CALVING AND RUTTING DISTRIBUTION OF THE DOLPHIN AND UNION CARIBOU HERD BASED ON RADIO-TELEMETRY, VICTORIA ISLAND (1994–1997)

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ABSTRACT

In the early 1990s, a research program was proposed in response to concerns that the number of calving areas and status of southern Victoria Island caribou, i.e., the Dolphin and Union herd, were unknown. The research program included a radio-collaring project whereby a total of 60 VHF collars would be deployed over 3 years (1994, 1995, and 1996) to better understand the locations of caribou calving grounds on Victoria Island. In this report, I describe the initial deployment of 20 VHF radio-collars in April 1994 and the rationale for not proceeding with the deployment of 40 additional collars. I present results based on radio-tracking the 20 collared cows from 1994 to 1997. Although Dolphin and Union cows exhibited traditional behaviour by returning to a calving area, they showed varying degrees of fidelity to a previous calving location. Despite few observations of cows' calving locations from one year to the next, distances between successive annual calving locations ranged from under ten kilometres to hundreds of kilometres. Observations of calving locations over the study period showed that the calving ground of Dolphin and Union caribou was extensive along the entire southern region of Victoria Island. Compared to a previous study that delineated one relatively small calving ground on southwest Victoria Island, I found the distribution of calving locations to be extended further to the east and north. I confirmed that Collinson Peninsula was a calving area, as well as central Victoria Island and the base of Storkerson Peninsula. The overall result was a much more extensive distribution of calving locations than previously described. Another important finding was the confirmation that a majority of collared caribou were congregating along the southern coastline during the fall rut. This provided useful insight into the distribution of caribou during the fall, and subsequently aided in designing a precise aerial survey of the migratory Dolphin and Union herd. However, logistical constraints and the difficulties of repeatedly locating VHF collared cows over a large area severely limited the success and usefulness of this study. I advocate that further studies on calving locations, seasonal movements, and fall rut distribution of Dolphin and Union caribou cows be conducted using a combination of satellite telemetry and aerial surveys.

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INTRODUCTION

Hunters in Holman have long recognized that there are two types of caribou on western Victoria Island. Smaller-bodied caribou are found in the Minto Inlet area of northwest Victoria Island; those animals appear most similar to caribou on Banks Island. Larger-bodied caribou from the Dolphin and Union herd are found on southern, central, and eastern Victoria Island. Although larger, caribou from the Dolphin and Union herd are still more similar in body size, conformation, and pelage to Peary caribou *(Rangifer tarandus pearyi)* than barren-ground caribou *(R. t. groenlandicus)*. Hunters' knowledge of the two types of caribou was supported by satellite telemetry between 1986 and 1988 (Gunn and Fournier 2000b, Gunn in prep.) and later reinforced by nuclear DNA analyses (J. Nagy and K. Ziitlau 1999, unpubl. data). Until the taxonomy of caribou on Victoria Island is discerned, biologists refer to both Minto Inlet and Dolphin and Union caribou as arctic-island caribou (see Miller 1990).

Initially, management concerns over arctic-island caribou in the west Kitikmeot focussed on the decline of caribou on northwest Victoria Island (i.e., the Minto Inlet herd). As a result of the caribou decline in northwest Victoria Island (Heard 1992, Gunn in prep.), the Olokhaktomiut Hunters and Trappers Committee self-imposed a 5-year hunting moratorium in the area north of Minto Inlet (see Figure 1). Following initiation of the hunting moratorium in the Minto Inlet area, there was a concern that Holman hunters would shift their summer

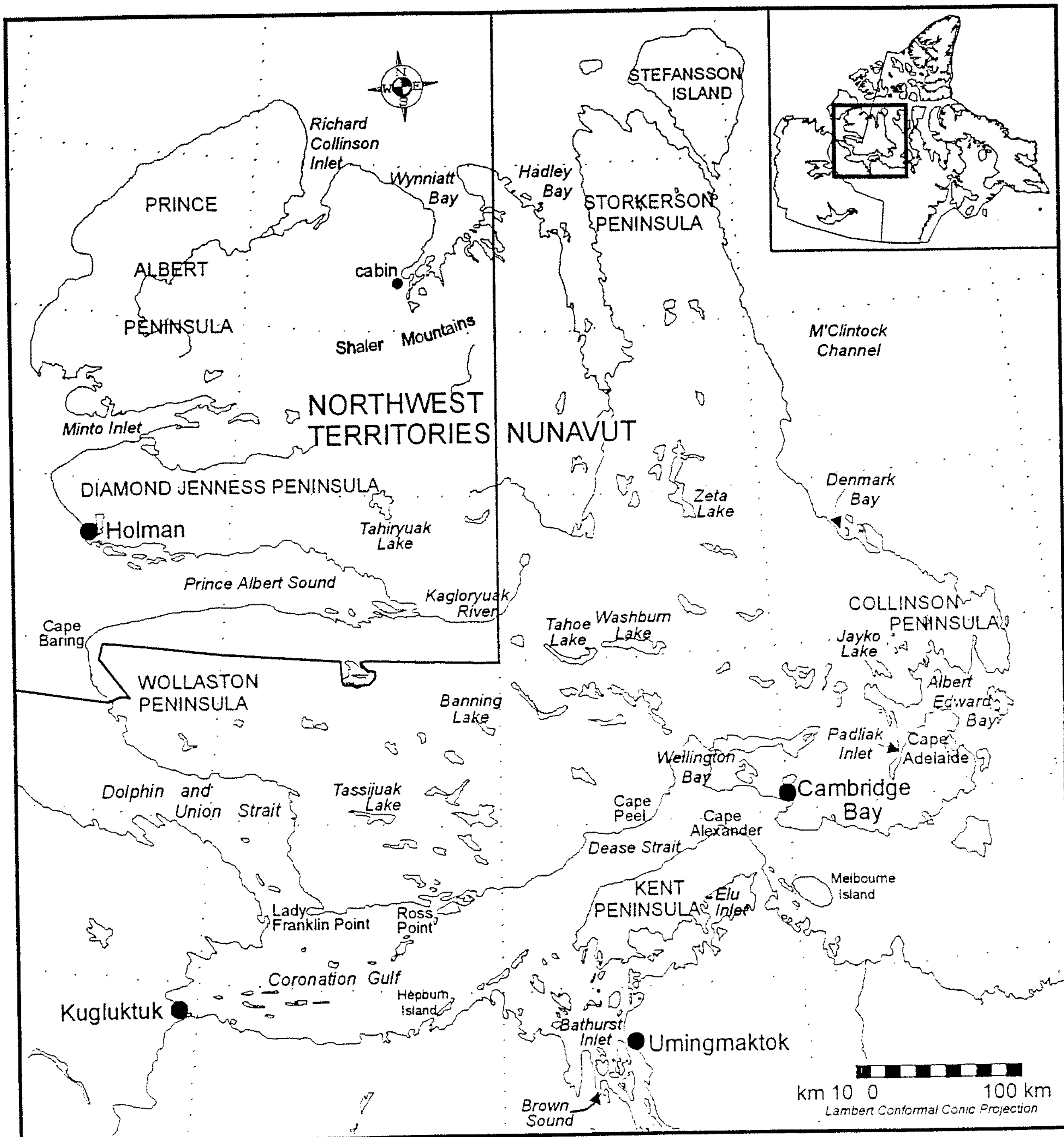

Figure 1. Place names and locations on Victoria Island, Canada.

and fall caribou hunting efforts to the Dolphin and Union herd.

However, there were already concerns about the status of the Dolphin and Union herd. In 1991, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed arctic-island caribou on Victoria Island as "Threatened" wildlife in Canada based on concerns about the level of harvesting compared to the only available estimate of population size (Miller 1990).

The migratory Dolphin and Union herd was first described by Manning (1960) as an intergrade between Peary and barren-ground caribou. More recently Eger and Gunn (1999) used mitochondrial DNA sequencing to suggest that arctic-island caribou evolved from barren-ground caribou that spread north after glaciation; they considered arctic-island caribou as ancestral stock to Peary caribou.

In the late 1980s and early 1990s, the Dolphin and Union herd was increasingly resuming its historical migration between Victoria Island (see Manning 1960) and the mainland (Gunn *et al.* 1997). Resumption of this traditional migration by the Dolphin and Union herd was important because, in addition to the harvest by Cambridge Bay, the communities of Kugluktuk, Umingmaktok, and Bathurst Inlet were now able to harvest arctic-island caribou on the mainland during winter. With the added harvest by Holman hunters and potential effects of proposed ship traffic increasing mortalities (i.e., drownings) associated with the fall migration (Nunavut Planning Commission 1998), there was a risk that the migratory Dolphin and Union herd would be overharvested.

In October 1993, the Department of Renewable Resources (DRR)[1] in consultation with the Inuvialuit Wildlife Management Advisory Council, designed a research program in response to the concern that status of caribou on Victoria Island was unknown. The research program consisted of determining population trend through aerial survey and a hunter harvest study of caribou on Victoria Island (DRR 1993). The research program was based on the assertion that the calving ground survey technique could be effectively used to monitor herd size and trend. The calving ground survey technique is one conventional method used to estimate size of a caribou herd (Heard 1985) and is based on the traditional behaviour of pre-parturient cows returning to a calving ground (see Thomas 1969, Gunn and Miller 1986). The first requirement for effective design of a calving ground survey is information on the size and location of the traditional calving ground and the most recent annual calving grounds.

Although Gunn and Fournier (2000b) used satellite telemetry to describe calving grounds on northwest (north of Minto Inlet) and southwest (south and east of Prince Albert Sound) Victoria Island, there was need for additional and recent information on the size and location of additional calving areas[2]. Therefore, a major component of the research program was a radio-collaring project whereby a total of 60 VHF collars would be deployed over 3 years to improve our understanding of size and location of caribou calving grounds on

[1] DRR is now the Department of Resources. Wildlife and Economic Development.

[2] One collared cow from Gunn and Fournier's (2000b) study calved on Collinson Peninsula. Local hunters (D. Kaomayok pers. comm.) also reported Collison Peninsula as a caribou calving area.

Victoria Island. Rationale for VHF transmitters was to increase sample size of collared caribou cows (DRR 1993) as VHF collars were a fraction of the price of satellite collars.

The overall objective of the radio-telemetry was to delineate calving areas on Victoria Island for subsequent calving ground surveys, and secondarily to describe timing and extent of spring and fall migrations between Victoria Island and the mainland. The project was to deploy 20 radio collars each year for three years. In the first 2 years, the strategy was to collar cows in their wintering areas to determine where they calved. In the 3rd year, collars were to be placed on barren cows or yearlings on the calving grounds to determine how they separated onto their respective winter ranges.

Specific objectives for the radio-telemetry study were as follows:

- In winter 1993/94, 10 collars would be placed on cows near Cambridge Bay and 10 cows on Kent Peninsula to determine where the animals hunted by Cambridge Bay go to calve.
- In winter 1994/95, 20 collars were to be deployed around Kugluktuk.
- In 1995/96, 20 collars would be placed in the calving grounds.

Due to logistical difficulties in finding and observing VHF collared cows in spring and fall and anticipated problems with interpretation of the infrequent data, I did not deploy the 20 collars in 1994/95 and 1995/96, respectively. In this report, I describe the first year of collar deployment (April 1994) and efforts to track those collared cows between 1994 and 1997.

METHODS

Caribou Capture

In April 1994, I used a hand-held net-gun (Capture Techniques, Calgary, AB) (Barrett *et al.* 1982) fired from a Bell 206L to capture 20 Dolphin and Union caribou cows (Appendix A). I made up to two or three unsuccessful attempts (i.e., helicopter passes) on an individual cow before passing it up for another animal. For the majority of captures, times for chase initiation, net launch, restraint (i.e., when the caribou was blindfolded and hobbled), and release of the animal were recorded. From those recorded times, I later determined elapsed time during each phase of the capture.

After each cow was hobbled, blindfolded and untangled from the net, I inserted a small wire temperature probe ca. 4 cm into its rectum to measure and monitor the animal's core body temperature. The attached temperature datalogger (HOBO® Temp, Onset Computer Corp. MA) was programmed to record temperatures at 16 second intervals, and recorded continuously for at least 1.5 minutes. The wire probe was left in the animal during the handling process and then removed prior to its release.

Once the caribou was restrained, I fitted it with a VHF radio collar (Telonics MOD-600). I placed three fingers between the top of the caribou's neck and the collar. For each animal, I attempted to standardise collar tightness by ensuring that four of my fingers could be inserted snugly between the collar and the animal's neck. Although somewhat subjective, this ensured that collars were fitted consistently and not too tightly.

Using a steel tape, I measured length (to the nearest cm) of a metatarsus, head length (hairline on the upper lip of the snout to the occipital crest), height at the shoulder (hoof-tip of an extended foreleg to the top of the withers) and body length (tip of the nose to the base of the tail). All mean values are presented with a standard deviation (±SD). I also drew a sample of blood and administered a 1.5 ml intramuscular injection of long-acting penicillin (PenLong) as a precaution against infection from any minor injury sustained during capture (B. Elkin pers. comm.). All blood samples were preserved in EDTA vacutainers (Beckton Dickson Co.) and sent to the University of Alberta for subsequent genetic analyses.

June Surveys

In June 1994, I opportunistically monitored the collar radio frequencies during a systematic aerial survey of western Victoria Island (Nishi and Buckland 2000). I also flew a high-altitude reconnaissance of central and eastern Victoria Island to determine whether caribou were outside the surveyed area.

I used a Cessna 337 and Helio-Courier H-295 to fly high-altitude systematic surveys of southern Victoria Island in June 1995, 1996, and 1997 (Appendix B). I flew the radio-tracking flights twice in June a few days apart to determine the timing of calving. I planned for a minimum altitude of 1800 metres above sea level (range 1800–2400 m) for all high-altitude telemetry flights and designed those monitoring surveys with the assumption that a radio-signal could be detected 40–50 km from its source (T.M. Williams pers. comm.). Consequently, I used an 80–100 km distance between adjacent flight lines.

Following initial detection of a radio-signal at high altitude, the aircraft descended to get an accurate location from an on-board Global Positioning System (GPS) and a visual observation of the collared caribou. The navigator-observer classified the collared cow as either a breeding female or a non-breeding female and determined whether it had a calf at heel (Table 1).

October Surveys

In October 1994, a Cessna 337 and a Helio-Courier H-295 were used to conduct high-altitude radio telemetry flights over southern Victoria Island to find radio-collared caribou cows that were not located in June 1994. My specific objectives were: 1) to confirm that all cows initially collared in April 1994 had actually migrated to Victoria Island in spring, and 2) to determine distribution of all radio-collared cows during the fall rut. Survey flightlines were to be flown at an altitude of ca. 1800 m above sea level and spaced ca. 80 km apart.

In October 1997, I used a Helio-Courier H-295 to conduct high altitude radio-telemetry flights over southern Victoria Island to locate and collect the remaining collared cows. Once a radio signal was received and the cow located, the aircraft landed in the vicinity and a hunter (D. Amegainek) shot the caribou.

