ABR inc.
environmental research & services

December 30, 2011

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

Subject: **Data report for Alpine Pipeline caribou surveys, 2011**

Dear Ms. McGhee:

This letter report constitutes our primary deliverable for the 2011 project titled "Caribou along the Alpine Pipelines" (SO 4515041442). It summarizes data on caribou distribution, abundance, and movements in 2011 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 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 2011 (as well as additional telemetry data from 2007–2010) 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 by ABR, Inc. in concert with surveys conducted for two other, larger projects under contract to ConocoPhillips Alaska, Inc. (CPAI): the Greater Kuparuk Area (GKA) mammal study (Lawhead and Prichard 2011c) 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 (1999–2011) (Lawhead and Prichard 2007b, 2008b, 2009b, 2010b, 2010b, 2011b).

The Colville East aerial survey area (Figure 1) encompasses most of the length of the Alpine pipelines 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 area surveyed was expanded slightly following the calving surveys to provide broader coverage for the postcalving survey.

Methods

Two methods—aerial transect surveys and telemetry—have been used to examine caribou distribution and movements in the area of the Alpine pipeline corridor in recent years. 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.

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) in the Colville East survey area twice during the calving season, on June 2–3 and June 10, 2011. The first survey was timed to occur near the peak of calving and the second survey was timed to occur near the end of calving. Another survey was flown during the postcalving period (June 22–23) 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 2011b). The number of caribou observed within the transect strips was doubled to estimate the actual number present, based on the 50% sampling coverage. Sightability was poor due to patchy snow cover during both calving surveys in 2011, so the estimated densities were adjusted using a previously calculated sightability correction factor for calving caribou in the Kuparuk area (Lawhead et al. 1994). 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 three surveys.

To summarize calving distribution and abundance data from aerial transect surveys in mid-June (June 8–16) 1993 and 1995–2011, 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 2011 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 collared caribou from both herds that occur in the vicinity of the study area: the Teshekpuk Herd (TH) and Central Arctic Herd (CAH). The CAH consistently uses the area between Alpine and Kuparuk, whereas the TH typically remains west of the Colville River delta (Lawhead et al. 2011).

In July 2008, Alaska Department of Fish and Game (ADFG) biologists outfitted four female CAH caribou with Global Positioning System (GPS) collars purchased by CPAI. Six female caribou were collared in July 2009 (a seventh caribou died soon after collaring) and 12 female caribou were collared in June 2010. Ten of those 12 caribou were still alive in September 2011. Most CAH caribou collared in 2010 were captured near the Prudhoe Bay oilfield, but five animals were captured west of the Kuparuk River.

Twelve female TH caribou were outfitted with GPS collars purchased by CPAI in June 2007 (Table 1) (Lawhead et al. 2008). 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. Six more GPS collars purchased by CPAI were deployed on TH females in late June 2009 and 14 satellite collars purchased by NSB, ADFG, and the Bureau of Land Management (BLM) were deployed on 13 male and one female caribou. 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 eight males were outfitted with GPS collars funded by NSB, ADFG and BLM. In all years, the TH collars were deployed in the area around Teshekpuk Lake. In addition, satellite telemetry data were available from the NSB, BLM, and ADFG for 25 TH caribou (20 females and 5 males) that had been outfitted with satellite collars before 2007 and still had functioning transmitters in 2007 (Table 1). One satellite-collared TH caribou switched to the CAH in early 2007. Telemetry data from the period before November 2010 are described in previous reports (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, and 2011a).

Table 1. Number, type, and dates of radio-collars deployed on caribou of the Teshekpuk Herd (TH) and Central Arctic Herd (CAH) between June 2006 and June 2011.

Herd	Collar Type	Funding Source	Deployment Date	Retrieval Date	Male	Female	Total [a]
TH	Satellite	NSB, BLM, ADFG	Before 2007	Various [b]	5	20	25
	GPS	CPAI	June 2007	June 2008 [c]	0	12	12
	GPS	CPAI	June 2008	June 2009 [d]	0	7	7
	GPS	NSB, BLM, ADFG	June 2008	Various	0	20	20
	GPS [e]	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	–	4	0	4
	GPS	NSB, BLM, ADFG	June 2010	June 2012	0	13	13
	Satellite	NSB, BLM, ADFG	June 2011	–	4	4	8
	GPS	NSB, BLM, ADFG	June 2011	June 2013	0	8	8
CAH	Satellite [f]	NSB, BLM, ADFG	July 2006	June 2009	0	1	1
	GPS	CPAI	June 2008	July 2009	0	4	4
	GPS [g]	CPAI	July 2009	June 2011	0	6	6
	GPS [h]	CPAI	June 2010	June 2012	0	12	12

