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CALVING DISTRIBUTION, INITIAL PRODUCTIVITY AND NEONATAL MORTALITY OF THE PORCUPINE CARIBOU HERD, 1983

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The most common technique used to evaluate caribou calf mortality is aerial survey to measure the chronology and over-all magnitude of caribou calf mortality on an annual basis (Kelsall 1968, Davis et. al. 1980). The gregarious nature of parturient and post-parturient females and the relatively high level of calving synchrony exhibited by migratory caribou, contribute to the utility of aerial survey methods (Bergerud 1974, Dauphine and McClure 1974). The achievement of accurate calf mortality estimates, however, is often complicated by difficulties in identification of age and sex classess from the air and by frequent mixing of barren females and non-productive yearlings with productive females (Miller and Broughton 1974). Another problem is that comparative cow-calf ratios developed from aerial survey data do not provide information on causes of mortality or the spatial and temporal distribution of that mortality.

Intensive searches for calf carcasses using helicopters for low-level flight over calving and post-calving areas have provided data on causes and spatial distribution of neonatal caribou calf mortality (Miller and Broughton 1974, Miller et al. 1983). However, this technique only provides data on mortalities that are found and does not provide an inference base for overall calf mortality within a given year. Recently, techniques using expandable neck collars with attached mortality sensing radio-transmitters have produced improved data on neonatal mortality rates and factors for several species of ungulates (Cook et al. 1967, 1971, Logan 1972, Beale and Smith 1973, Garner et al. 1976, Schlegel 1976, Franzmann and Peterson 1978, Franzmann et al. 1980, Ballard et al. 1981, Bjarvall and Franzen 1981).

The feasibility of using mortality sensing radiotransmitters with expandable neck collars on neonatal caribou calves of the Porcupine Caribou Herd was tested during 1982 (Mauer et al. 1983). Test results indicated that the technique was feasible, and movements of individual neonates could be followed to detect and locate mortalities in a timely manner which enables collection of information relative to cause of death. The test also confirmed that the technique provided means to obtain detailed data on the chronology and geographic location of mortalities and that potential exists for inferences on over-all mortality rates of calves in the population. The feasibility study identified logistical requirements and strategies necessary to successfully collect caribou calf mortality data using radio telemetry techniques.

ANILCA requires the evaluation of potential adverse effects that oil and gas exploration, production, and development on ANWR might have upon the Porcupine caribou herd. In addition, if petroleum development on ANWR is allowed, more information on caribou distribution and habitat use during the calving and post-calving periods is needed to formulate recommendations for leasing schedules, placement of facilities, and other mitigative measures. In particular, causes and patterns of calf mortality need to be examined with emphasis on differences among areas or habitat types, in order to assess the possible effects of displacement from development sites.

Based upon the results of the feasibility study, a 3 year investigation of caribou calving distribution, initial productivity, and neonatal calf mortality was initiated in 1983 as a joint project between the Arctic National Wildlife Refuge, U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game.

Objectives for this study are as follows:

A. Primary

1. Delineate distribution of the Porcupine caribou herd calving as part of a continuing effort to collect baseline information on wildlife resources in the portion of ANWR open to petroleum exploration; identify any annual consistencies in calving distribution and/or common characteristics among separate calving areas.

2. Determine initial calf production and extent, causes, and chronology of mortality among neonatal calves (i.e., 4-6 weeks postpartum).

3. Measure variation in calf mortality and calf mortality factors between core and peripheral areas and/or between different habitat types or localities.

B. Secondary

1. Provide productivity data for analysis of herd status.

2. Identify characteristics (i.e., habitat, snow ablation patterns, topography, etc.) of core and peripheral calving areas and/or calving areas in different habitat types or localities.

3. Provide additional collared caribou for concurrent studies of overwinter calf survival and seasonal movements.

4. Provide incidental observations of other species as part of the overall ANWR baseline studies, including casual or incidental locations of radio-collared muskoxen and bears.