Table 1. Classification of the reproductive status of radio-collared caribou cows in June based on observations from fixed-wing aircraft.

Reproductive status	Observed characteristics[a] (and assumptions)
Breeding females	
Parturient	Cow with hard antlers and no calf (cow is pregnant but has not calved)
Post-parturient	Cow with hard antlers and a calf (cow has calved recently, i.e. within one or two days; newborn calf has appearance of a bent back and hocks)
Post-parturient	Cow with no antlers and a calf (cow has calved and calf is greater than three days old)
Non-breeding females	
Non-parturient	Cow with new growth of velveted antlers and no calf (cow did not become pregnant during rut)
Unknown	Cow with no antlers and no calf (reproductive status is unknown because of the possibility that this cow was pregnant but lost it's calf after parturition)

[a] I did not use presence or absence of an udder as an observable characteristic because it would have been too disruptive for caribou; recorded observations would have suffered from poor repeatability (observer bias and Type 2 error) and comparability between aircraft.

Collar slackness was estimated on shot caribou by firmly lifting the collar from the top and measuring the distance (mm) from the inside of the collar to the dorsal side of the caribou's neck. Skin samples were collected from the neck and frozen for histological examination of tissue responses to collars. Depth of back fat was recorded (mm) using a steel ruler and was measured at the greatest depth of back fat observed along a forward cut starting at the base of the tail and at an angle of ca. 45 degrees from the spinal column (Riney 1955). Kidney fat indices were determined both as Riney's trimmed fat index (Riney 1955) and Huot's (1988) untrimmed index. Percent femur marrow fat was determined using Neiland's (1970) method where percent fat is equal to oven dried fat weight (g) divided by wet fat weight (g).

RESULTS

Caribou Capture

From the 23–28 April 1994, I used 27.0 hours of helicopter flight time to capture 23 caribou cows and fitted collars to 20 of them on Melbourne Island, Minto Island, Kent Peninsula, and southeast Victoria Island (Figure 2, Appendix A). On the 23 April, one cow was struck by a net weight in the left tibia and suffered a compound fracture above the metatarsal joint. She was subsequently euthanized and the carcass was delivered to the Ekaluktutiak Hunters and Trappers Association (EHTA). On the 25 April, a second cow died while still entangled in the capture net. Upon necropsy, the only evident abnormality was two burst blood vessels on the outside of the heart. Haemorrhaging within the pericardium suggested that the cow died from acute heart failure. The carcass was also given to the EHTA. On the 26 April, a third cow was captured and found to be thin and weak. The cow had a 4-cm diameter lump in the right side of her neck, with associated scabs, contusions, partially healed lacerations, and hair loss within an area of ca. 4 x 6 cm. That cow was released without a collar.

Daily temperature over the capture period ranged from –10° to –22°C. Mean chase times (interval between start of pursuit and net launch) averaged 2.5 ± 1.2 minutes (n=17). Mean restraint time (interval between net launch and physical restraint of netted cow, i.e., control of the head and body in sternal or lateral recumbency) was 4.2 ± 4.0 minutes (n=14) and mean handling time

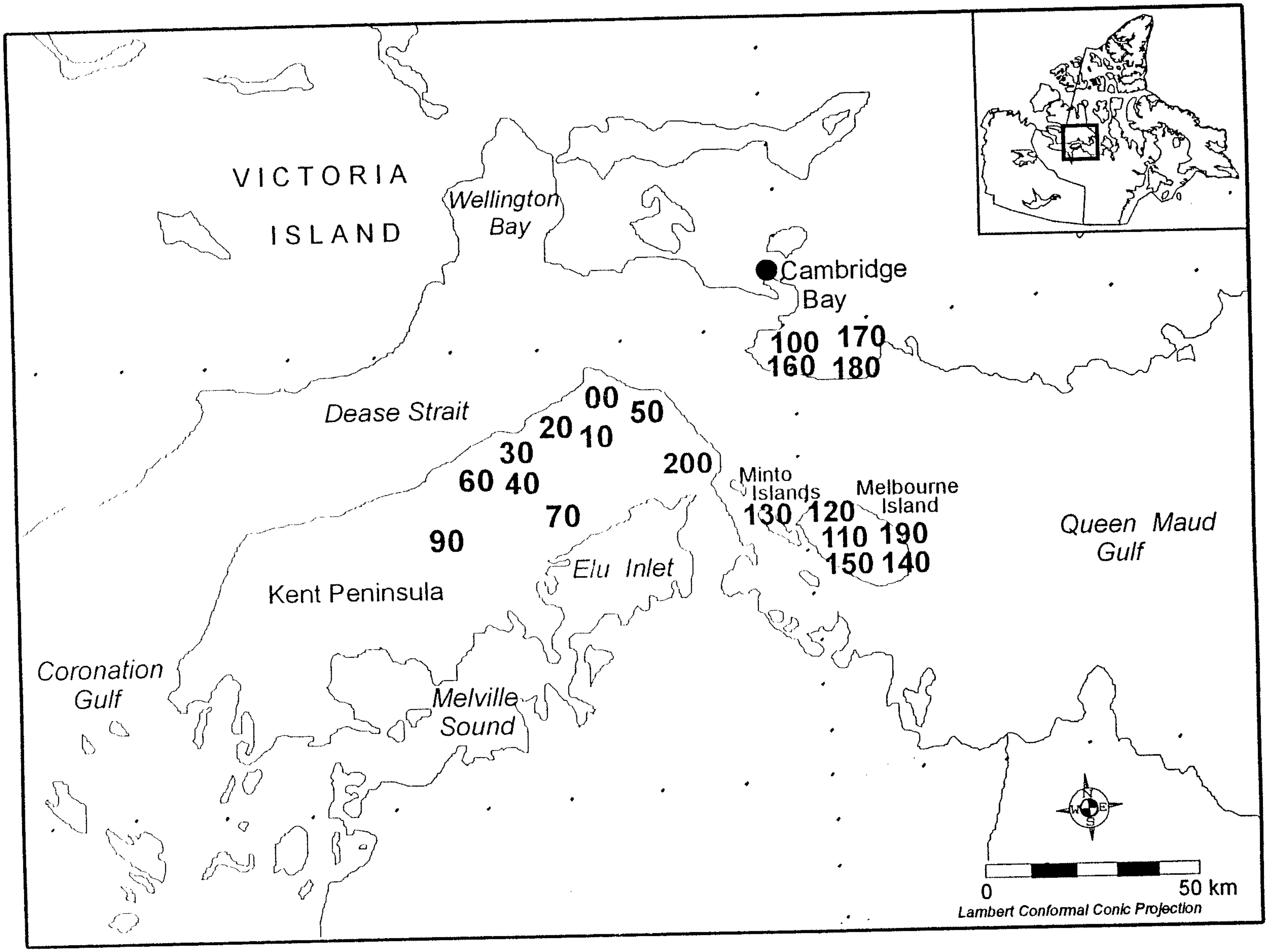

Figure 2. Capture locations for 20 Victoria Island caribou, 23-28 April 1994.

(interval between restraint and release) was 28.7 ± 9.3 minutes (n=15). Mean rectal temperature of captured caribou was 39.9 ± 0.5°C (range: 38.9 to 40.8°C; n=17), and remained relatively constant over the sampling period (range: 2 to 37 minutes. Individual rectal temperature was not significantly correlated to either chase time (Pearson product-moment correlation r=0.05, P=0.86, n=14) or restraint time (r=0.07, P=0.82, n=11). Body measurements are summarised in Table 2.

Table 2. Body measurements (cm) of 20 adult female Dolphin and Union caribou.

Descriptive statistic	Head length	Body length	Metatarsal length	Shoulder height
Mean	39.2	162.7	33.4	93.5
SE[a]	2.1	7.3	1.1	3.2
CV[b]	0.05	0.04	0.03	0.03

[a] standard error
[b] coefficient of variation

June 1994–97 Surveys

June 1994:

I located 13 radio-collared cows and did not detect the signal for seven cows during 10–18 June 1994 while flying an aerial survey of western Victoria Island. Of those 13 cows, 10 individuals were observed and only radio signals were heard for the remaining three individuals (Figure 3, Table 3 and 4). Of the five radio-collared cows observed between 10-15 June 1994, two had a calf at heel (Figure 3). When I saw the next five collared cows (17–18 June 1994), all had calves at heel (Figure 3).

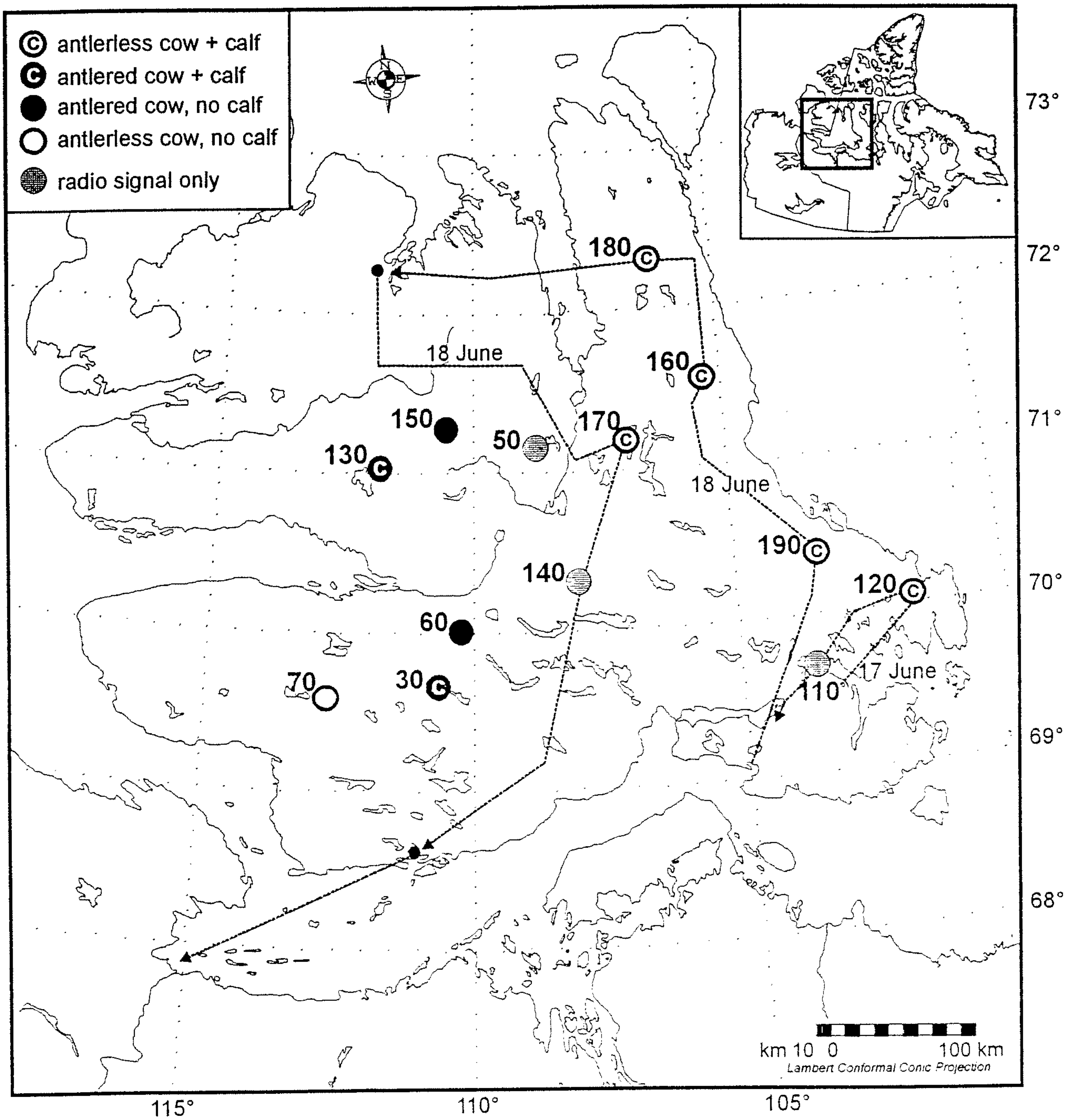

Figure 3. Flight lines and locations of seven radio-collared caribou cows on Victoria Island, 17 and 18 June 1994. The six collared cows not on the flight path were located during a systematic aerial survey of Victoria Island, 10-15 June 1994.

Table 3. Status of radio-collared Dolphin and Union caribou cows during calving, June 1994 to 1997.

	June 1994		June 1995		June 1996		June 1997	
Collar no.	Early (10-15 June)	Late (17-18 June)	Early (6-8 June)	Late (17-18 June)	Early (1-6 June)	Late (14-16 June)	Early (10-12 June)	Late (16-18 June)
00	not heard[a]	not heard	mortality[b]	--	--	--	--	--
10	not heard	not heard	antlered	antlerless	signal	antlered+calf	not heard	not heard
20	not heard	not heard	antlerless	not heard	not heard	antlerless+calf	not heard	not heard
30	antlered+calf	not heard	not heard	not heard	antlered+calf	not heard	signal	not heard
40	not heard	not heard	antlered	not heard	signal	not heard	mortality signal	mortality signal
50	signal	not heard	mortality signal	--	--	--	--	--
60	antlered	not heard	antlerless	not heard	antlered	antlered+calf	antlerless	antlerless
70	antlerless	not heard	antlerless	not heard	not heard	antlered+calf	antlerless	antlerless
90	not heard	not heard	antlered+calf	not heard	not heard	antlerless+calf	mortality[c]	--
100	not heard	not heard	not heard	mortality	--	--	--	--
110	not heard	signal	mortality signal	--	--	--	--	--
120	not heard	antlerless+calf	antlered	antlerless	antlered	antlerless+calf	antlerless	antlerless
130	antlered+calf	not heard	antlered+calf	not heard	not heard	antlerless	antlered	antlerless+calf
140	not heard	signal	antlerless	not heard	not heard	antlerless+calf	antlered	antlered+calf
150	antlered	not heard	mortality signal	--	--	--	--	--
160	not heard	antlerless+calf	mortality signal	--	--	--	--	--
170	not heard	antlerless+calf	not heard	not heard	not heard	not heard	not heard	not heard
180	not heard	antlerless+calf	not heard	antlerless	not heard	not heard	not heard	not heard
190	not heard	antlerless+calf	antlered	antlerless+calf	not heard	antlerless+calf	antlered	antlered
200	not heard	not heard	antlered	antlered	not heard	antlered	antlered	antlered+calf

[a] Signal from collar was not heard during radio-tracking flights.
[b] 26 May 1995 collar found on ice.
[c] Killed by hunter on 17 October 1996.

Table 4. Radio-collared caribou cows categorised by reproductive status, Victoria Island, June 1994 to 1997.