[a] Some individuals were outfitted sequentially with more than one collar over a period of years.
[b] Six caribou died in 2007, three collars were retrieved in 2007, four caribou died in 2008, five collars were retrieved in 2008, and seven collars were retrieved in 2009.
[c] One caribou died in November 2007, one died in April 2008, and one caribou was not captured until March 2009.
[d] One caribou died in February 2009.
[e] One caribou died in June 2010 and one died in November 2010.
[f] Originally captured in the range of the TH.
[g] One collar stopped transmitting and one caribou died in June 2009 and one caribou died in October 2009.
[h] One caribou died in July 2010 and one died in September 2010.

A complete data set for 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.

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 2011, the highest densities of calving caribou occurred south of the Alpine pipelines in the Colville East calving survey area (Figures 2 and 3). The areas of highest densities in 2011 generally were further west than the high-density distribution of calving activity in most years since 1993 (Lawhead and Prichard 2009b), which was similar to patterns seen in some recent years (2007, early 2009, and 2010). 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, 2011b). This inland/coastal gradient is reflected in the estimated density data (Table 2), which showed greater numbers and densities south of the Alpine pipelines on both calving surveys in June 2011, as in 2005–2010 (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a). About 35% of the Colville East calving survey area lies north of the Alpine pipelines, where 19% and 14% of the groups and total caribou, respectively, were found on the late calving survey. In 2011, a small secondary area of relatively high-density calving also occurred north of the Alpine pipelines and south of DS-3S (Figures 2 and 3).

During the early calving survey, 422 caribou were observed on transects (Table 2) and 1,587 caribou were estimated in the Colville East survey area after adjusting for low sightability due to patchy snow cover. During the late calving survey, 594 caribou were observed on transects (Table 2) and 2,233 caribou were estimated in the Colville East survey area after adjusting for low sightability. About two weeks later on June 22–23, 778 caribou were observed (1,556 estimated) in the expanded Colville East survey area (Figure 4). On June 22–23, the caribou moved north relative to their distribution during calving surveys. The portion of the postcalving survey area north of the pipelines (30% of the survey area) contained 27% of the groups and 31% of the individuals seen that day (Table 2, Figure 3).

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. ABR biologists conducting ground activities in June 2011 reported midges (which typically become active shortly before mosquitoes) had emerged inland by June 16 and some mosquitoes had emerged inland by June 22, but mosquito activity was low. Cool and windy conditions prevailed during most of late June, however, and mosquito harassment was recorded on only one day in June (June 27). More details on weather conditions and inferred insect harassment in 2011 are provided by Lawhead and Prichard (2011c).

During the early 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 zones 2–6 km north of the pipelines (Figure 5). During the late calving survey, the highest densities of caribou occurred west of the Meltwater (DS-2P) road. Examination of caribou distribution during calving (Figures 2 and 3) suggests that the lower densities observed near the Alpine pipelines on the surveys 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 were more evenly distributed throughout the area, with a larger proportion north of the pipeline (Figure 4, Table 2). The large number of caribou relatively far inland on the postcalving survey and the similarity of the distribution on the calving and postcalving

surveys indicated that mosquitoes had not yet emerged in numbers by the time of the postcalving survey, as would be expected from the cool temperatures observed in June. Average daily temperatures at the Kuparuk airport in the first half of June 2011 were the third lowest on record since 1983 (Lawhead and Prichard 2011c).

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, 2011.

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[b]	North	248	18	29	2	0.22	0.02
(June 2–3)	South	470	177	393	38	1.57	0.15
	Total	718	195	422	40	1.10	0.10
Late calving[b]	North	248	33	81	16	0.61	0.12
(June 10)	South	470	143	513	116	2.05	0.46
	Total	718	176	594	132	1.56	0.35
Postcalving	North	254	34	242	44	0.95	0.17
(June 22–23)	South	594	93	536	62	0.90	0.10
	Total	848	127	778	106	1.72	0.24

[a] Sampling coverage was 50% of the survey area.
[b] Sightability was low due to patchy snow cover, so densities were multiplied by SCF of 1.88 (see text).

Movements of Collared Caribou

GPS collars (CAH), November 2010–October 2011 — Movements before November 2010 were described previously (Lawhead and Prichard 2011a). In June 2010, ADFG biologists outfitted 12 female CAH caribou with GPS collars purchased by CPAI. One of those animals died in mid-July 2010 and another died in September 2010. The remaining 10 caribou are alive at this writing in November 2011. Of those 10 CAH caribou, three crossed the Alpine pipelines between November 2010 and October 2011.