This study is being conducted concurrently with studies of the status (population size, and trend), overwinter calf mortality, and winter distribution of the Porcupine Caribou Herd. Adult caribou collared in conjunction with those studies aid in the conduct of this investigation. Collectively this study is a part of a comprehensive environmental inventory and assessment of the potential petroleum developement area of ANWR. This report presents preliminary findings of the 1983 field season.

Methods and Materials

Study Area

The study area consists of the north slope of ANWR and may extend east to the Blow River in Canada and south to the southern slopes of the Brooks Range, depending on annual variations in caribou distributions. In 1983, the study area extended from the Kaktakturuk River on the west to the Firth River in Canada on the east, and from the continental divide in the Brooks Range on the south to the Beaufort Sea coast on the north.

Most study activities occurred on the coastal plain and foothills portions of the area described above. Descriptions of the physical environment,

climate, geology, vegetation, and other wildlife resources of the study area are found in U.S Fish and Wildlife Service (1982). Logistical operations were based at Kaktovik, Alaska.

Age Determination

The new hoof measurement described by Haugen and Speake (1958) for aging neonatal white-tailed deer (Odocoideus virginianus) fawns was investigated for use in aging neonatal caribou calves. In late April, 3 known age reindeer calves of a captive reindeer herd at the University of Alaska-Fairbanks campus were repeatedly measured for new hoof length. Each distal hoof on both forelegs was scribed to standardize the measurements and calves were measured daily from 21 April-17 May. In late May, 6 caribou calves were captured from the Delta caribou herd and transported to the University of Alaska-Fairbanks by Alaska Department of Fish and Game personnel. Each calf was examined and an estimated age was determined using criteria described by Miller (1972). Each caribou calf had the distal hoof of both forelegs scribed as above and University personnel measured new hoof length intermittently until late June. Regression analysis was used to determine the relationship between new hoof length and age in reindeer and caribou calves.

Calving Distribution and Initial Productivity

General calving distribution was determined primarily by locating all radio-collared adult female caribou in the Porcupine Herd during late May and early June. All radio-tracking was conducted from aircraft equipped with standard tracking equipment (Telonics, Mesa, AZ.). Radio-tracking flights during calving distribution surveys were usually at altitudes greater than 1,000 m AGL. Low altitude (20-100 m AGL) aerial searches were also conducted to identify calving caribou.

Low-level transects were flown in fixed-wing aircraft over the areas where collared cows were located. Strong, easterly winds blew almost every day during calving period, and groundspeed consequently varied greatly between east and westbound flight lines. In areas of low caribou density, essentially all caribou within approximately 300 m of the flight line were counted and classified. In high density areas, and especially on downwind transects, only partial counts of caribou could be obtained, and only newborn calves and adults were classified.

Transects were also flown by helicopter to determine age/sex composition of caribou in an area of particularily high density. During these helicopter transects, all caribou within approximately 400 m of each flight line were counted and classified. In addition to determining caribou distribution and density, these surveys also provided data on initial productivity on the calving grounds. Observations of antler shedding (Lent 1965, Epsmark 1971), udder distention (Bergerud 1964), and calves at heel of radio-collared cows and unmarked cows in certain areas provided information on the progression of calving.

High altitude radio-tracking flights over the northern part of the winter range, and over the mountains and coastal plain east of the calving areas were conducted to determine the distribution of bulls and yearlings during calving. These surveys were coordinated and data were exchanged with

Canadian Wildlife Service personnel who were concurrently monitoring the distribution and movement patterns of bull caribou during spring migration.

Neonatal Mortality

Caribou calves were captured from a high density area of calving females located in the lower foothills and adjacent coastal plain along the Jago River in the Arctic National Wildlife Refuge (Fig. 1). Two calf capture sites were selected in the lower foothills portion of the high density area near VABM Bitty, 1 on the east side of the Jago River (foothills-east) and 1 on the west side (foothills-west). Two capture sites were also selected on the coastal plain portion of the high density calving area (coastal plain-north and coastal plain-south). These sites were located between the Jago and Okpilak Rivers approximately 20 km south of Barter Island.