Status	June 1994 Early (10-15 Jun)	June 1994 Late (17-18 Jun)	June 1995 Early (6-8 Jun)	June 1995 Late (17-18 Jun)	June 1996 Early (1-6 Jun)	June 1996 Late (14-16 Jun)	June 1997 Early (10-12 Jun)	June 1997 Late (16-18 Jun)	Row total	% of total assumed live
Antlered	2	0	5	1	2	1	4	1	16	13.2
Antlered + calf	2	0	2	0	1	3	0	2	10	8.3
Antlerless + calf	0	5	0	1	0	5	0	1	12	9.9
Anterless	1	0	4	3	0	1	3	3	15	12.4
Signal (live)	1	2	0	0	1	0	1	0	5	4.1
Not found (assumed live)	14	13	4	9	10	4	4	5	63	52.1
Dead	0	0	5	6	6	6	8	8	39	
Total observed	5	5	11	5	3	10	7	7	53	
Total live	6	7	11	5	4	10	8	7	59	
Total assumed live	20	20	15	14	14	14	12	12	121	
Observed / assumed live	0.250	0.250	0.733	0.357	0.214	0.714	0.583	0.583		
Not found / assumed live	0.700	0.650	0.267	0.643	0.714	0.286	0.333	0.417		

June 1995:

In June 1995, I was able to account for a total of 18 of 20 collared cows. From the 6-8 June, I flew 24.9 hrs in a Cessna 337 and surveyed the southern part of Victoria Island (Appendix B, Figure 4). During those flights, I accounted for 16 of 20 collared caribou. Those collared cows were distributed extensively throughout southern Victoria Island, from Tassijuak Lake in the west (cow 70), to Padliak Inlet in the east (cow 120) (Figure 4). Of those 16 cows, 5 had died. Of the 11 remaining cows, only 2 had calves at heel and both cows were antlered (Tables 3 and 4).

On the 17 and 18 June, I tried to located collared cows not found during the previous survey by covering an area north of Collinson Peninsula up the length of Storkerson Peninsula and as far as Stefannson Island. I flew 17.3 hours in a Helio-Courier (Appendix B) and observed 6 cows, of which 2 were not previously found: 1 collar was on mortality mode on Stefannson Island, and the other cow was antlerless and halfway up Storkerson Peninsula (Figure 5, Table 3).

Of the 6 mortalities in 1995, 4 were detected as radio signals on mortality mode (collars 50, 110, 150, and 160) and were not investigated further because they were not accessible by fixed-wing aircraft. Those 4 unretrieved collars were on Kent Peninsula and on the adjacent mainland south of Elu Inlet (Figure 4).

I first detected collar 00 on mortality mode on the 17 May 1995 while en route to Gjoa Haven to survey the Northeast mainland for migrating caribou

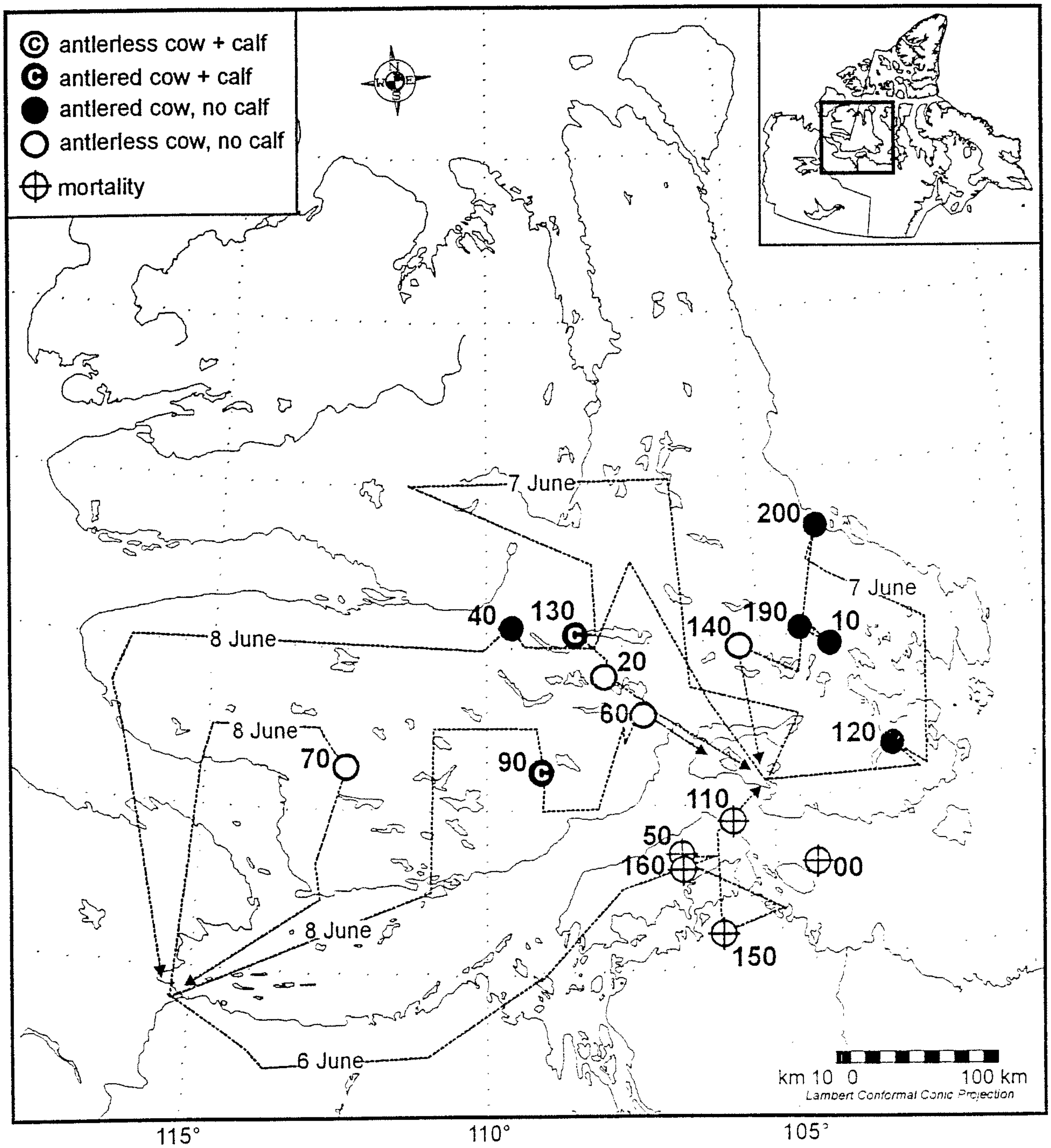

Figure 4. Flight lines and locations of 16 radio-collared caribou cows on Victoria Island, 6 to 8 June 1995.

(Buckland *et al.* 2000). On the 26 May 1995, I retrieved that collar on the sea-ice ca. 9 km northeast of Melbourne Island (Figure 4). The collar was buried under ca. 10 cm of snow and there was fox scat and caribou hair in the immediate area of the collar. The collar had several small puncture marks in the belting (likely from a fox's canines), but there was no sign of the cow's carcass. There was however, a scavenged and disarticulated skull and spinal column of an adult male caribou partially buried in the snow and ca. 10 m from where the collar was found. Given that the bull's carcass was partially buried in the snow and ice and that its large antlers were still attached to the skull, it was likely that both it and the collared cow died during the previous fall migration. Hunters have reported occurrences of caribou carcasses found partially frozen in the sea ice along Coronation Gulf likely as a result of falling through thin ice in fall (C. Adjun pers. comm.). These sites are commonly used to trap fox (D. Kaomayok pers. comm.).

On the 18 June 1995, I retrieved collar 100 on the northern part of Stefansson Island on a raised beach (Figure 5). The long bones from two hind legs and a right front leg, skull fragments and parts of the lower jaw were scattered over an area of ca. 5 x 5 m. All bones had been cleaned of flesh and the hide was still attached to the lower metatarsi and metacarpus; dried connective tissue around the joints held the bones together.

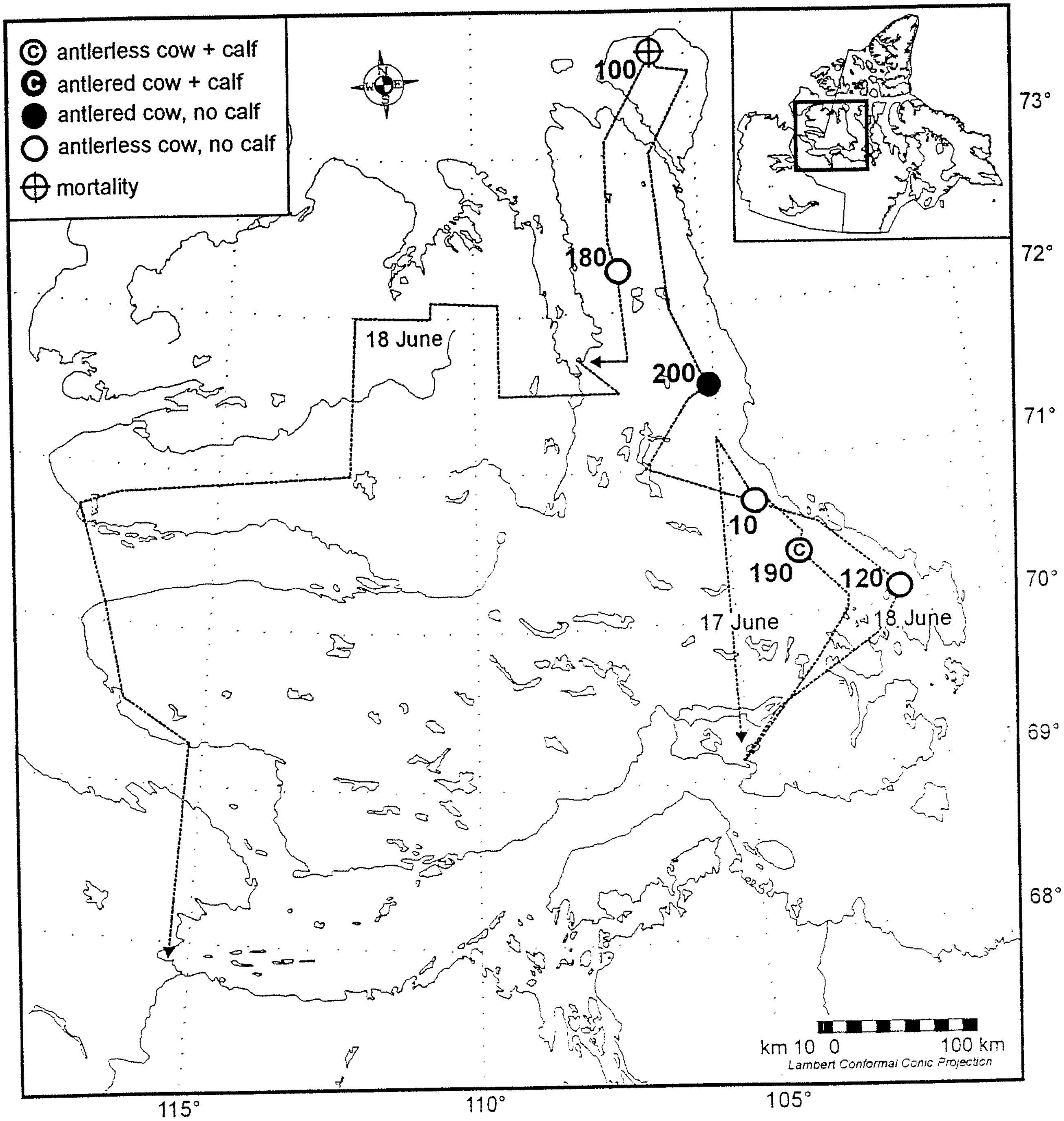

Figure 5. Flight lines and locations of six radio-collared caribou cows on Victoria Island, 17 and 18 June 1995.

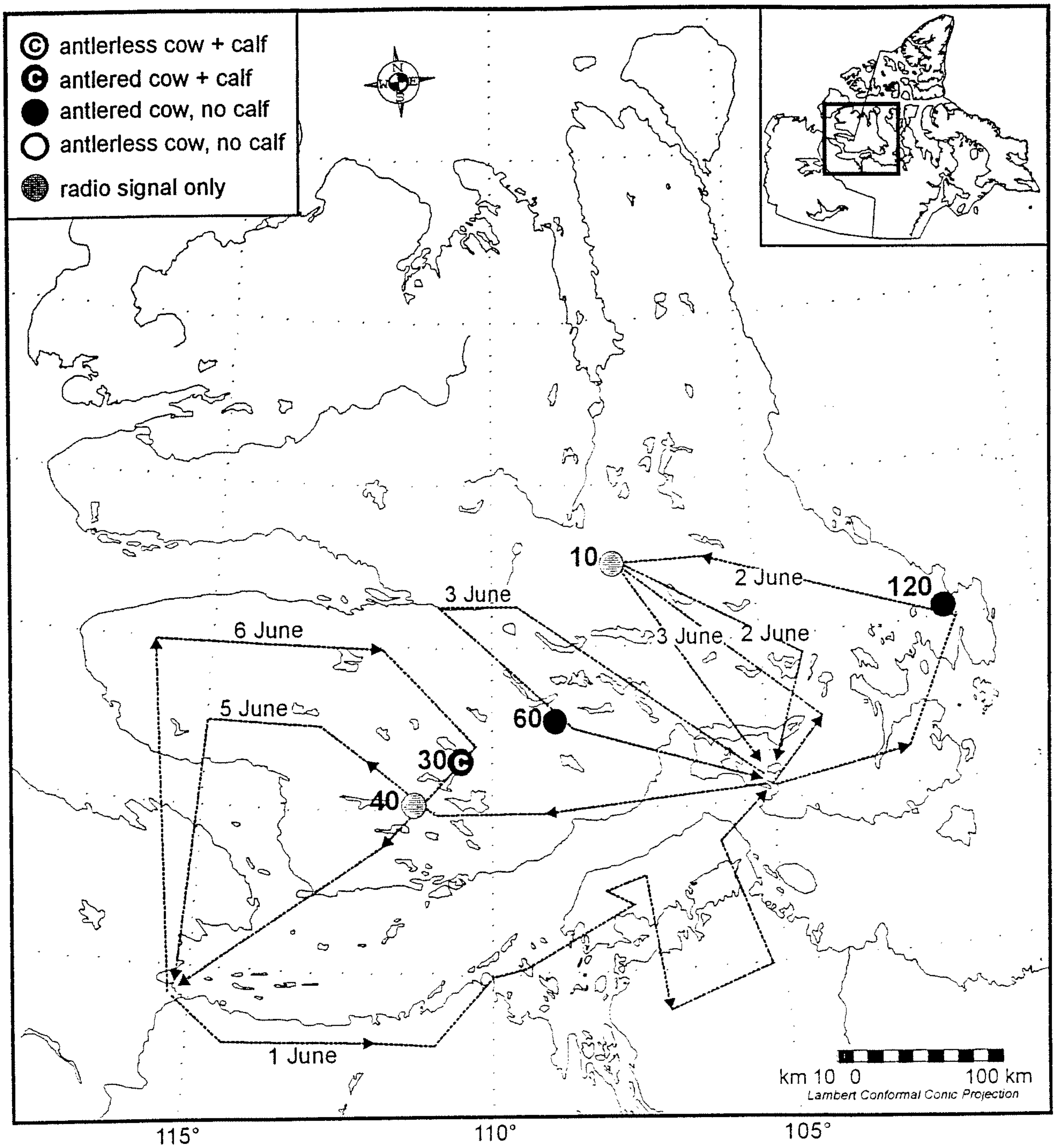

Figure 6. Flight lines and locations of five radio-collared caribou cows on Victoria Island, 1 to 6 June 1996.