CAH Caribou C0412 moved onto the Colville River delta from the east on July 17, 2011 (Figure 6). She moved just west of CD-2 on July 25 and remained on the delta until August 4, when she moved west into NPRA. She crossed the road and pipelines between Alpine CD-1 and CD-2 twice on August 4 before moving west. This caribou remained in NPRA until September 27, when she crossed the Colville River and moved southeast toward the Brooks Range.

CAH Caribou C04189 crossed near the eastern end of the Alpine pipelines on July 17, 2011 and then moved northwest onto the Colville River delta on the same day (Figure 6). She remained on the delta until July 25, when she crossed the pipeline/road corridor between CD-1 and CD-2 and then crossed the Alpine pipelines about 3 km south of CD-1. She moved off the delta and crossed the Alpine pipelines again northwest of DS-2L on July 27 before crossing and recrossing the Meltwater (DS-2P) pipeline/road corridor and moving off to the southwest.

CAH Caribou C04219 moved north in June 2011 and crossed the middle portion of the Alpine pipelines on June 23 (Figure 6). She crossed back to the south, then crossed again to the north side of the pipelines on June 25.

GPS collars (TH), June 2010–October 2011 — No GPS-collared TH caribou crossed the Alpine pipelines during this period, but three were located just west of Alpine CD-2 in late July 2011. A more detailed portrayal of their movement patterns will be possible after the collars are retrieved and the complete datasets are downloaded.

Satellite collars (TH), November 2010–August 2011 — No satellite-collared TH caribou crossed the Alpine pipelines during this period. Caribou 1101 was less than 1 km west of the Alpine pipelines in the CD-4 area in late July 2011, but was not recorded on the east side of the pipelines.

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 pipelines in 2011. Although caribou densities were higher south of the Alpine pipelines during the calving surveys than they were north of the pipelines, caribou were distributed on both sides of the pipeline corridor, suggesting successful crossings. The general pattern of caribou distribution during the 2011 calving season 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). No indication of consistent displacement from areas near infrastructure without human activity, such as the Alpine pipelines, has been documented. The density of caribou near the Alpine pipelines during calving in 2011 was lower than to the north or south (Figure 5), but it is unclear whether that pattern was due to displacement from the pipeline or to selection for other areas, such as the high-density nodes of calving activity farther south and north of the Alpine pipelines. During the 2011 postcalving survey, caribou were distributed throughout the survey area in a pattern roughly similar to that seen during calving (Figure 4) and density was highest in the zone near the Alpine pipelines (Figure 5).

GPS telemetry has demonstrated that collared CAH caribou cross the Alpine pipelines frequently (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a, 2011a). Northward crossings occur in 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 suggesting that the Alpine pipelines were not impeding caribou movements (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a). Since 2004, CAH caribou have moved as far east as the Arctic National Wildlife Refuge during the insect season (Lenart 2009, Lawhead et al. 2011), so they have had less contact with the Alpine pipelines in that season than in previous years. In July 2011, however, some large groups of CAH caribou moved into the area between the Kuparuk field and the Colville delta.