Caribou groups were approached by helicopter (Hughes 500 D) with a capture crew of 3 persons aboard. The helicopter landed approximatedly 200 m from the caribou and 1 person took a sitting position on the left skid. The helicopter then proceeded towards the group and a calf was selected for capture. Selection from groups was standardized (calf on extreme right) to minimize sampling bias for slower, younger, and/or weaker calves.

The selected calf was pursued by flying approximately 1 m above the ground. When the helicopter was within 2-3 m of the running calf, the person on the skid stepped off to the side, ran, and grasped the calf. Sterile surgical gloves were worn by personnel handling captured calves and were discarded after each handling. When a calf was captured, the helicopter landed and the remaining members of the capture crew assisted in processing the calf.

Captured calves were sexed (Bergerud 1961), weighed, and measured for total body length, right hind foot length, and new hoof length (Haugen and Speake 1958). Characteristics of the umbilicus (moist, dry, absent), and hooves (degree of wear), were noted as described by Miller and Broughton (1974). Each calf was examined for abnormalities and fecal samples were collected from those calves with scours.

An expandable white elastic collar supporting a mortality sensing transmitter (Telonics Inc., Mesa, Az.), weighing approximately 114 g was installed around the neck of each calf. Mortality mode for transmitter units was a doubling of normal pulse rate following a 1 hour motion free period. Estimated battery life was 15 months. Each collar was constructed from 3.75 cm wide elastic band. Adjustment of the initial collar size at installation was achieved by fastening the left and right ends of the elastic collar band together with aluminum "pop" rivets. Three separate expansion folds per collar were sewn with incremental amounts of cotton thread stitching. Each expansion fold provided an additional 7 cm of collar circumference. Maximum expansion circumference of each collar was 53 cm. Collars were constructed to breakaway after the last expansion fold was used.

Helicopter-supported ground observers were used to observe reunion of cow-calf pairs following release of calves captured in portions of the foothills areas. The helicopter capture crew noted cow/calf reunions on the coastal plain area and frequent aerial relocations using fixed-wing aircraft were used to monitor reunions during the capture operation.

Aircraft (PA-18) equipped with standard radio tracking equipment were used to monitor instrumented calves, locate mortalities, determine calf locations, and movements. In those cases in which the capture crew did not observe an immediate reunion of the calf with its dam, aerial relocation and visual checks were made at 1-3 hour time intervals following release. All calf radio frequencies were monitored for mortality signals at least once daily and visual locations or locations to caribou group were made for each calf every other day from 4 June to 2 July 1983. Relocation surveys were conducted on a monthly basis from July through November 1983. All visual and group locations were plotted on a 1:250,000 scale topographic map.

All mortalities were investigated as soon as possible using a helicopter for access. Each carcass and mortality site was examined for information on the cause of death. Photographs were taken to document mortality sites. Evidence of predators/scavengers at the carcass site were noted and collected. Each carcass was placed in a plastic garbage bag, labeled, and frozen for later study. Laboratory necropsies were performed on carcasses when sufficient remains were present. In cases where only hair and bones remained, measurements of weight, right hind foot length, and new hoof length were recorded whenever possible. The location of retrieved carcasses was plotted on 1:250,000 scale topographic maps. Criteria for determining the category (Cook et al. 1971) and the cause of each mortality (Table 1) were developed from descriptions of predator kills and feeding characteristics in the literature (Murie 1948, Thompson 1949, Johnson 1951, Borg 1961, Atwell 1954, Mech 1970, Wiley and Bolen 1971, Alford and Bolen 1972, Cole 1972, White 1973, Miller and Broughton 1974, Bolen 1975, Henne 1975, Miller 1975, Mysterud 1975, Buskirk and Gipson 1978).