June 1996:

I accounted for 12 of 14 remaining radio-collared cows (Table 3). During the first week of June, a search of southern Victoria Island (Figure 6, Appendix B) resulted in observations of 3 collared caribou; only 1 of those cows had a calf at heel. Two weeks later (14–16 June), the surveyed area was extended further north to include part of Storkerson Peninsula, the Shaler Mountains, and the area east of Prince Albert Sound (Figure 7). During that survey (Appendix B), 8 of 10 cows observed had a calf at heel (Tables 3 and 4).

June 1997:

I accounted for 9 of 13 remaining[3] collared cows (Table 3). During the early radio-telemetry flights on 10–12 June 1997 (Appendix B), 0 of 7 cows observed had a calf at heel (Figure 8). When the 7 cows were observed ca. 1 week later, 3 had a calf at heel (Figure 9). The second telemetry survey (Appendix B) confirmed that collar 40 was on mortality mode, and provided a confident location for the collar (Figure 9).

Calving Distribution

Distribution of collared cows during calving from June 1994 to June 1997

[3] Cow 90 was shot by a hunter on the 17 October 1996, 5 km west of Cambridge Bay and north of the Dewline site (G. Corey pers. comm.).

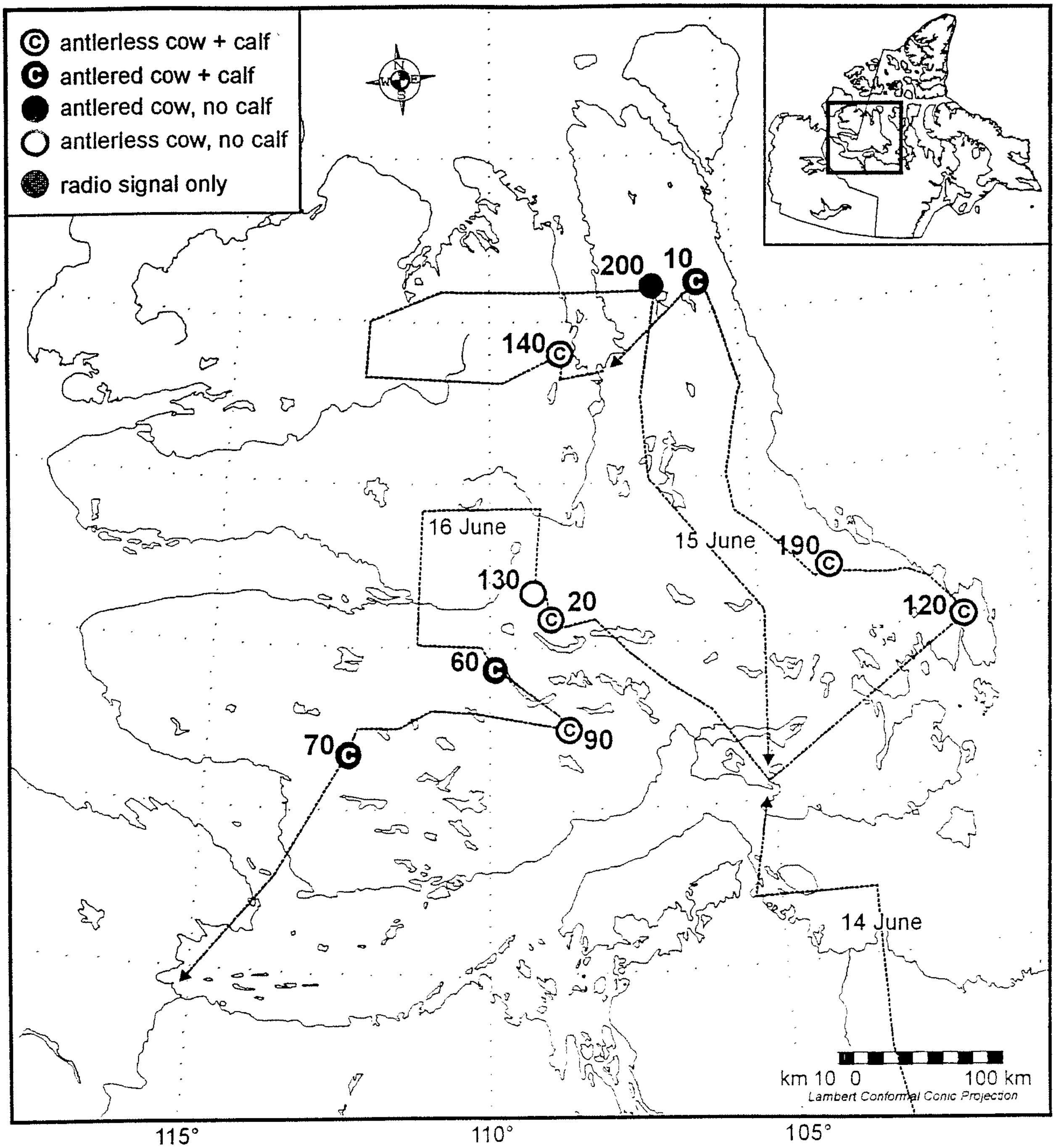

Figure 7. Flight lines and locations of ten radio-collared caribou cows on Victoria Island, 14 to 16 June 1996.

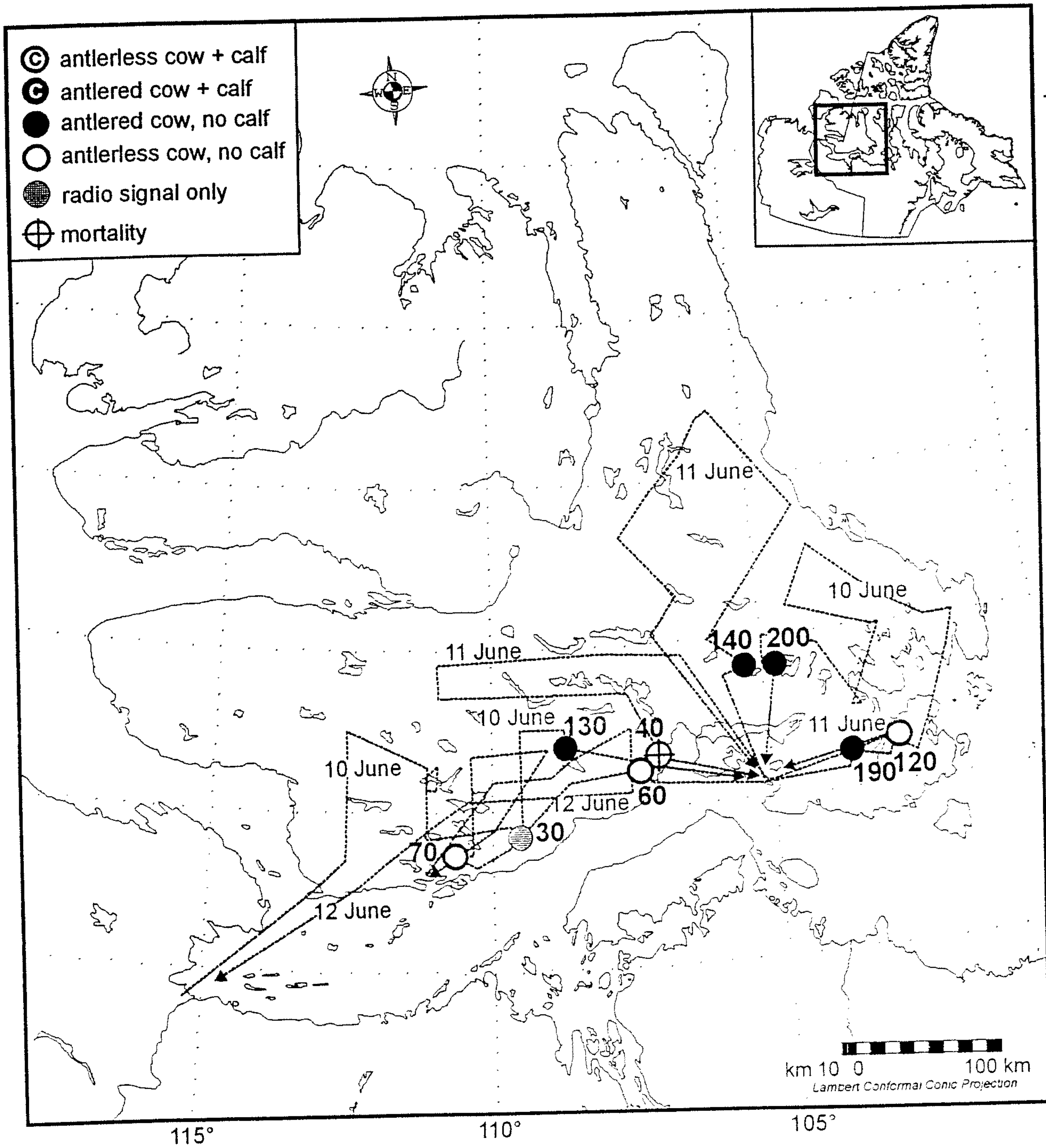

Figure 8. Flight lines and locations of nine radio-collared caribou cows on Victoria Island, 10 to 12 June 1997.

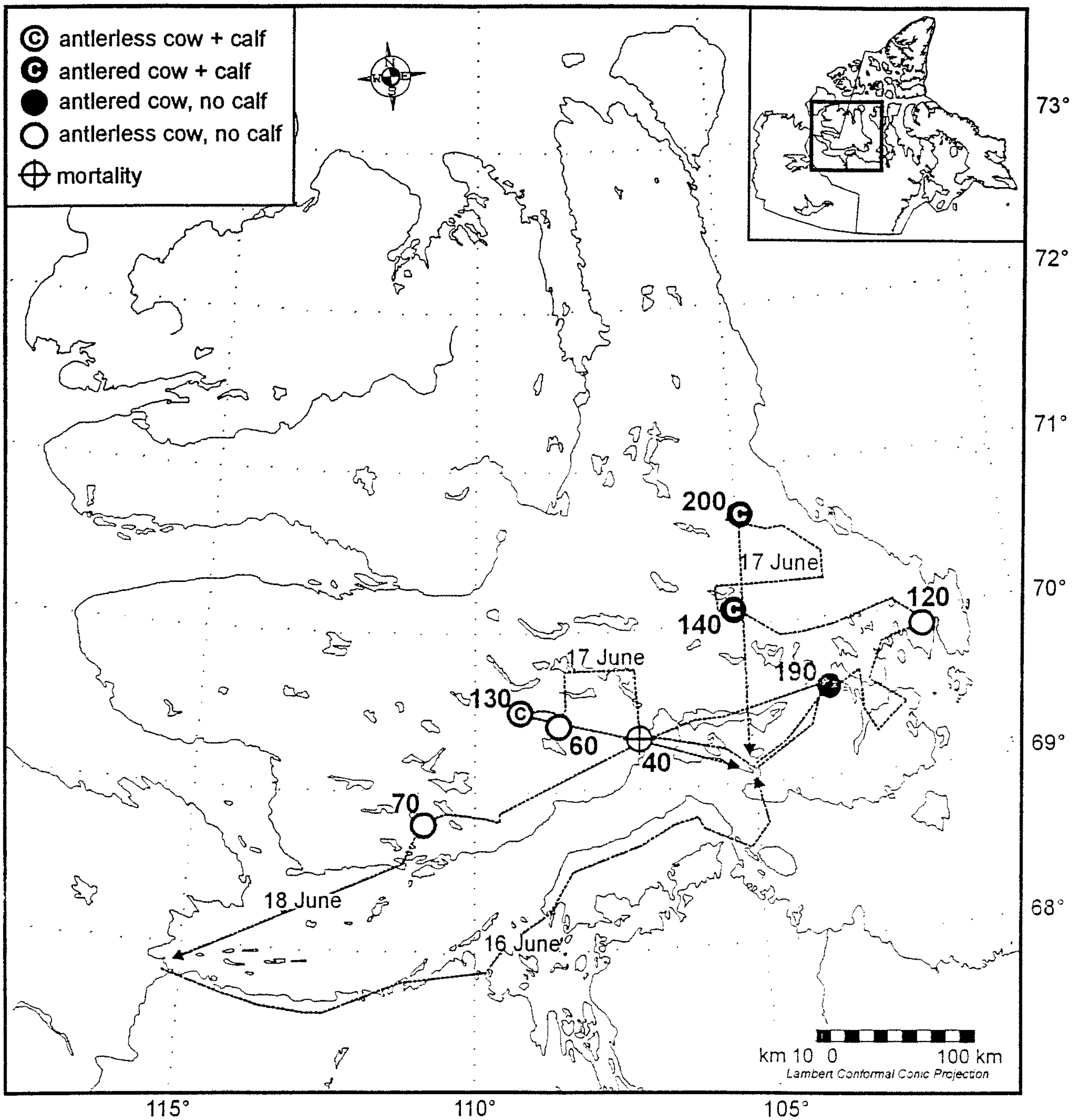

Figure 9. Flight lines and locations of eight radio-collared caribou cows on Victoria Island, 16 to 18 June 1997.

was extensive including southern, central, and eastern Victoria Island. Although subjective, the area encompassed by calving locations over the 3-year study period was *ca.* 54 540 km^2 (Figure 10).

Collared cows were found with newborn calves on the eastern portion of Wollaston Peninsula (cow 70) to areas east including Banning, Tahoe, and Washburn lakes (cows 30, 60, 130, 90, and 20). The north-central distribution included the general area between Tahiryuak Lake northeast to the southern extent of Hadley Bay (cows 130, 140 and 170), and the eastern distribution included Storkerson Peninsula (cows 180, 10, 160 and 200) down to Collinson Peninsula (cows 190 and 120) (Figure 10).