In 2004–2011, most movements by collared 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 (Lawhead and Prichard 2006a, 2007a, 2008a, 2009a, 2010a). The limited data from TH 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 on file) 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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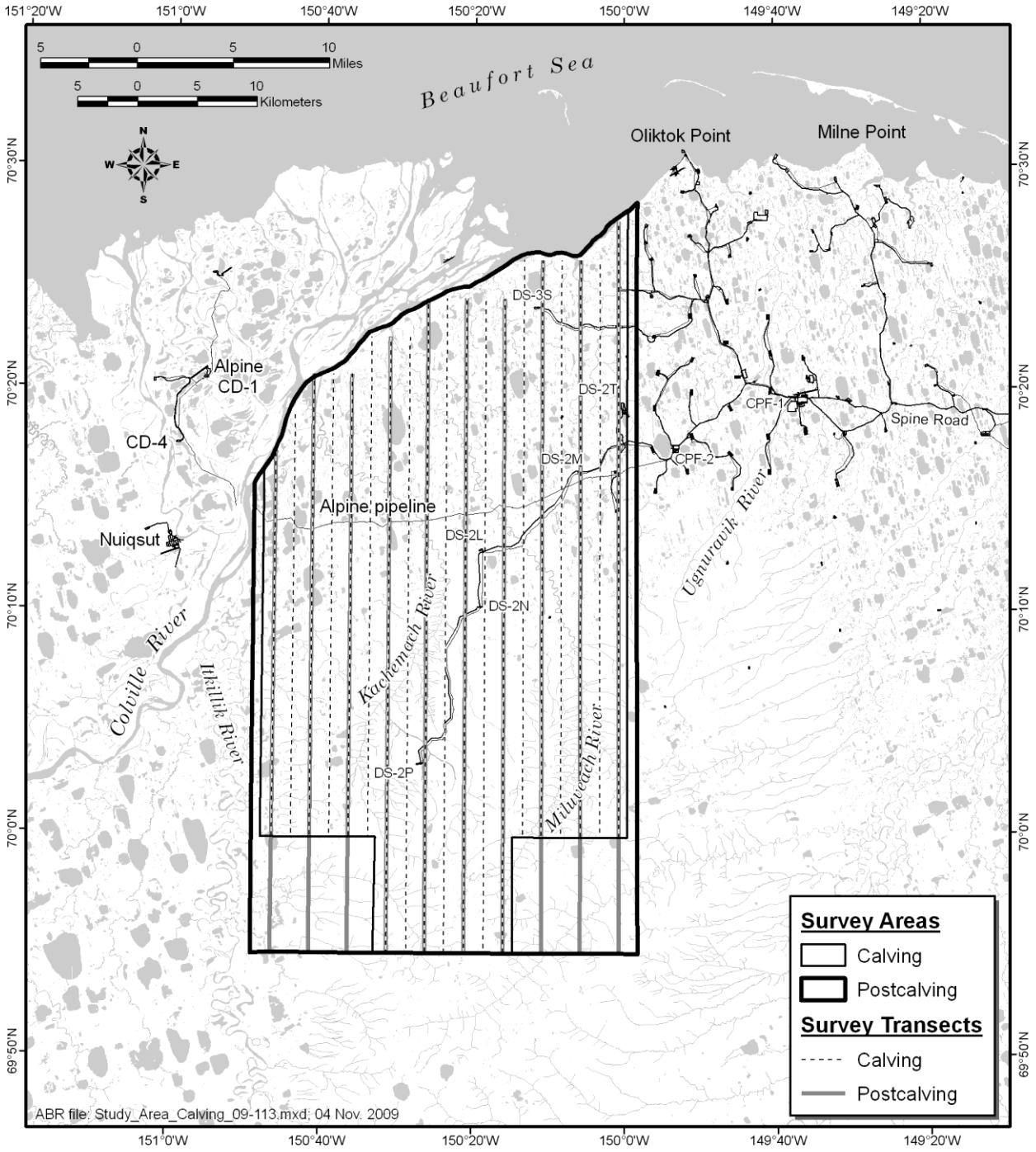

Figure 1. Colville East survey area for systematic aerial strip-transect surveys of caribou, June 2011.