Carcasses of unmarked calves encountered during this and other field studies were also examined as opportunity allowed. The locations of predators observed on the calving grounds were noted and observations of interactions between caribou and predators were recorded. Concurrent field studies of brown bear ecology on the coastal plain of ANWR also provided additional information relative to this study (Phillips 1984, Garner et al. 1984).

The mortality rate of calves from the 23 radio-collared control cows were compared to the mortality rate of the study calves. The control females were radio-tracked in late May and early June 1983 as they arrived on the calving grounds and their locations were plotted on 1:250,000 scale topographic maps. Parturition status was determined by low-level aerial observations of the presence/absence of young, antler shedding (Lent 1965, Epsmark 1971), and udder distention (Bergerud 1964). Following parturition, productive members of the control group were monitored on a 24-72 hr basis until approximately 2 July.

Results and Discussion

Age Determination

New hoof length measurements (NHL) on 3 reindeer calves were linearly related to age in days (Fig. 2) and the correlation coefficient was statistically significant ($p < 0.01$, $n = 112$). The relationship between new hoof length and age in days for 6 caribou calves (to 18 days estimated age) was also significant ($p < 0.01$, $n = 32$), however there was more

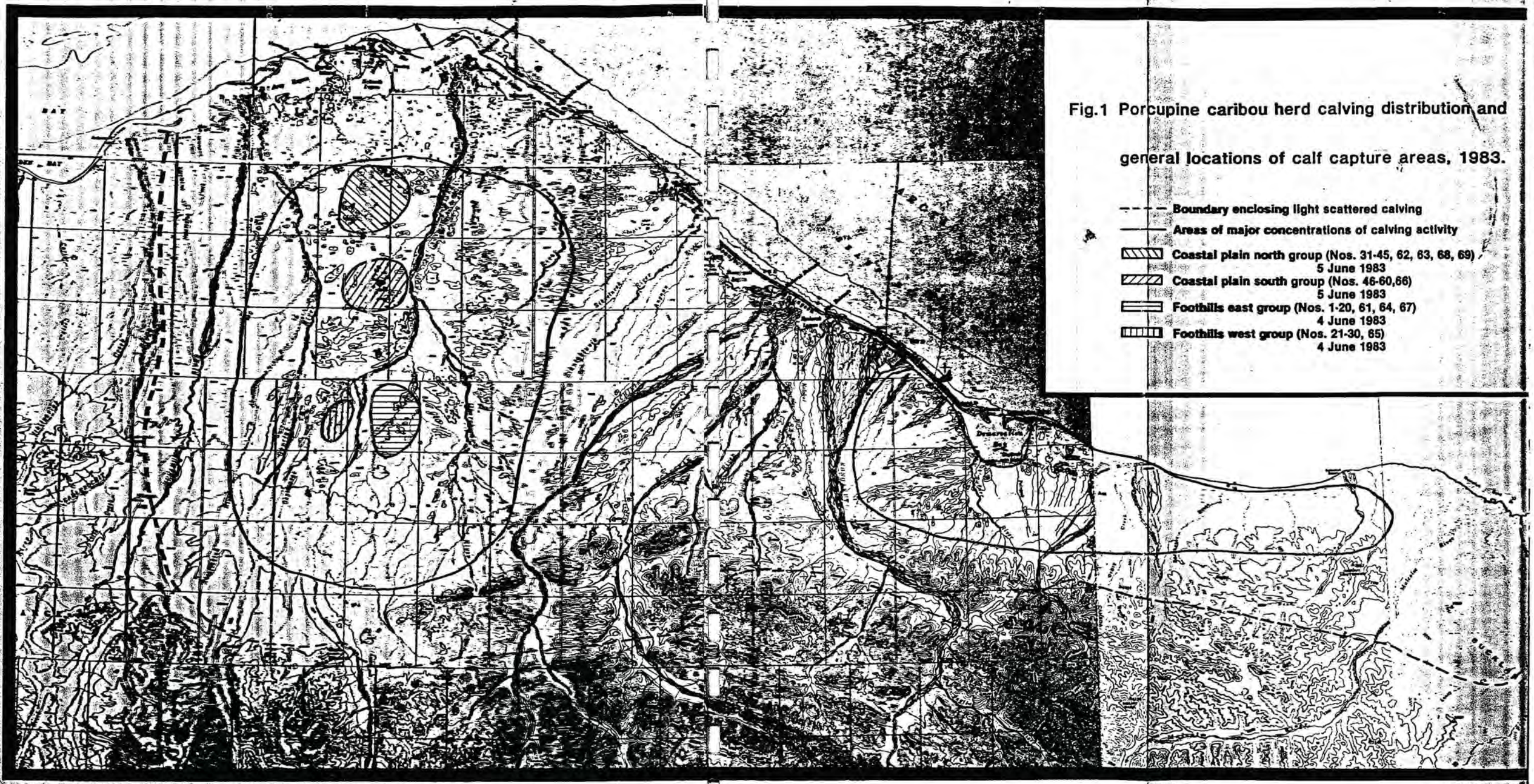
Fig.1 Porcupine caribou herd calving distribution and general locations of calf capture areas, 1983.
Boundary enclosing light scattered calving
Areas of major concentrations of calving activity
Coastal plain north group (Nos. 31-45, 62, 63, 68, 69)
5 June 1983
Coastal plain south group (Nos. 46-60,66)
5 June 1983
Foothills east group (Nos. 1-20, 61, 64, 67)
4 June 1983
Foothills west group (Nos. 21-30, 65)
4 June 1983