Fidelity to Calving Sites

To examine fidelity between annual calving sites, I visually determined calving status of 5 cows for 4 consecutive years (60, 70, 120, 130, and 190), 2 cows (140 and 200) for 3 consecutive years and 4 cows (10, 20, 90 and 180) for 2 consecutive years. Distance between calving locations, whereby a collared cow was accompanied by a newborn calf in successive years, was variable and ranged from 1 km to 230 km (n=5) (Table 5, Figure 10). Inclusion of distances between successive June observations of the same collared cow, but without a newborn calf, showed similar variability (distances ranged from 6 to 236 km, n=18) (Table 5, Figure 10). Of the cows observed successively for at least 3 years, mean distance between annual locations during calving was

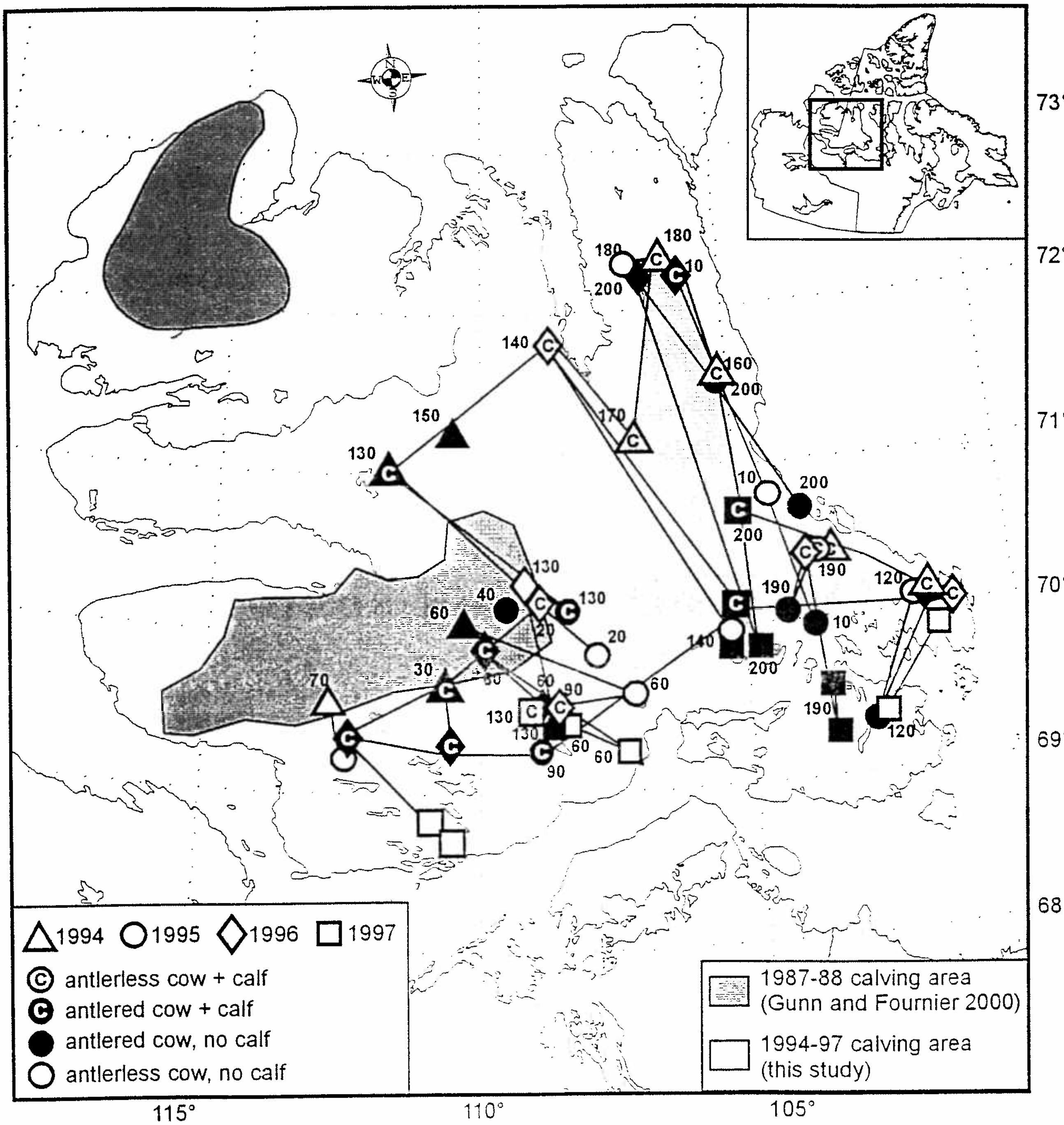

Figure 10. Distribution of calving locations from observations of radio-collared caribou cows (VHF telemetry 1994-1997) and calving areas in 1987 and 1988 (satellite telemetry).

Table 5. Distances (km) between successive June observations of collared Dolphin and Union cows, 1994–1997.

Cow	1994–1995			1995–1996			1996–1997			Mean distance	SD[b]
	Distance (km)	Time[a]	Direction	Distance (km)	Time	Direction	Distance (km)	Time	Direction		
60	129	E-E	SE	110	E-L	NW	79	L-L	SE	106	25
70	37	E-E	S	11	E-L	N	89	L-L	SE	46	40
120	6	L-L	W	24	L-L	E	19	L-L	SW	16	9
130	**167**[c]	E-E	SE	42	E-L	NW	93	L-L	S	101	63
190	**10**	L-L	W	**1**	L-L	--	90	L-L	S	34	49
140	--	--	--	236	E-L	NW	**230**	L-L	SE	233	4
200	--	--	--	94	L-L	NW	180	L-L	SSE	137	61
10	--	--	--	170	L-L	NNW	--	--	--	--	--
20	--	--	--	57	E-L	NW	--	--	--	--	--
90	--	--	--	**35**	E-L	NNE	--	--	--	--	--
180	17	L-L	W	--	--	--	--	--	--	--	--

[a] E-E: early June locations from both years
L-L: late June locations from both years
E-L: early June location in first year compared to late June location in second year
[b] Standard deviation
[c] Distances in bold indicate successive years in which a cow was accompanied by a newborn

lowest for cows 120 and 190 on Collinson Peninsula, and greatest for cows 140 and 200 (Table 5, Figure 10).

Directional shifts in calving locations from one year to the next were consistent for collared cows. Three cows (70, 60, and 130) in the western calving distribution during June 1994 were all located to the south and east during the following calving season in June 1995 (Table 5, Figure 10). Correspondingly, in June 1996, those cows were found to the north and west, and subsequently closer to their June 1994 locations (Table 5, Figure 10). Cows 140, 200, 10, and 20 demonstrated a similar directional shift to the north and west. The following June 1997, most collared cows were predominantly located to the south and east of their June 1996 locations (Table 5, Figure 10).

Calving Rates

Despite the small sample size of caribou observations, overall calving rates also showed interannual variability. By the 18 June 1994, calving by collared cows was essentially complete as 7 of 10 cows (70%) had a calf at heel and an additional 2 cows (20%) were antlered but with no calf yet (Figure 3, Table 3). Only 1 cow of 10 observed was considered a non-breeding female as she was antlerless and without a calf.

On 6-8 June 1995, the calving status of 11 cows was determined. Two of 7 antlered cows had calved and 4 cows were antlerless (Figure 4, Table 3). Ten days later, 3 more of the 7 antlered cows (10, 120, and 190) had calved – all 3 had lost their antlers but only Cow 190 was seen with a calf at heel. Those observations suggest that fewer cows successfully calved in 1995 (25%) than 1994 (70%).

Observations from June 1996 showed that calving rates were relatively high as 9 cows out of 11 observed (82%) had a calf at heel (Figures 6 and 7). One cow (200) still retained hard antlers but had no calf and the other cow (130) was antlerless and without a calf (Table 3, Figures 6 and 7). In June 1997, only 3 of 7 (43%) cows observed had a calf at heel. One cow of the 7 still retained hard antlers and did not have a calf, and the other 3 cows were antlerless and without a calf (Table 3, Figures 8 and 9).

Timing of calving also showed variability from one year to the next. Based on the relative number of collared cows observed during a telemetry flight in early or late June, and whether that cow had a calf at heel or was antlered or antlerless, results suggested that calving was completed earliest in June 1994 (Figure 11). A high proportion of antlerless cows with calves in June 1996 suggests that calving in that year was later than in 1994, but more advanced than in either 1997 or 1995 (Figure 11).

October Surveys

In October 1994, I used 16.1 hours in a Cessna 337 and 20.8 hours in a Helio-Courier to complete high altitude telemetry flights over southern Victoria Island (Appendix B, Figure 12). Another biologist (A. Gunn) assisted in those

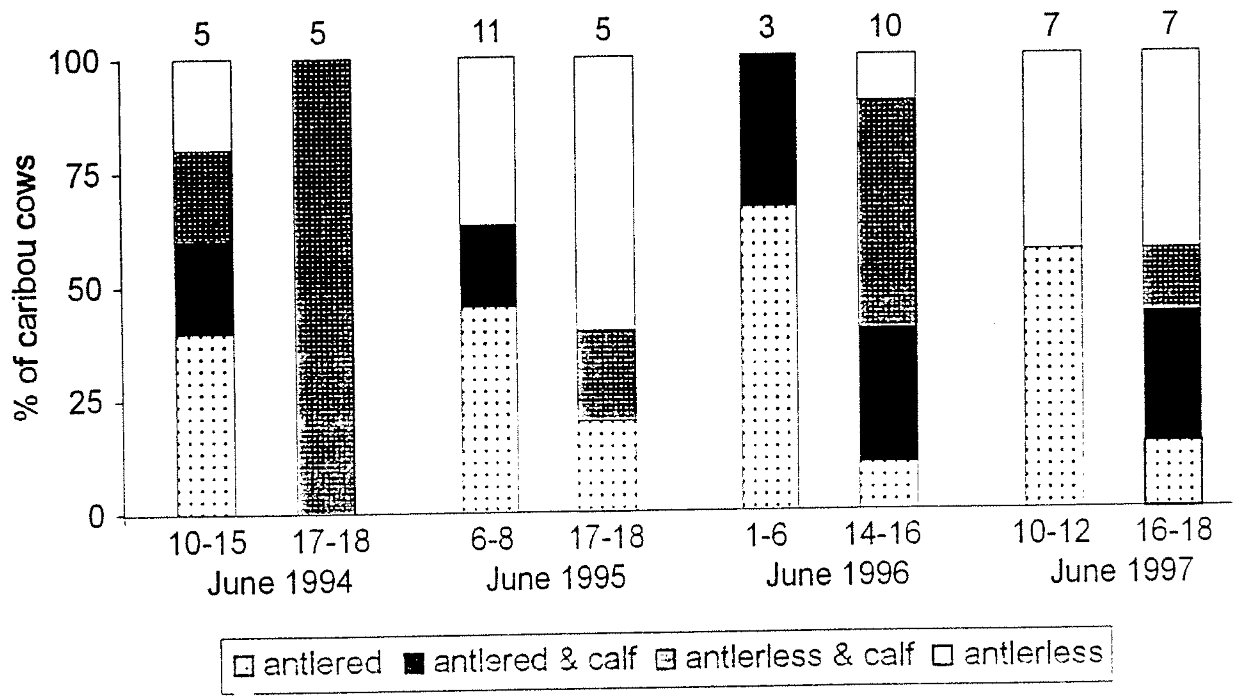

Figure 11. Percentage of radio-collared caribou cows characterized by reproductive status, Victoria Island, June 1994-1997. Respective sample sizes shown above bars.

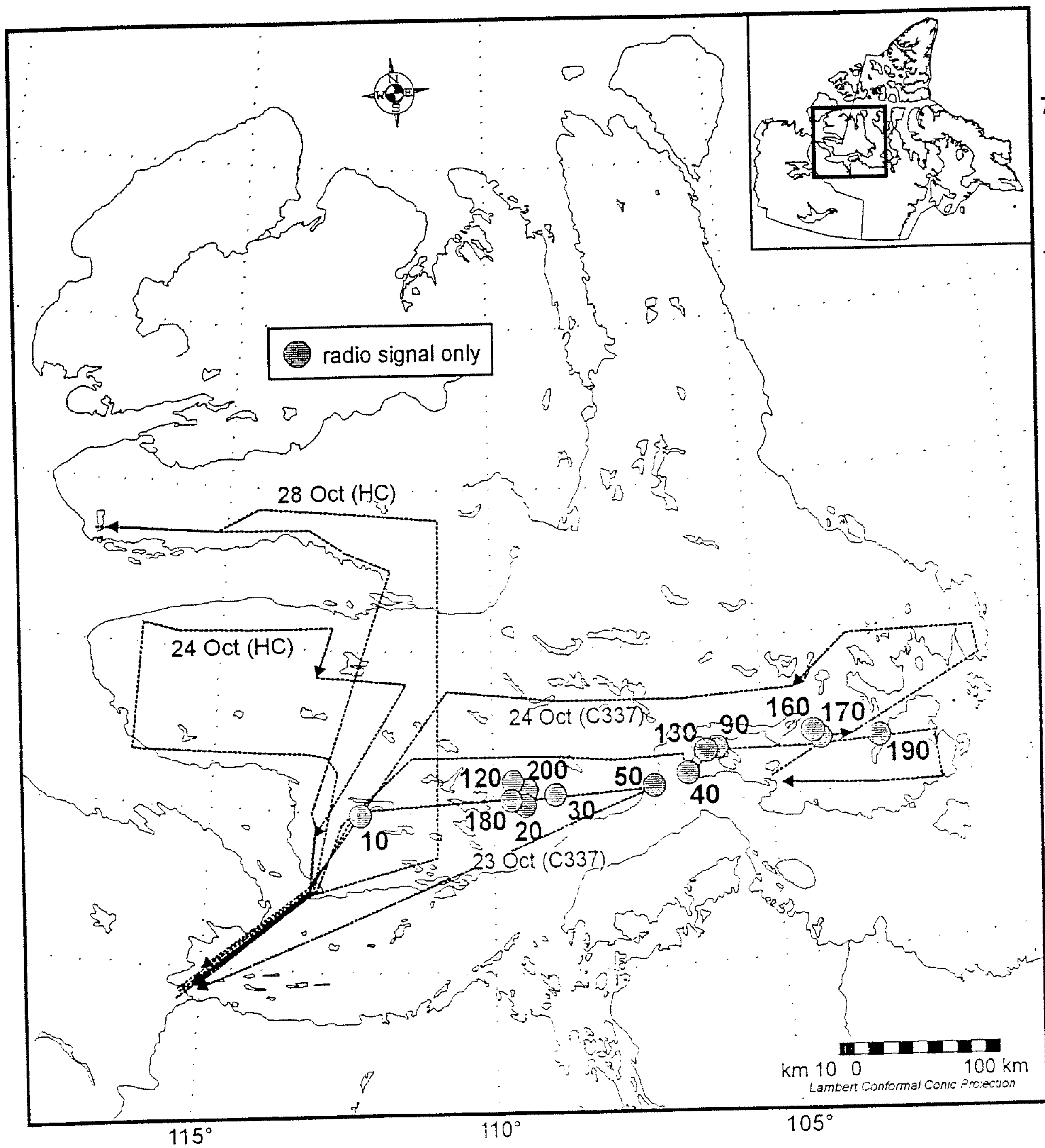

Figure 12. Flight lines and locations of 13 radio-collared caribou cows on Victoria Island, 23-28 October 1994.

telemetry flights so that both aircraft could be used simultaneously. Because of inclement fall weather, frequent IFR conditions, and ice formation on wings (due to repeated descent and ascent through cloudbanks), we were not able to observe any of those collared animals. Locations of those caribou were recorded at survey altitude. The distribution of fourteen collared cows was extensive along the entire southern coast of the island (Figure 12). I also surveyed the northern coastline of Prince Albert Sound because Holman hunters had reported caribou in that area (P. Ekpakohak pers. comm.)

From the 8–17 October 1997, a survey crew flew 19.2 hours to relocate and shoot remaining collared cows (Appendix B). The surveyed area mostly included the southern shoreline of Victoria Island (Figure 13). Nine cows out of a possible total of 12 collared caribou were shot. Cows 10, 20, and 170, were not found. Of the 9 collared caribou that were collected, cows 130, 180, and 190 were accompanied by calves; the calves of cows 130 and 180 were also shot. Condition indices of the collected caribou are shown in Table 6 and observations on the effects of the collars are described in Table 7.