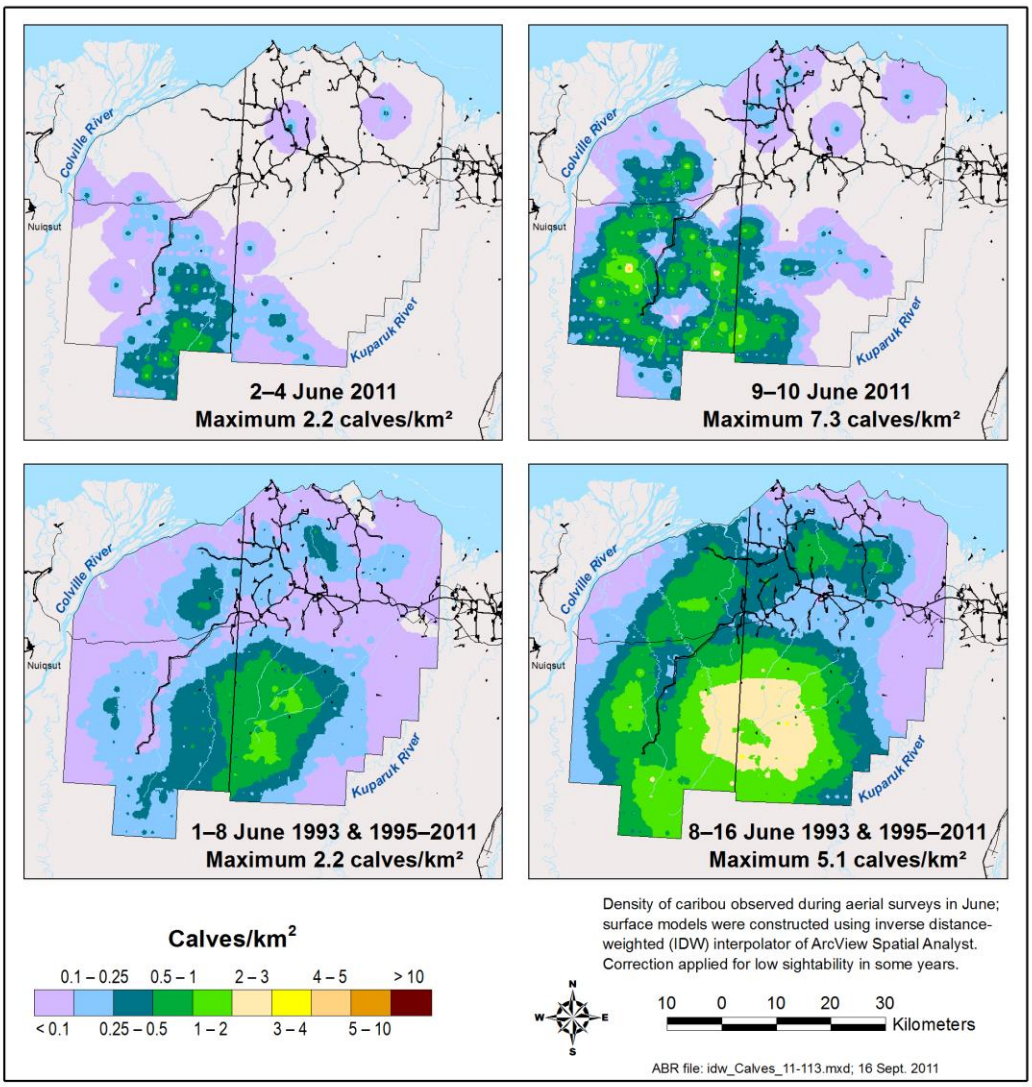

Figure 2. Distribution and density of caribou calves in the Kuparuk–Colville calving survey areas during June 2–4 June and June 9–10, 2011 (top), and distribution and mean density of caribou calves during early June and mid-June in the Kuparuk–Colville calving survey areas, 1993 and 1995–2011 (bottom).

