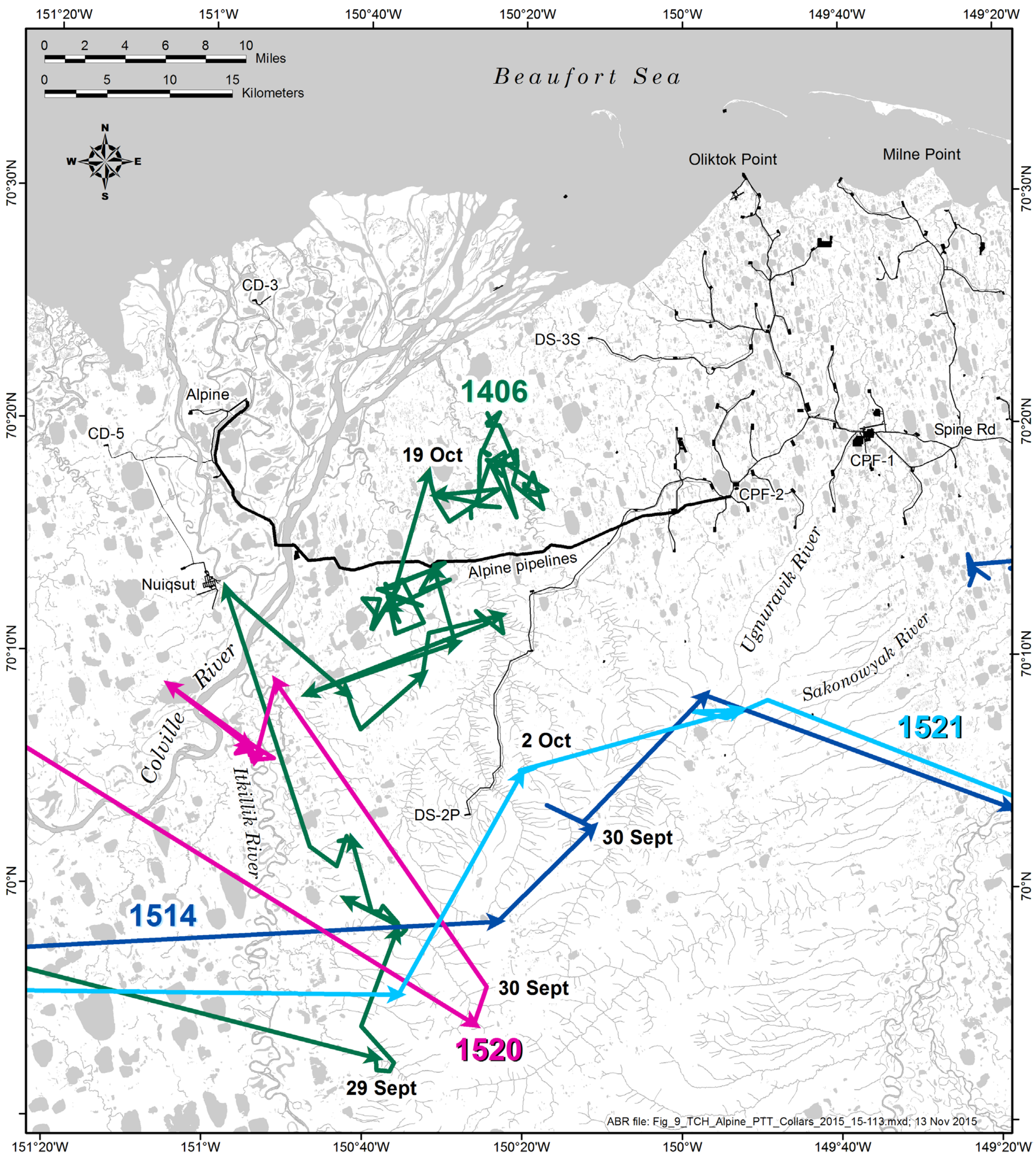

Figure 8. Movements of four PTT satellite-collared caribou (1406, 1514, 1520, and 1521) during November 2014–October 2015 in the area encompassing the Alpine pipeline corridor (see text for details).