VHF Radio-telemetry

Most radio-collars worked well and radio signals provided a predictable beacon to locate the transmitter. However, there were two radio-collar frequencies that were consistently unreliable: collars 10 (150.010 MHz) and 20 (150.020 MHz). More often than not, when a radio signal was detected on either

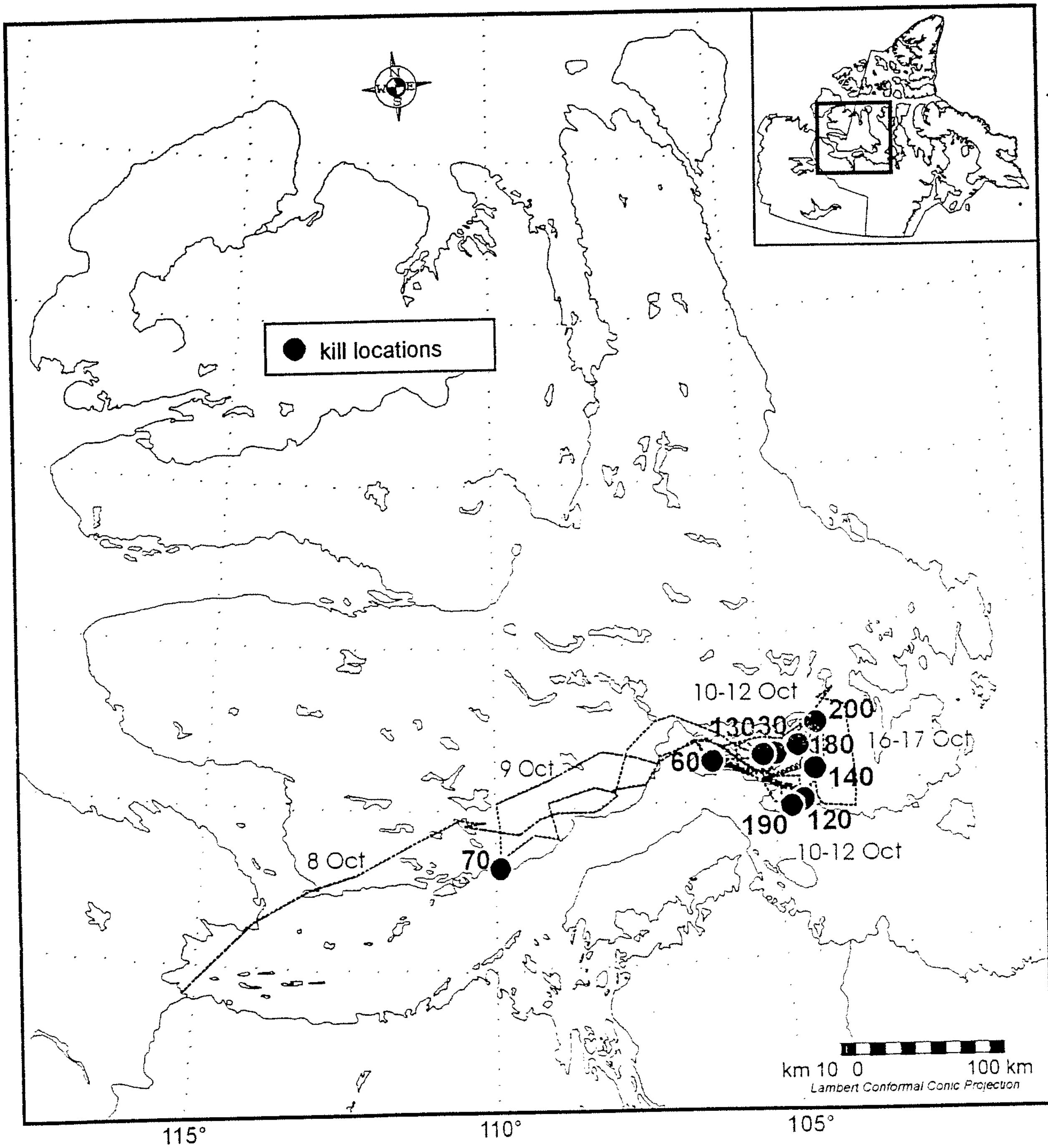

Figure 13. Flight lines and kill locations of radio-collared caribou on southern Victoria Island, 8-17 October 1997 (meat donated to Olokhaktomiut HTC).

Table 6. Condition indices of radio-collared Dolphin and Union caribou cows collected during 9 to 17 October 1997.

Collar No.	Kill Date	Depth of back fat (mm)	Kidney weight (g)	Total fat[b] weight (g)	Perirenal[c] fat weight (g)	Kidney fat index[d]	Kidney fat index[e]	Bone marrow (% fat)	Warbles	Collar play (mm)	Comments
70	9-Oct-97	25	96.5	45.6	35.5	36.8	47.3	94	320	20	Some hair frozen to collar
120	10-Oct-97	25	96.2	42.1	36.3	37.7	43.8	91	208	25	Some hair frozen to collar and rivets; 2 black lumps of greasy dirt in bottom inside of collar
190[a]	10-Oct-97	0	89.7	15.5	13.9	15.5	17.3	81	236	40	Some hair stuck to rivets, and frozen to collar
130	12-Oct-97	15	65.7	132.0	28.0	42.6	200.9	100	55	45	Some hair frozen to collar
130's calf	12-Oct-97	3	43.9	21.1	17.4	39.6	48.1	88			
30	12-Oct-97	20	87.9	35.9	28.9	32.9	40.8	88	450	43	Several lumps of ice sticking to fur on bottom inside of collar
60	16-Oct-97	35	90.0	50.0	40.6	45.1	55.6	92		38	Some hair on left side of neck that was easy to pull off, but did not result in a bald patch; possible shedding hair which had not fallen off
140	16-Oct-97	25	93.2	37.5	35.6	38.2	40.2	89	160	35	Some hair frozen to collar
180	17-Oct-97	30	109.8	121.5	54.6	49.7	110.7	93	48	45	Some hair frozen to collar
180's calf	17-Oct-97	1	41.7	28.2	15.8	37.9	67.6	88	0		
200	17-Oct-97	30	71.5	59.7	50.2	70.2	83.5	94	98	35	Some hair frozen to collar

[a] Cow 190 was accompanied by a calf but the calf was not harvested.
[b] Includes fat masses at ends of kidney.
[c] Only includes fat surrounding kidney; fat masses at ends of kidney were discarded.
[d] Kidney Fat Index as per Riney (1955): perirenal fat wt/kidney wt.
[5] Kidney Fat Index as per other authors (in Huot 1988): total fat wt (incl. end masses)/kidney wt.

Table 7. Gross necropsy and histopathology of neck skin on collared caribou.

Collar No.	Pathological diagnosis	Gross necropsy	Histopathology (miscroscopic anatomical changes in tissue)	Comments
190	Mild perivascular dermatitis	--	Mild thickening of skin; in 1 region, 2 hair follicles plugged with keratin; overall mild skin inflammation (perivascular infiltration of eosinophils (white blood cells) usu seen in response to allergic reaction); 2 areas with small mineralized structures in dermis	Can not ascribe these changes specifically to collar as many local and generalized conditions could produce mild dermatitis of this type. [a]
130	Skin atrophy – localized, severe	No gross lesions	2 sections taken: 1 normal & 1with severe atrophy of hair follicles & very few hair shafts; sebaceous glands severely atrophic; almost total cessation of normal hair growth	Atrophy in this case means that hair growth had stopped, many hairs have been shed and the skin glands have also "withered away". [a]
30	No abnormal findings	No gross lesions	--	--
60	Skin atrophy; superficial & deep dermatitis	Hair matted in linear pattern across neck; hair darker than normal; on skin surface, grey tint in pattern matching that of matted hair	2 sections examined: 1- hair shafts appear normal with mild skin inflammation in some parts; 2- areas with severe atrophy (like cow 130); skin inflammation	[a]
140	Skin atrophy	Hair matted in linear area across neck	In both sections there appears to have been atrophy of the adnexa (area joining hair to skin?), with occasional hair follicles dilated with keratin.	[a]
200	Dermatitis – localized, chronic, severe	--	1 section normal & 1 section – very severe superficial and deep skin inflammation; many follicles lack hair shafts & some contain excessive keratin; one pustule.	[a]

[a] The group of animals had a variety of skin changes that were impossible to interpret in relation to the radio collars because of poor sampling. To assess the skin properly, it would have been necessary to collect small samples of skin from directly under the collar, and from areas away from the collar for comparison together with similar skin sections from normal caribou at the same time of year.

of those frequencies, the signal would be lost upon descent and difficult to re-acquire after climbing back to initial survey altitude. On several occasions, these radio-collars would be detected and the signal would be lost on one day, only to repeat the occurrence the next day in a location several hundred kilometres away.

Distances between the initial radio-signal and observed caribou location varied considerably ($\bar{x}$=22.8 km, SD=11.7, Range=5.8 – 46.5 km, n=42: excluding collars 10 and 20) and there was no significant correlation between those distances and survey altitude (Figure 14). There was no significant difference between survey aircraft (Cessna 337 vs. Helio-Courier) in the distances between initial signal and caribou location (Kruskal-Wallis *H*=2.944, P=0.086, df=1).

The proportion of collared cows observed (seen at least once each June) relative to the number of collared cows assumed to be alive in June 1994, 1995, 1996 and 1997 was 50.0%, 85.7%, 78.6%, and 58.3% respectively (see Tables 3 and 4). That variability increased when each telemetry period was considered individually (range: 21.4% to 73.3%) (Table 4). The corollary was that the proportion of collared cows that were not found (i.e., neither observed nor detected through radio-telemetry) during an individual telemetry survey period ranged from 20.0% to 71.4% (Table 4). Calculated over the entire study period (June 1994–97), the proportion of collared caribou observed during a given telemetry period was 43.8% and those not found was 51.2% (Table 4).

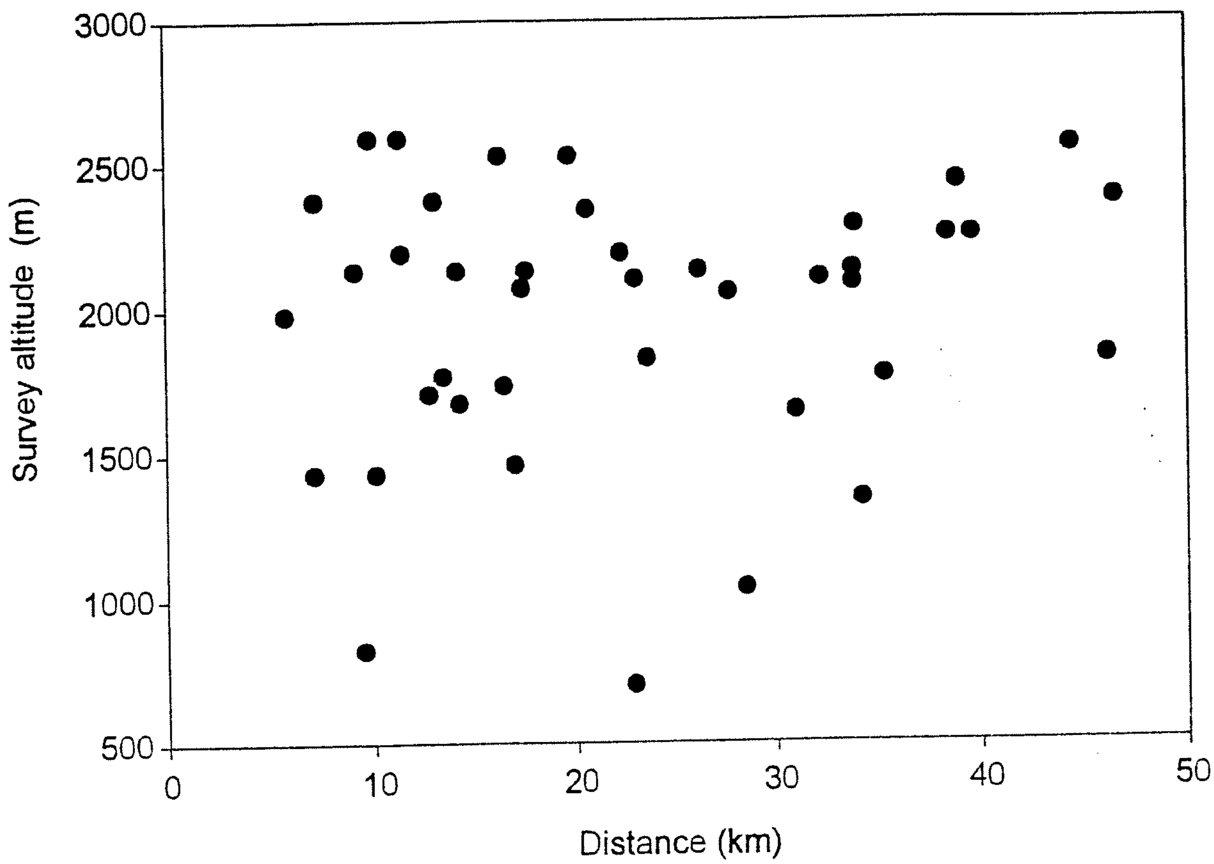

Figure 14. Correlation between survey altitude (m) above sea level and distance (km) from initial radio-signal to observed caribou location, 1994-1997 (Pearson's product-moment *r*=0.133, *P*=0.407, n=41).

DISCUSSION

The distribution of collared cows during calving 1994–97 was on a large and extensive traditional calving ground for Dolphin and Union caribou on Victoria Island (Figure 10). However, the radio-collar locations do not provide a defined boundary for the traditional calving ground on Victoria Island[4].

Using satellite collars on 10 caribou cows between 1987 and 1989, Gunn and Fournier (2000b) described two calving grounds on Victoria Island: Minto Inlet caribou calved on northwest Victoria Island and Dolphin and Union caribou calved on south-central Victoria Island. Although one of their collared cows consistently calved on Collinson Peninsula, Gunn and Founier (2000b) were not able to conclude whether she represented a separate herd or was part of the Dolphin and Union herd.

Radio-tracking between 1994 and 1997 (this report) extends the calving distribution for Dolphin and Union caribou to the east and north of that depicted by Gunn and Fournier (2000b) and suggests that there is a single continuous calving ground within southern Victoria Island (Figure 10). The observation that collared cows also aggregated along the southern coast of Victoria Island during the fall rut and prior to the mainland migration adds further strength to the assertion that those caribou comprise one herd.

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[4] Low caribou densities and the logistic difficulties associated with surveying an extensive spatial distribution of parturient females during a narrow temporal window confound an accurate delineation of calving ground boundaries on Victoria Island (Nishi and Buckland 2000).

Calving Distribution of Caribou Cows

Collared cows demonstrated fidelity to a calving area by returning to the same general areas on Victoria Island from one year to the next. Although this met the general definition of a traditional calving ground (see Gunn and Miller 1986), the spatial scale of this fidelity was variable among collared cows.