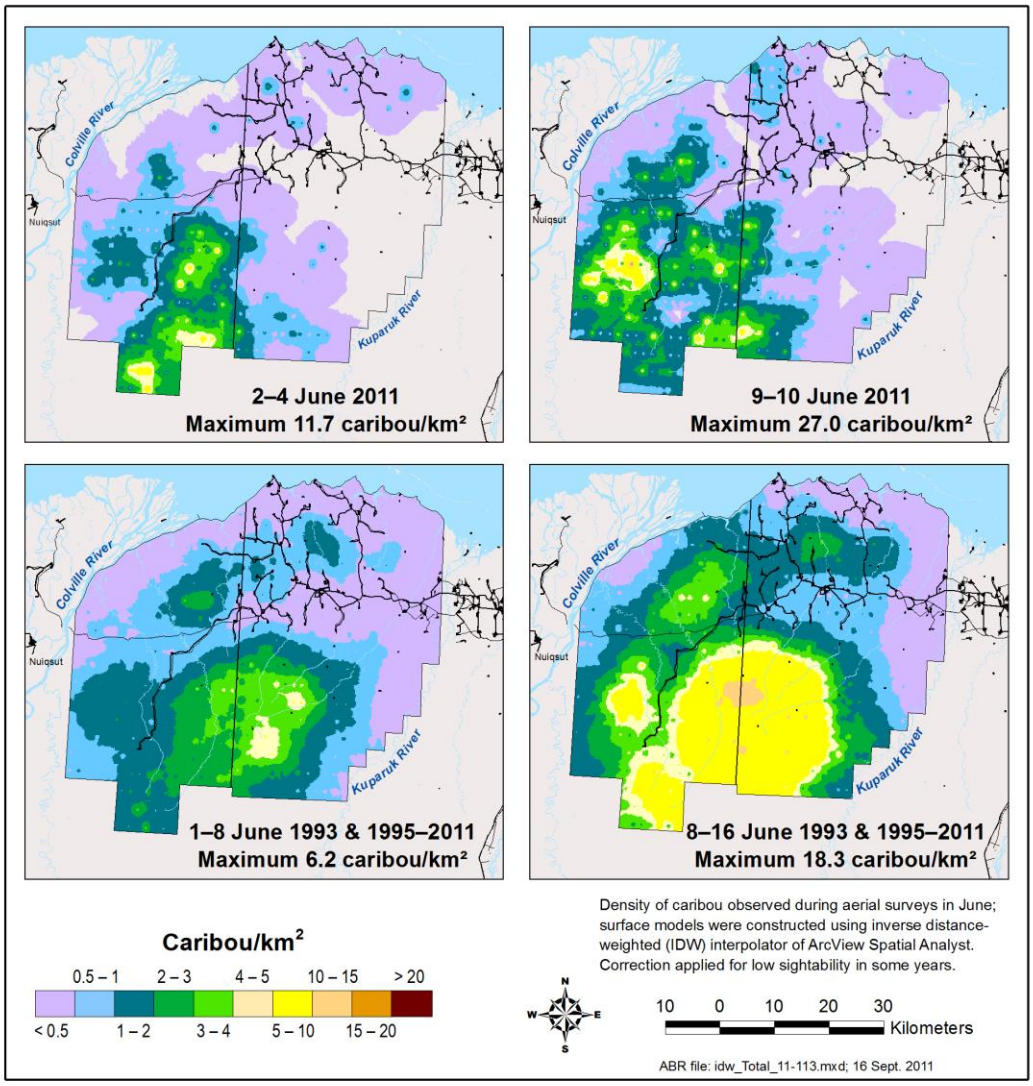

Figure 3. Distribution and density of all caribou in the Kuparuk–Colville calving survey areas during June 2–4 and June 9–10, 2011 (top), and distribution and mean density of all caribou during early June and mid-June in the Kuparuk–Colville calving survey areas, 1993 and 1995–2011 (bottom).