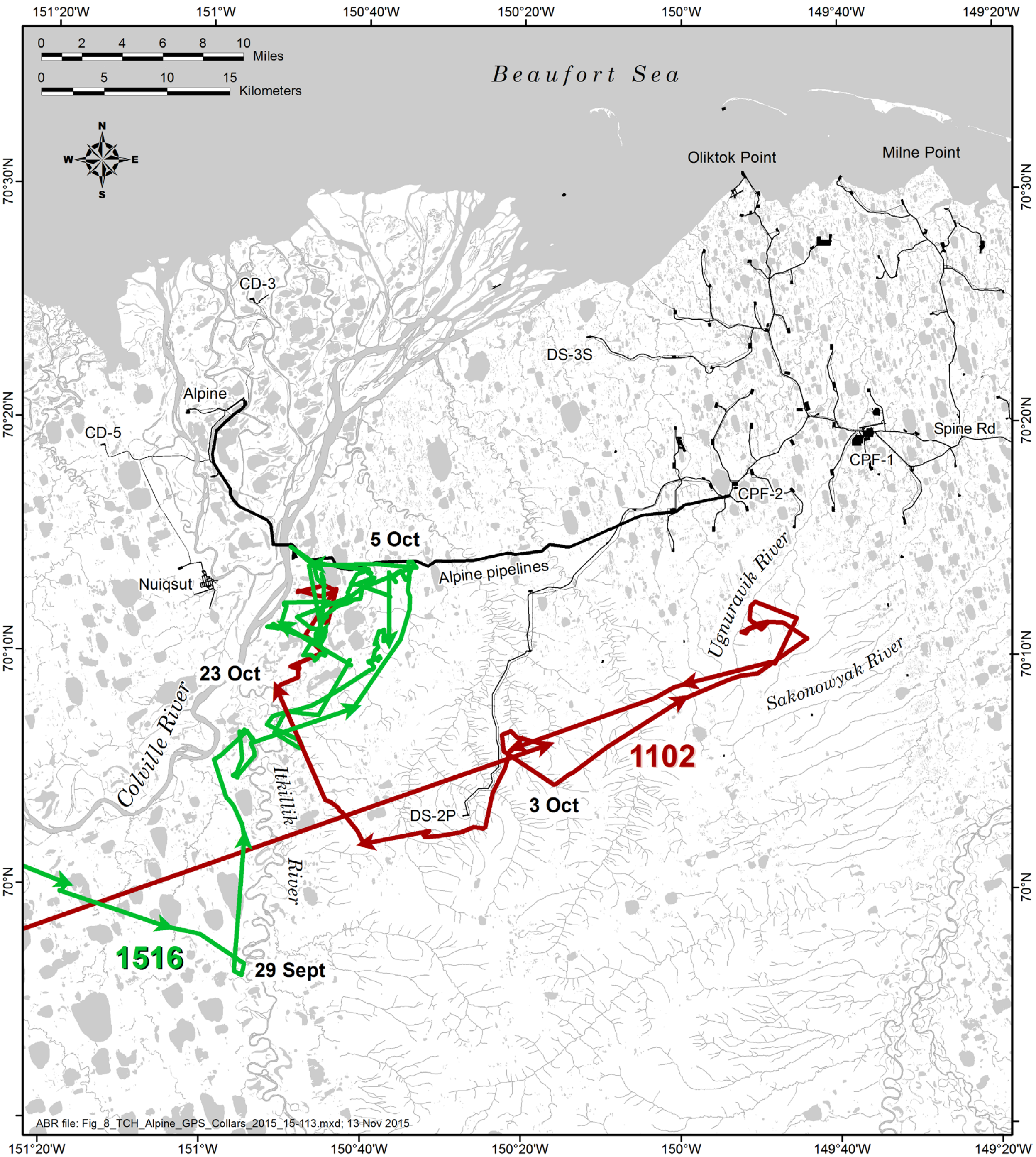

Figure 9. Movements of two GPS-collared TH caribou (1102 and 1516) during November 2014–October 2015 in the area encompassing the Alpine pipeline corridor (see text for details).