Gunn and Fournier (2000b) defined individual affinity to a calving site when a collared pregnant cow returned to the previous year's calving site or within an arbitrary 20 km of that site. This study showed that caribou cows exhibit fidelity to a calving area but at a courser and more variable landscape level. Cows 190 and 120, which showed the greatest affinity to Collinson Peninsula during the calving and early post-calving period, and cows 200, 140, and 130, which had the least affinity to a specific calving site, demonstrate the range of variability (Figure 10). Although some of the observed spatial variability in annual calving locations arose from a poor reference to actual calving date, the observations did provide a calving location that was robust enough to show that inter-annual calving site fidelity occurred at a spatial scale $\geq$ 20 km.

As the directional shifts in calving locations from one year to the next were predominantly along a north-south axis, it is likely that environmental factors along a latitudinal gradient played an important role in determining annual calving locations. However, with these data it is not possible to determine whether this observed pattern is more a result of individual behavioural fidelity or whether environmental variability plays a larger role in determining where cows calve and are located within their calving and post-calving range.

One possible explanation for inter-annual variability in calving sites is the relative distance a cow must travel to reach its "preferred" calving site once they migrate back to Victoria Island from winter range on the mainland. With reference to the southern coastline of Victoria Island, cows 130, 140 and 200 generally had to travel further north to calve than either cows 190 or 120. In this way timing of spring snowmelt and ease of travel may have a greater effect on the spatial variability of annual calving locations of those cows that had to travel further to reach their previous calving area.

Alternatively or in addition, trends in the timing of snowmelt and plant phenology may influence a cow's choice of calving sites. Earlier snowmelt, plant growth, arrival of migratory waterfowl at Walker Bay on Kent Peninsula, and a warming trend in spring temperatures at Cambridge Bay in the 1990s (R.G. Bromley unpubl. data) suggest that climatic changes have also occurred on southern Victoria Island. As such, increased variability in snowmelt patterns and associated timing of early plant growth may affect selection of calving locations by Dolphin and Union caribou.

Relative to Gunn and Fournier's (2000b) description of caribou calving grounds on Victoria Island in the late 1980s, the overall calving distribution of Dolphin and Union caribou during the mid 1990s has seemingly shifted northeast (this report) toward areas with later snowmelt and plant growth. To what level the influence of changing herd size since at least the 1980s has affected the directional shift is unknown. Shifts in calving distributions over decades have been documented for the Beverly and Bathurst caribou herds on the mainland (Sutherland and Gunn 1996, Gunn and Sutherland 1997).

Additional work is required to better understand the temporal and spatial dynamics of calving grounds for Dolphin and Union caribou. Gunn and Fournier (2000a) question whether the concept of traditional calving grounds applies directly to Dolphin and Union caribou. In agreement, I suggest that our definition and understanding of traditional calving grounds needs to be improved to better reflect the diversity of caribou behaviour and ecology on calving grounds on the arctic islands. Much of what we know about calving grounds has been learned through studies of barren-ground caribou (Fleck and Gunn 1982, Gunn and Fournier 2000a, and see Ferguson 1999). We must consider and better understand the adaptive capabilities of arctic-island caribou and their ability to respond to environmental changes and long-term changes in population density in their environment in order to arrive at a more complete understanding of their calving ecology. This will require long-term studies of arctic-island caribou on their calving grounds.

As exploration activities to identify economic deposits of mineral resources increase, there will be continued need to monitor the spatial and temporal dynamics of caribou calving grounds on Victoria Island. This information will be required to assist with mitigation and land use planning on caribou calving grounds in the West Kitikmeot (Nunavut Planning Commission 1998). In the mean time, the approach to land use planning and activity on southern Victoria Island should be conservative (Gunn and Fournier 2000a).

October Surveys

The distribution of Dolphin and Union caribou was aggregated along the southern coastline of Victoria Island during the fall rut in October. The migration of caribou brought them to the coastline during the rut, which immediately preceded their migration across the sea-ice to winter range on the mainland. Observations during the fall telemetry flights and reconnaissance surveys suggested that the highest densities of caribou during the year occurred during this fall staging period along the coastline. Consequently, when caribou were collected in October 1997, we used the distribution of collared cows to design an aerial survey of the fall rut distribution to estimate herd size (Nishi and Gunn in prep.). The method of surveying the fall rut distribution allowed effective stratification, and resulted in a relatively precise estimate (Nishi and Gunn in prep.). However, as this is a novel approach to estimating herd size (standard caribou census methods have either emphasized surveys of calving grounds or post-calving aggregations), additional work will be required to assess its accuracy.

Specifically, the inherent assumption that fall rut distribution along the shoreline represents the entire herd remains to be tested. As Holman hunters report that low densities of caribou are present along the northern coastline of

Prince Albert Sound in winter, it will be important to determine whether those animals represent a resident segment or a different herd altogether.

VHF Telemetry

Based on the early difficulties with locating all collared caribou in June 1994 and in October 1994, I did not deploy the additional 20 VHF collars in April 1995 and 1996 respectively. The use of VHF collars to locate Dolphin and Union caribou was logistically difficult because calving date (and location) had to be determined by either observing a collared cow with a newborn calf at heel, or inferring calving date based on reproductive status of the cow over the calving period. To determine calving date and location as accurately as possible, each collared cow had to be observed twice during the calving period.

Given the extensive distribution of collared cows in June, it was not possible to find and observe all live caribou in one telemetry period (ca. 25 hours). Therefore the decision to allocate sampling effort during a second telemetry period involved a trade-off between finding remaining caribou and determining whether they were alive or dead, or relocating and observing a caribou for a second time. The net result was infrequent data on the reproductive status of every collared cow. The proposal to deploy an additional 40 VHF collars in 1995 and 1996 (DRR 1993) would have magnified this problem.

Another confounding issue in finding collared cows was the possibility that an animal not found in the search area could have died anywhere within the herd's annual range. Since the annual range of Dolphin and Union caribou extends as far south as Brown Sound and Bathurst Inlet (A. Kapolak pers. comm., B. Patterson unpublished data, Gunn *et al.* 1997), and as far north as Stefansson Island (this report), a dead collared caribou could be completely outside the search area and never be found. Alternative explanations for a cow not being found (Table 3) were that the radio transmitter failed, that she calved outside the surveyed area, or that the telemetry flight lines were too far apart to achieve 100% coverage within the search area and the collared animal was missed.

In summary, in the case of migratory Dolphin and Union caribou on Victoria Island, standard VHF collars are not the technique of choice for determining the distribution of parturient cows on calving grounds. The method is compromised by logistical and technical considerations. First, because of unpredictable weather and the sheer size of Victoria Island, there is uncertainty in being able to locate collared cows. Secondly, one or even two visual relocations of a sample of radio-collared cows may not be well referenced temporally to peak of calving for the population of breeding females. Similarly, information obtained during the calving period on the location and reproductive status of collared cows alone may not provide good data on discreteness of an annual calving area for a population of breeding cows. In short, the information gained from VHF collars relative to cost and effort is low because all search effort is required to relocate collared cows during calving.

Satellite collars are a practical solution for collecting data on calving distribution and seasonal movements of migratory Dolphin and Union caribou cows. Although the initial cost of satellite collars would be much greater than the same number of VHF collars, the benefits of remote data collection, programmable duty cycles, and frequency and quality of location data outweigh initial cost considerations (Fancy *et al.* 1989, Fancy and Whitten 1991, Gunn and Fournier 2000b). At the time of writing this report in 2000, a study using 20 satellite-collared caribou had been initiated on Dolphin and Union caribou in October 1999 (B. Patterson pers. comm.).

Caribou Capture

The most stressful phase for a caribou during a capture using a hand-held net-gun is during the helicopter chase and secondly during the period of time between when the net is dropped and when the animal is restrained. Upon proper restraint (i.e., blindfolding and hobbling), the respiration rate declines rapidly during the first few minutes and seems to resume a normal resting rate (J. Nishi pers. obs.).

Based on this capture experience, I suggest that a Bell 206L should not be used for future capture work. The poor low-level manoeuvrability inherent to this aircraft makes it less than ideal for helicopter-based capture work (J. Revenboer pers. comm.). Helicopters more suitable for capture work would be the Bell

206B or Hughes 500. Any options that may minimize time to capture caribou, i.e., stress, and risk to personnel should be considered; this includes the obvious prerequisite of a skilled, experienced pilot and suitable helicopter, or preferably the use of a professional capture crew.

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APPENDIX A. Helicopter flight log for caribou capture, April 1994.

Date: 23– 30 April 1994
Aircraft: Bell 206 Long Ranger (G-LMV)
Pilot: J. Revenboer
Engineer: J. Kaminski
Crew: J. Nishi, W. Nakashook, M. Williams

Date	Fuel purchased (l)	Hours Flown
23 April	173	1.8
24 April	--	--
25 April	327	5.6
26 April	557	7.5
27 April	617	6.1
28 April	650	6.0
29 April	--	--
30 April	235	--
TOTAL	**2559**	**27.0**

APPENDIX B. Caribou radio-tracking trip reports and flight logs, Victoria Island, 1994–1997.

Date: 10–13 June 1994
Aircraft: Cessna 185
Pilot: K. Williams
Crew: J. Nishi, P. Panegyuk, K. Niptanatiak
Altitude: 120 m

Trip report

Date	Routing	Hours Flown
10 June	Search signal during systematic aerial survey (0944h–1003h) (located and observed cow 60)	0.3
11 June	Search signal during systematic aerial survey (2000h–2015h) (cow 50, signal only)	0.3
13 June	Search signal during systematic aerial survey (located and observed cow 70)	0.5
	TOTAL hours	**1.1**

Date: 15–18 June 1994
Aircraft: Helio-Courier
Pilot: P. Linton
Crew: J. Nishi, L. Buckland
Altitude: 5000 feet

Trip report

Date	Routing	Hours Flown
15 June	YCO to Wynniatt Bay (located and observed cows 30, 130, and 150)	3.3
17 June	Albert Edward Bay – Cambridge Bay (YCB) (1846h–2130h)	2.7
18 June	YCB – Shaler Mtns. / Wynniatt Bay (1018h–~1730h)	7.2
18 June	Wynniatt Bay – Fort Ross (1920h–2300h)	3.7
	TOTAL hours	**16.9**

Appendix B. *continued*

Date: 23, 24 and 28 October 1994
Aircraft: Cessna 337
Pilots: L. Burkowski, E. Mass
Crew: A. Gunn (23 Oct), J. Nishi (24 Oct)
Altitude: 2500–6000 feet

Trip report

Date	Routing	Hours Flown
23 Oct	Norman Wells (YVQ) – Kugluktuk (YCO)	2.5
23 Oct	YCO – Lady Franklin Point – survey – YCO (1600h–1920h)	3.3
24 Oct	YCO – S Victoria Island – Cambridge Bay (YCB) (1047h–1417h)	3.5
24 Oct	YCB – Collinson Pen. – S Victoria Island - YCO (1520h–1935h)	4.3
25 Oct	YCO – YVQ	2.5
	TOTAL hours	**16.1**

Aircraft: Helio-Courier H-295
Pilot: P. Linton
Crew: A. Gunn (24 Oct), J. Nishi (28 Oct)
Altitude: 2500–6000 feet

Trip report

Date	Routing	Hours Flown
23 Oct	YVQ to YCO	3.5
24 Oct	Kugluktuk (YCO) – SW Victoria Island – YCO	5.8
28 Oct	YCO – Holman (YHI) (0930h–1330h)	4.0
28 Oct	YHI – Prince Albert Sound – Lady Franklin – YCO (1400h–1748h)	3.8
29 Oct	YCO to YVQ	3.8
	TOTAL hours	**20.9**

Appendix B. *continued*

Date: 6–8 June 1995
Aircraft: Cessna 337
Pilot: L. Burkowski
Navigator: J. Nishi
Observers: P. Panegyuk, J. Mackenzie, N. Kaniak
Altitude: 6000–8000 feet

Trip report

Date	Routing	Hours Flown
6 June	Norman Wells (YVQ) – Kugluktuk (YCO)	2.5
6 June	YCO – Cambridge Bay (YCB) (1400h–1806h)	4.1
7 June	YCB – Collinson Pen. – YCB (1007h–1417h)	4.2
7 June	YCB – Tahoe Lake – YCB (1502h–1932h)	4.5
8 June	YCB – Wollaston Pen. – YCO (0925h–1319h)	3.8
8 June	YCO – Wollaston Pen. – Lady Franklin – YCO (1440h–1717h)	1.6
8 June	YCO – Wellington Bay – YCB (1746h–2156h)	4.2
	TOTAL hours	**24.9**

Date: 17–19 June 1995
Aircraft: Helio-Courier H-295
Pilot: P. Linton
Navigator: J. Nishi
Altitude: 6000–8000 feet

Trip record

Date	Routing	Hours Flown
17 June	Cambridge Bay (YCB) – Collinson Pen. – YCB (1400h–1830h)	4.5
18 June	YCB – Collinson Pen. – Storkerson Pen. – Stefansson Isl. (1025h–1510h)	4.8
18 June	Stefansson Isl. – Storkerson Pen. – Hadley Bay fuel cache (1720h–1921h)	2.0
18 June	Hadley Bay fuel cache – Shaler Mountains – Holman (YHI) (1945h–2331h)	3.8
19 June	YHI – Wollaston Pen. – Kuglukguk (YCO) (0002h–0214h)	2.2
19 June	YCO – Norman Wells (YVQ) (1300h–1630h)	3.5
	TOTAL hours	**20.8**

Appendix B. *continued*

Date: 1–6 June 1996
Aircraft: Cessna 337
Pilot: J. Downy
Crew: J. Nishi (1 Jun.), P. Panegyuk (1–6 Jun.)
Altitude: 6000–8000 feet

Trip record

Date	Routing	Hours Flown
1 June	Norman Wells (YVQ) – Kugluktuk (YCO)	2.6
1 June	YCO – Cambridge Bay (YCB) (1609h–1923h)	3.5
2 June	East/north Victoria Island (1216h–1645h)	4.5
3 June	YCB – Prince Albert Sound (1009h–1436h)	4.5
3 June	YCB – NE to N Victoria Island (1629h–1952h)	3.4
4 June	YCB – YCB (Started surveying and had to return due to bad weather)	3.0
5 June	YCB – Prince Albert Sound – Cape Baring – YCO (1844h–2218h)	3.6
6 June	YCO – Prince Albert Sound – east – south – YCO (1420h–1844h)	4.4
	TOTAL hours	**29.5**

Appendix B. *continued*

Date: 14–16 June 1996
Aircraft: Helio-Courier H-295
Pilot: P. Linton
Navigator: J. Nishi
Altitude: 6000–8000 feet