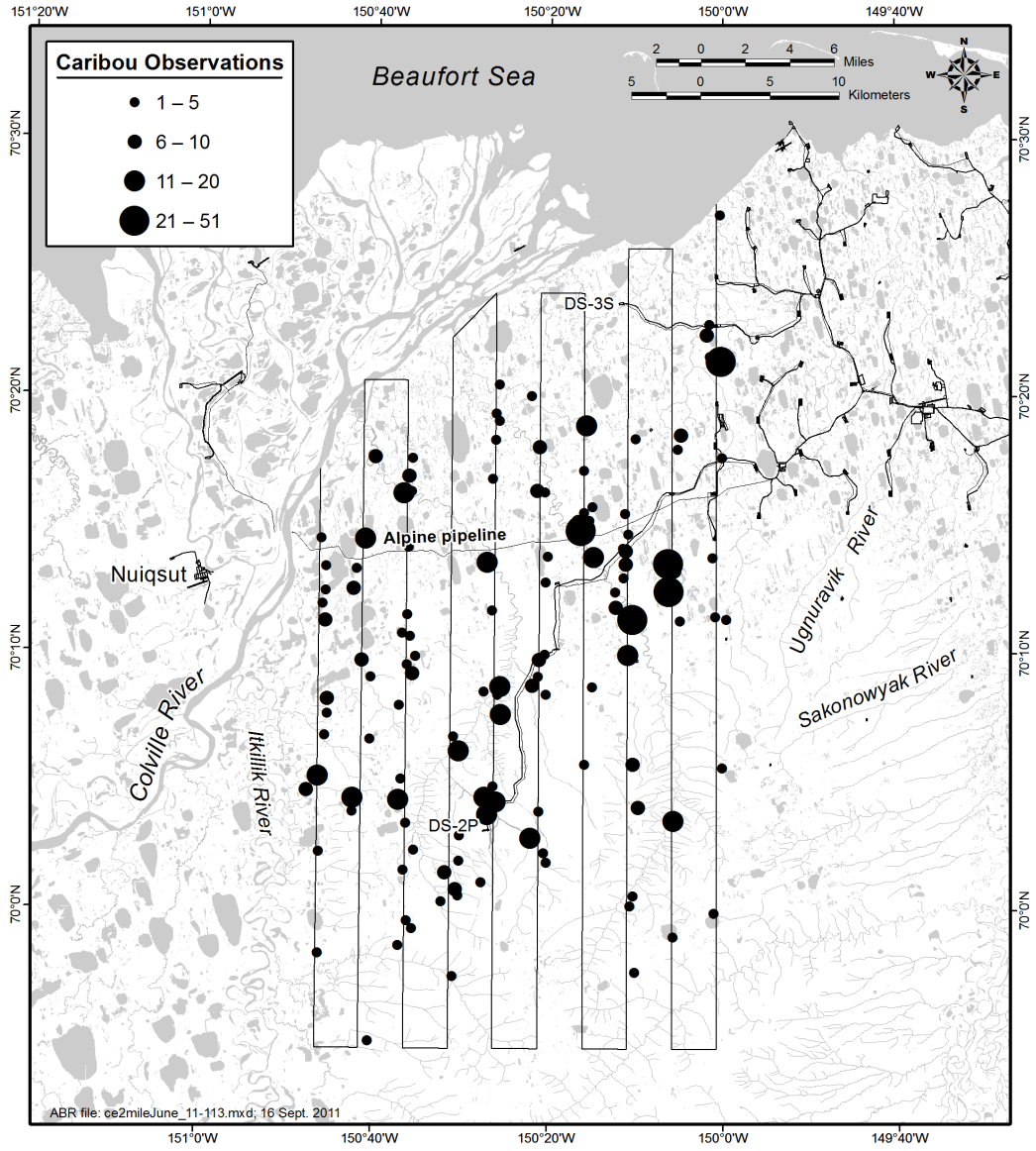

Figure 4. Distribution and size of caribou groups in the Colville East survey area during the postcalving survey on June 22–23, 2011.

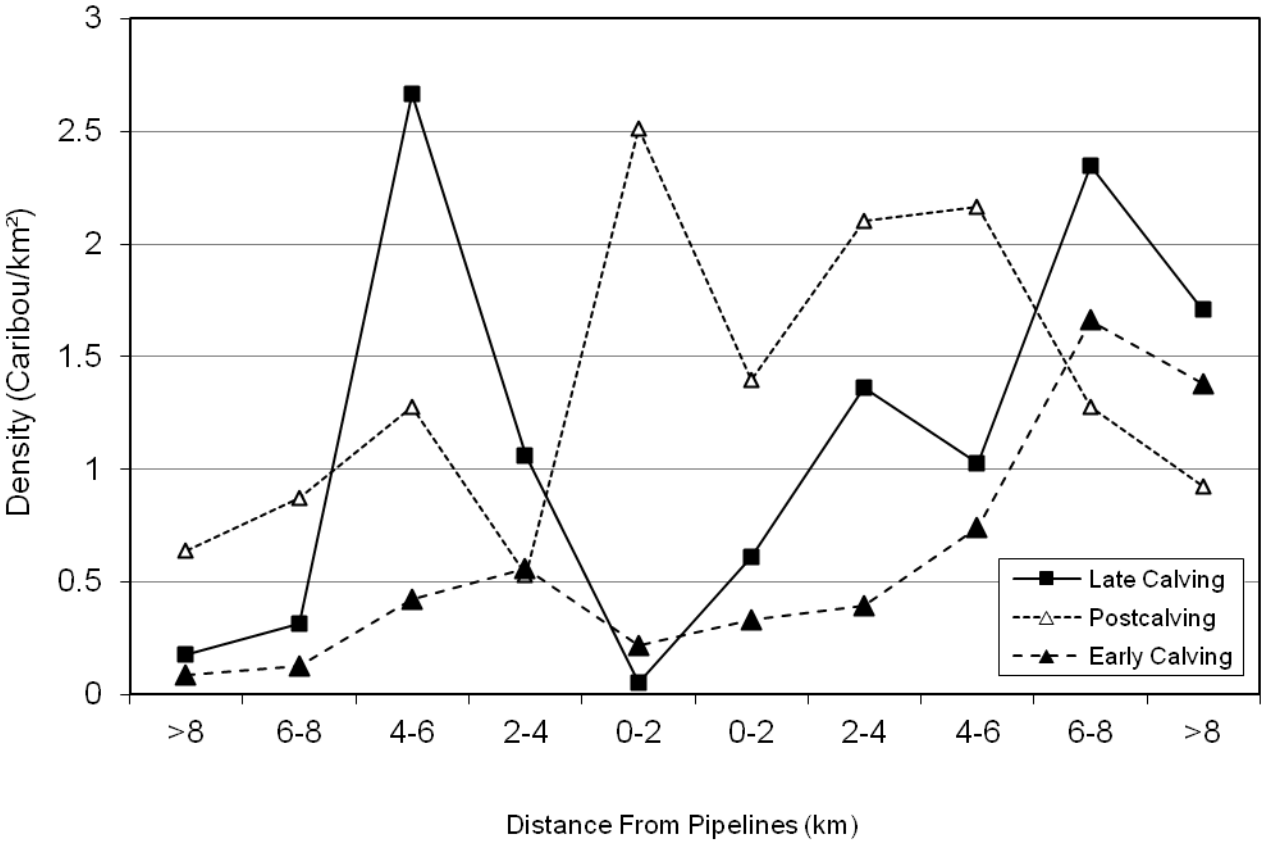

Figure 5. Densities of caribou in different distance zones north (left) and south (right) of the Alpine pipeline corridor during calving and postcalving surveys in the Colville East survey area, June 2011. Densities during calving surveys in 2011 were multiplied by 1.88 to adjust for lowered sightability due to patchy snow.