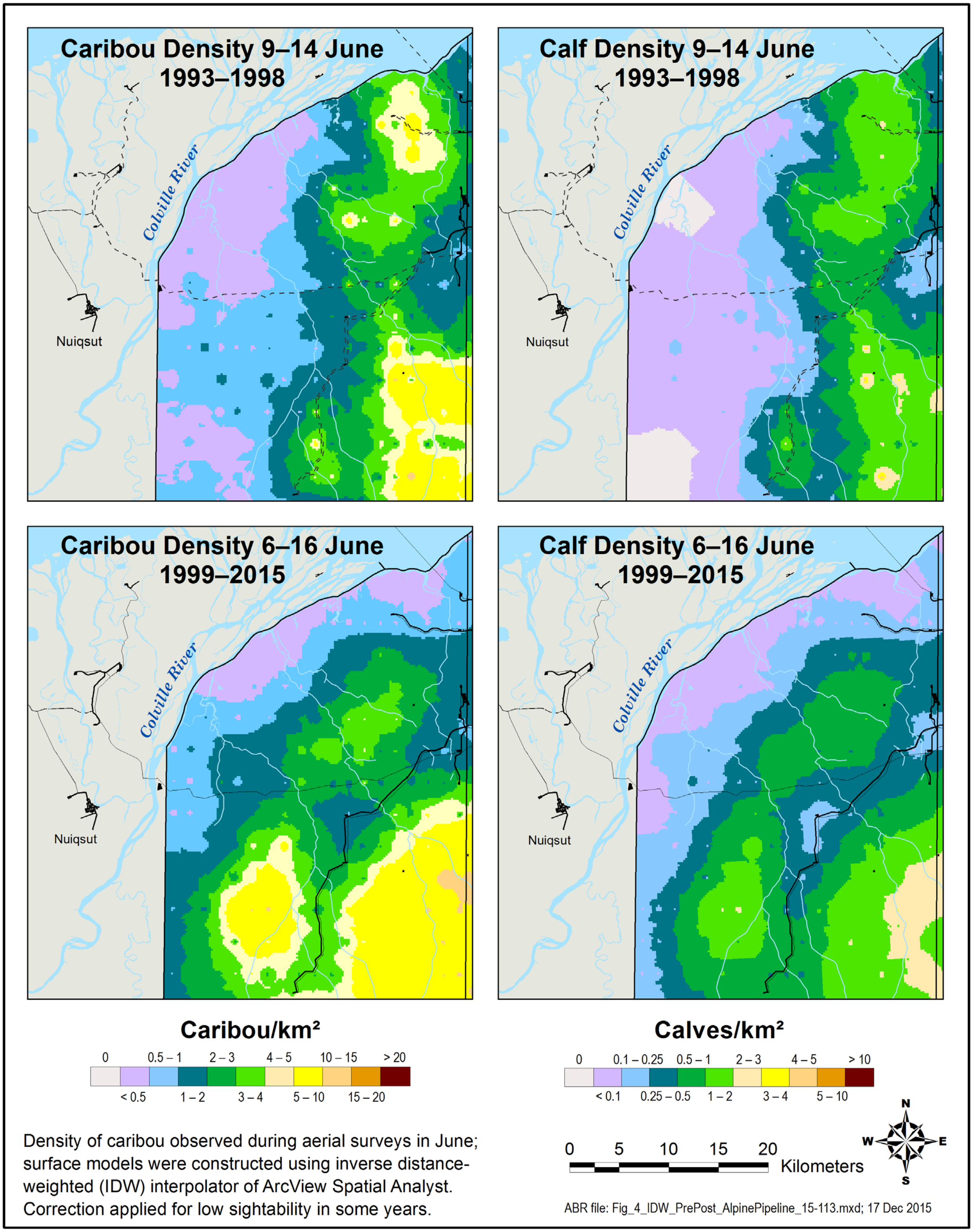

Figure 10. Distribution and density of all caribou (left) and calves only (right) in the Kuparuk–Colville calving survey areas in mid-June before construction of the Alpine pipeline corridor (top) and after construction (bottom). Dashed lines denote infrastructure not yet constructed.