Trip record

Date	Routing	Hours Flown
14 June	QMG camp site – Nelson Hills Cabin (1407h–1432h)	0.4
14 June	Nelson Hills Cabin – Cambridge Bay (YCB) (1456h–1709h)	2.2
15 June	YCB – Collinson Pen. – Hadley Bay (0835h–1405h)	5.5
15 June	Hadley Bay – Storkerson Pen. – YCB (1442h–1919h)	4.6
16 June	YCB – Washburn Lake – L. Franklin – Kugluktuk (YCO) (0855h–1702h)	8.1
16 June	YCO – Norman Wells (YVQ) (1730h–2100h)	3.5
	TOTAL hours	**24.3**

Appendix B. *continued*

Date: 10–12 June 1997
Aircraft: Cessna 337
Pilot: A. Bailes
Crew: J. Nishi, D. Panayi & G. Corey
Altitude: 6000–8000 feet

Trip record

Date	Routing	Hours Flown
9 June	Norman Wells (YVQ) – Kugluktuk (YCO)	2.3
10 June	YCO – Lady Franklin – Wollaston Pen. – Cambridge Bay (YCB) (1130h–1535h)	4.0
10 June	YCO – Collinson Pen. – Albert Edward Bay – YCB (1711h–2110h)	4.0
11 June	YCB – Collinson Pen. – YCB (0915h–1037h)	1.5
11 June	YCB – Zeta Lake – Washburn Lake – YCB (1109h–1541h)	4.5
11 June	YCB – Tahoe Lake – Kagloryuak River – YCB (1725h–2009h)	2.7
12 June	YCB – Cape Peel – Byron Bay – Ross Point (0902h–1242h)	3.7
12 June	Ross Point – Cape Peel – Lady Franklin – YCO (1311h–1549h)	2.6
12 June	YCO – YVQ	2.5
	TOTAL hours	**27.8**

Date: 16–18 June 1997
Aircraft: Helio-Courier H-295
Pilot: P. Linton
Crew: D. Panayi
Altitude: 6000–8000 feet

Trip record

Date	Routing	Hours Flown
16 June	Norman Wells (YVQ) – Kugluktuk (YCO)	3.5
16 June	YCO – Kent Peninsula & Melbourne Is. – Cambridge Bay (YCB) (1815h–2113h)	3.0
17 June	YCB – heading NE – YCB (0930h–1530h)	6.0
17 June	YCB – heading W – YCB (1905h–2210h)	3.1
18 June	YCB – YCB (1030h–1430h)	4.0
	TOTAL hours	**19.6**

Appendix B. *continued*

Date: 8–17 October 1997
Aircraft: Helio-Courier H-295
Pilot: P. Linton
Crew: D. Panayi, D. Amegainek
Altitude: 8500–1000 feet

Trip record

Date	Routing	Hours Flown
7 Oct	Norman Wells (YVQ) – Kugluktuk (YCO)	3.5
8 Oct	YCO – Lady Franklin Point – Cambridge Bay (YCB) (1445h–1807h)	3.4
10 Oct	YCB – YCB (0920h–1050h)	1.5
10 Oct	YCB – Albert Edward Bay (1145h–1450h)	3.1
10 Oct	Albert Edward Bay – YCB (1520h–1600h)	0.7
11 Oct	YCB – survey and collection – YCB (1000h–1035h)	0.6
12 Oct	YCB – survey and collection – YCB (1130h–1236h)	1.1
16 Oct	YCB – survey and collection – YCB (1235h–1435h)	2.0
16 Oct	YCB – survey and collection – YCB (1500h–1713h)	2.2
17 Oct	YCB – survey and collection – YCB (0907h–1135h)	2.5
17 Oct	YCB – survey and collection – YCB (1200h–1408h)	2.1
	TOTAL hours	**22.7**

APPENDIX C. Locations (degrees/minutes north latitude and degrees/minutes west longitude) of radio-collared Dolphin and Union cows during calving, June 1994 to 1997.

Collar no.	June 1994 Early (10-15 June)	June 1994 Late (17-18 June)	June 1995 Early (6-8 June)	June 1995 Late (17-18 June)	June 1996 Early (1-6 June)	June 1996 Late (14-16 June)	June 1997 Early (10-12 June)	June 1997 Late (16-18 June)
00	not heard[a]	not heard	68°36' 104°28'(M)[c]	--	--	--	--	--
10	not heard	not heard	69°55' 103°46'	70°45' 104°28'	70°32' 107°35'(S)	72°12' 105°49'	not heard	not heard
20	not heard	not heard	69°50' 107°51'	not heard	not heard	70°10' 108°58'	not heard	not heard
30	69°40' 110°42'	not heard	not heard	not heard	69°16' 110°36'	not heard	68°51' 109°33'(S)	not heard
40	not heard	not heard	70°08' 109°32'	not heard	69°03' 111°25'(S)	not heard	69°15' 107°05'(MS)	69°15' 107°05'(MS)
50	71°10' 108°46'(S)[b]	not heard	68°42' 106°44'(MS)	--	--	--	--	--
60	70°01' 110°19'	not heard	69°35' 107°14'	not heard	69°36' 108°47'	69°53' 109°57'	69°14' 107°21'	69°25' 108°25'
70	69°34' 112°45'	not heard	69°15' 112°30'	not heard	not heard	69°20' 112°37'	68°43' 110°40'	68°49' 110°56'
90	not heard	not heard	69°13' 108°58'	not heard	not heard	69°30' 108°36'	69°07' 105°11'[d]	--
100	not heard	not heard	not heard	73°38' 105°49'(M)	--	--	--	--
110	not heard	69°40' 103°42'(S)	68°51' 105°44'(MS)	--	--	--	--	--
120	not heard	70°04' 101°48'	69°16' 102°51'	70°05' 101°57'	70°06' 101°38'	70°00' 101°23'	69°19' 102°47'	69°53' 101°44'
130	71°01' 111°51'	not heard	70°05' 108°21'	not heard	not heard	70°19' 109°12'	69°23' 108°41'	69°29' 109°07'
140	not heard	70°18' 107°59(S)	69°57' 105°25'	not heard	not heard	71°39' 108°35'	69°49' 105°22'	70°04' 105°10'
150	71°15' 110°30'	not heard	68°12' 106°03'(MS)	--	--	--	--	--
160	not heard	71°32' 105°18'	68°40' 106°44'(MS)	--	--	--	--	--
170	not heard	71°11' 107°01'	not heard	not heard	not heard	not heard	not heard	not heard
180	not heard	72°18' 106°23'	not heard	72°15' 106°52'	not heard	not heard	not heard	not heard
190	not heard	70°24' 103°30'	70°01' 104°13'	70°24' 103°46'	not heard	70°24' 103°45'	69°13' 103°32'	69°36' 103°31'
200	not heard	not heard	70°39' 103°48'	71°28' 105°06'(S)	not heard	72°12' 106°40'	69°48' 104°49'	70°41' 104°59'

[a] Signal from collar was not heard during radio-tracking flights.
[b] M – mortality - collar retrieved; S – signal; MS – mortality signal.
[c] 26 May 1995 collar found on ice.
[d] Killed by hunter on 17 October 1996.

APPENDIX D. An aerial reconnaissance of the southern coastline of Victoria Island to investigate a report of drowned caribou (22 October 1996).

In October 1996, I received a report that several hundred caribou had fallen through thin ice just offshore by Cape Peel. The report was made by Canadian military personnel who had flown by helicopter to the Dewline sites on southern Victoria Island west of Wellington Bay for routine inspections (G. Corey pers. comm.). As a Twin Otter was situated in Kugluktuk at the time, I flew the southern coastline of Victoria Island to verify the report (Table D1).

We departed Kugluktuk at 1244 h on 22 October 1996. After arriving at Lady Franklin Point, we proceeded to fly eastward along the coastline towards the Richardson Islands. Survey altitude was 150 m. A left observer (C. Adjun) counted all caribou within a narrow strip along the shoreline (ca. 500–700 m), and a right observer (J. Kuneyuna) scanned the right side of the shoreline for sign of caribou fallen through the sea-ice. I also monitored the known frequencies of radio-collared caribou cows with a telemetry receiver, to determine if any of those animals were situated along the shoreline; radio telemetry antennae were mounted to the lower wing struts of the Twin Otter.

We observed scattered groups of caribou along the shoreline, with most animals travelling towards the east. When we arrived at the Richardson Islands, we came upon the first evidence of caribou that had fallen through thin sea ice but only observed 4 caribou actually in the water and attempting to get out. From the survey aircraft, we observed 8 trails within the newly formed sea ice north of Edinburgh Island (the largest island of the Richardson Islands archipelago). The trails of broken ice had been formed where a caribou had fallen through and swam a winding, and sometimes circuitous, route to find stronger and thicker ice onto which it could climb out of the water.

As we flew east of the Richardson Islands, the density of caribou along the shoreline remained fairly constant. When we passed east of the Byron Bay Dewline Site (ca. 68°45'N 109°05'W), the density of caribou increased dramatically. Between the Dewline site and Cape Peel (ca. 69°03'N 107°16'W), we counted 4736 caribou along the shoreline (Figure D1). Most groups were walking eastward, although some were heading westward and some were bedded in groups along the shoreline. There were caribou and tracks on newly formed sea ice, but we did not observe any large numbers of broken ice trails which would have indicated that many caribou had fallen through the ice. We did not see any carcasses floating in the sea and partially frozen in the ice.

As we approached Cape Peel, the number of caribou along the shoreline decreased. Between Cape Peel and midway up Wellington Bay, we counted 98 muskoxen and only 39 caribou. We flew directly across Wellington Bay to the mouth of the Ekalluk River. From Ekalluk River to the Finlayson Islands, we observed 76 muskoxen and no caribou (Figure D1). We observed several small herds of caribou walking on the sea-ice towards the Finlayson Islands. The ice was not continuous south beyond the Finlayson Islands and we observed 6 caribou that had fallen through the dark and translucent ice (between Duncan and Uhahitak Islands: the two largest islands of the Finlayson Islands archipelago) and were swimming to get out.

The shoreline patrol of the Augustus Hills and adjacent coastline between the Finlayson Islands and the Cambridge Bay airport resulted in a count of 615 caribou.

In total we counted 6172 caribou and 272 muskoxen, and detected radio-collars #40, 20, 10, 60, and 30 during the shoreline patrol (Figure D1). We landed in Cambridge Bay at 1550 h and departed at 1633 h after re-fuelling. On our return flight, we flew offshore ca. 1–3 km (depending on the extent of ice from the coastline) at 150 m above sea level from Cape Peel to Ross Point to verify whether caribou had fallen through the ice further offshore. We did not observe live caribou, tracks, or carcasses in the broken pans of newly formed sea-ice. However, we did observe 45 broken ice trails in the narrow strait east of Edinburgh Island. We returned to Kugluktuk at 1840 h.

Table D1. Trip record for flight along coastline of southern Victoria Island

Date: 22 October 1996
Aircraft: Twin Otter
Pilot: B. Knutsen & A. Bloemhof
Crew: J. Nishi, J. Kuneyuna, C. Adjun
Altitude: 450 feet
Study Area: southern coastline of Victoria Island

Date	Routing	Hours Flown
22 Oct 96	YCO – Lady Franklin – Byron Bay – Cape Peel – YCB	3.1
22 Oct 96	YCB – Cape Peel – PIN 4 – Ross Point – YCO	2.1
	TOTAL hours	**5.2**

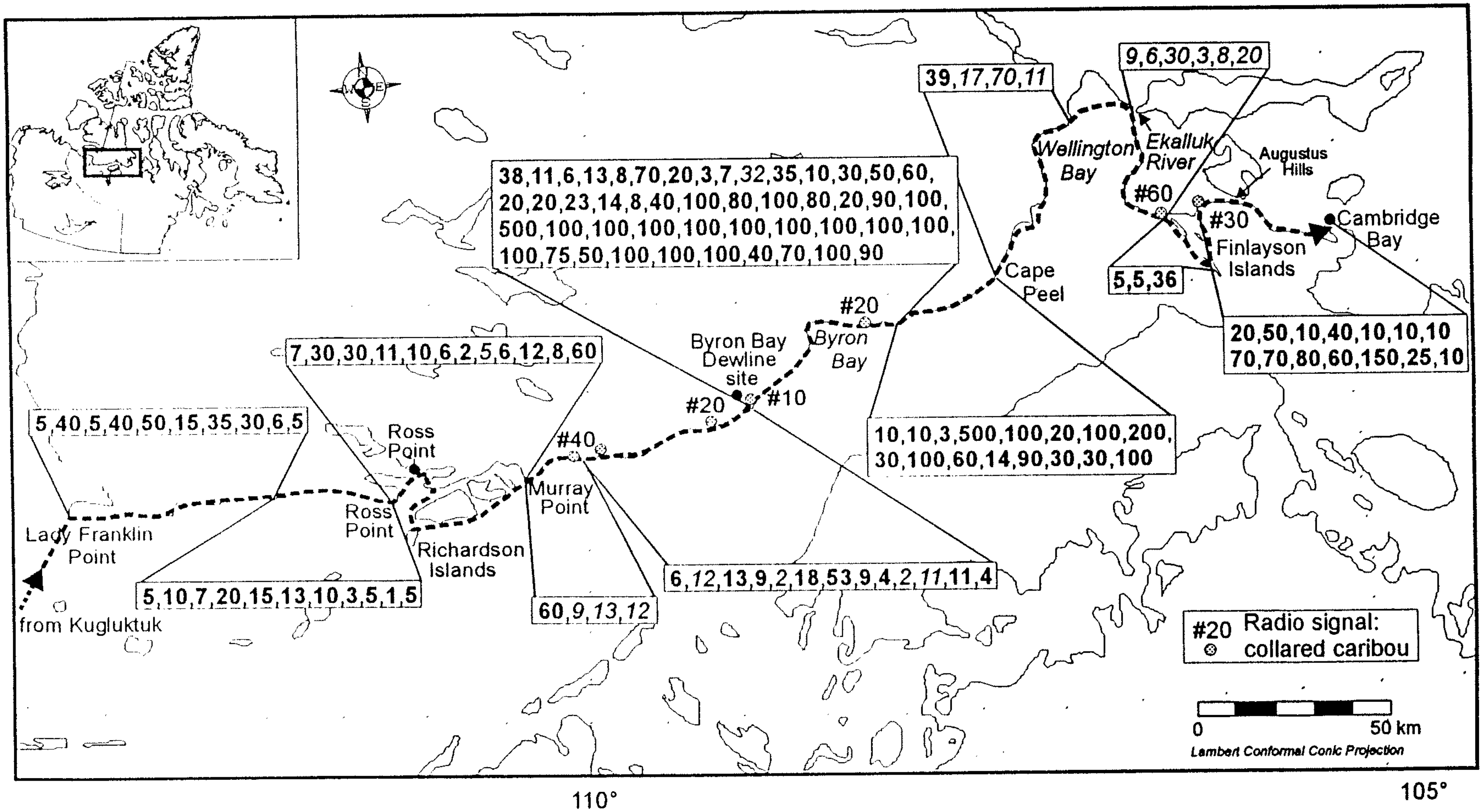

Figure D1. Group sizes of caribou (bold) and muskoxen (italics) along the south coast of Victoria Island during an aerial reconnaissance to investigate a report of drowned caribou, 22 October 1996.