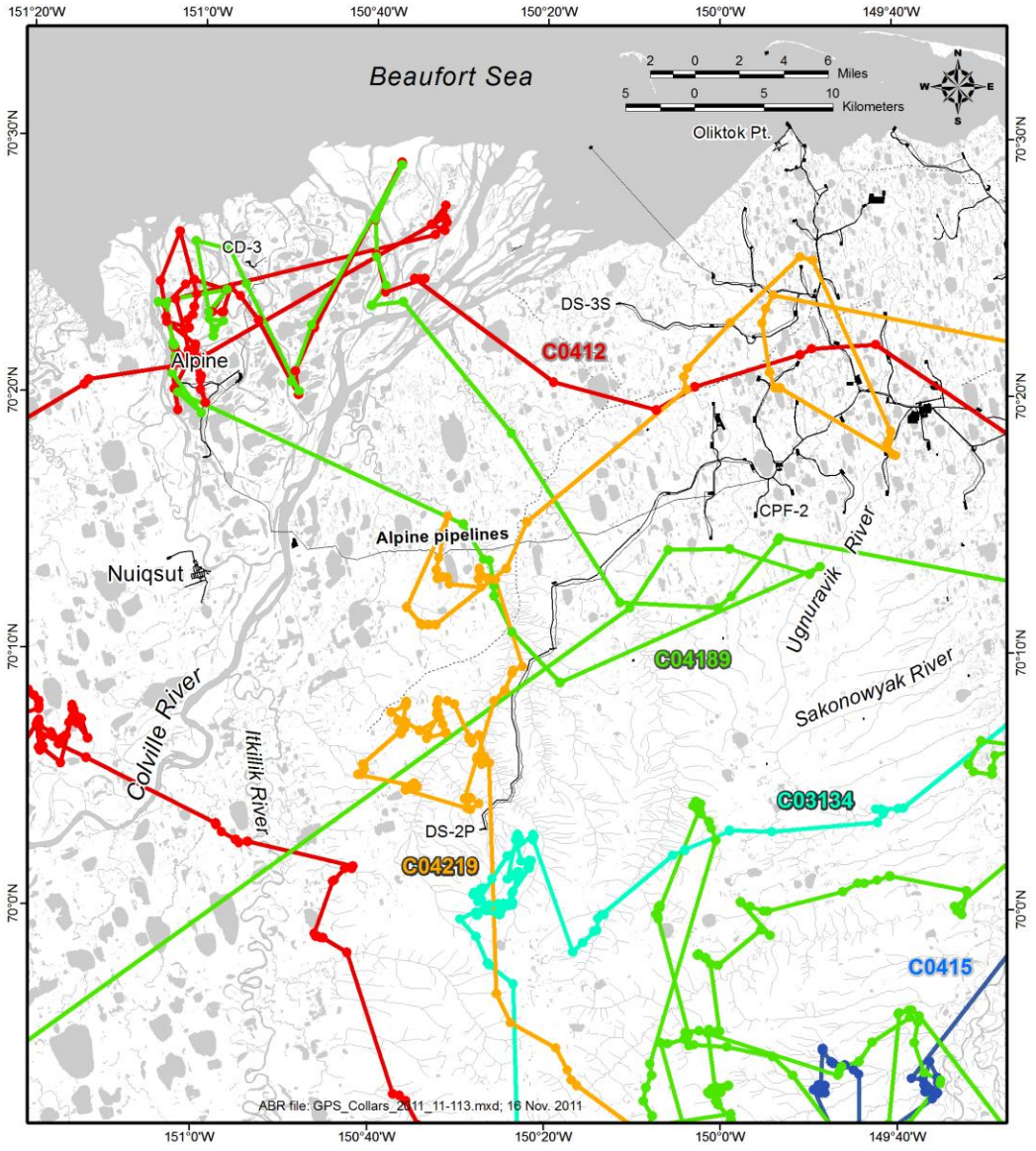

Figure 6. Movements of GPS-collared CAH caribou near the Alpine pipeline corridor during November 2010–October 2011.