Table 1. Criteria for determining category of observed mortalities of neonatal caribou calves.

Criterion	Category
I. Carcass lacks sign of being bitten, chewed, or disturbed by predators.	I. Predation-excluded
1. Milk curds absent in abomasum and intestinal tract. Lack of mesentery and subcutaneous fat. Rumen may be packed with vegetation.	1. Starvation
a. No reunion with dam observed following release and subsequently observed unattended by dam prior to death.	a. Probable study-induced abandonment
b. Reunion with dam observed following release but later observed unattended by dam prior to death.	b. Probable natural abandonment
2. Milk curds present or absent from abomasum or intestinal tract. Mesentery and subcutaneous fat present. Absence of any signs of starvation.	2. Exposure
3. Disease syndrome present, or disease syndrome noted at capture.	3. Disease
4. None of the above.	4. Undetermined
II. Carcass bitten, chewed, and/or partially eaten.	II. Predation/scavenging involved.
A. Lack of blood in wounds, lack of frothy blood in nares and trachea, no bruises surrounding tooth marks, or no subcutaneous hemmorrhages present.	A. Scavenging
1. Bones gnawed and chewed, feeding pattern generally not restricted to the upper portion of carcass.	1. Mammalian scavenger(return to I.1 to determine cause of death)
2. Bones not chewed, feeding limited to upper portions of carcass.	2. Avian scavenger (return to I.1 to determine cause of death)
3. Neither of the above, or some characteristics present from both.	
B. Blood in wounds, frothy blood in nares and trachae bruises surrounding wounds and sub-cutaneous hemmorrages present.	B. Predation
1. Debilitating physical disorder, or disease syndrome present.	1. Predator kill & other factors.
2. No debilitating physical disorder or disease syndrome present.	2. Predator kill.
a. Talon wounds on back and sides of body. Talon wounds on neck. Only upper portion of carcass fed upon. Ribs broken off at backbone. Leg bone usually intact.	a. Golden eagle kill.
b. Teeth wounds on neck, sides or legs. Carcass fed upon extensively, bones chewed and carcass parts scattered.	b. Mammalian predator.
c. Extensive trauma to carcass. Large portions of carcass missing. Bones broken or crushed. Skull crushed. In older calves, rumen not consumed.	c. Brown bear.
d. None of the above.	d. Undetermined predator.

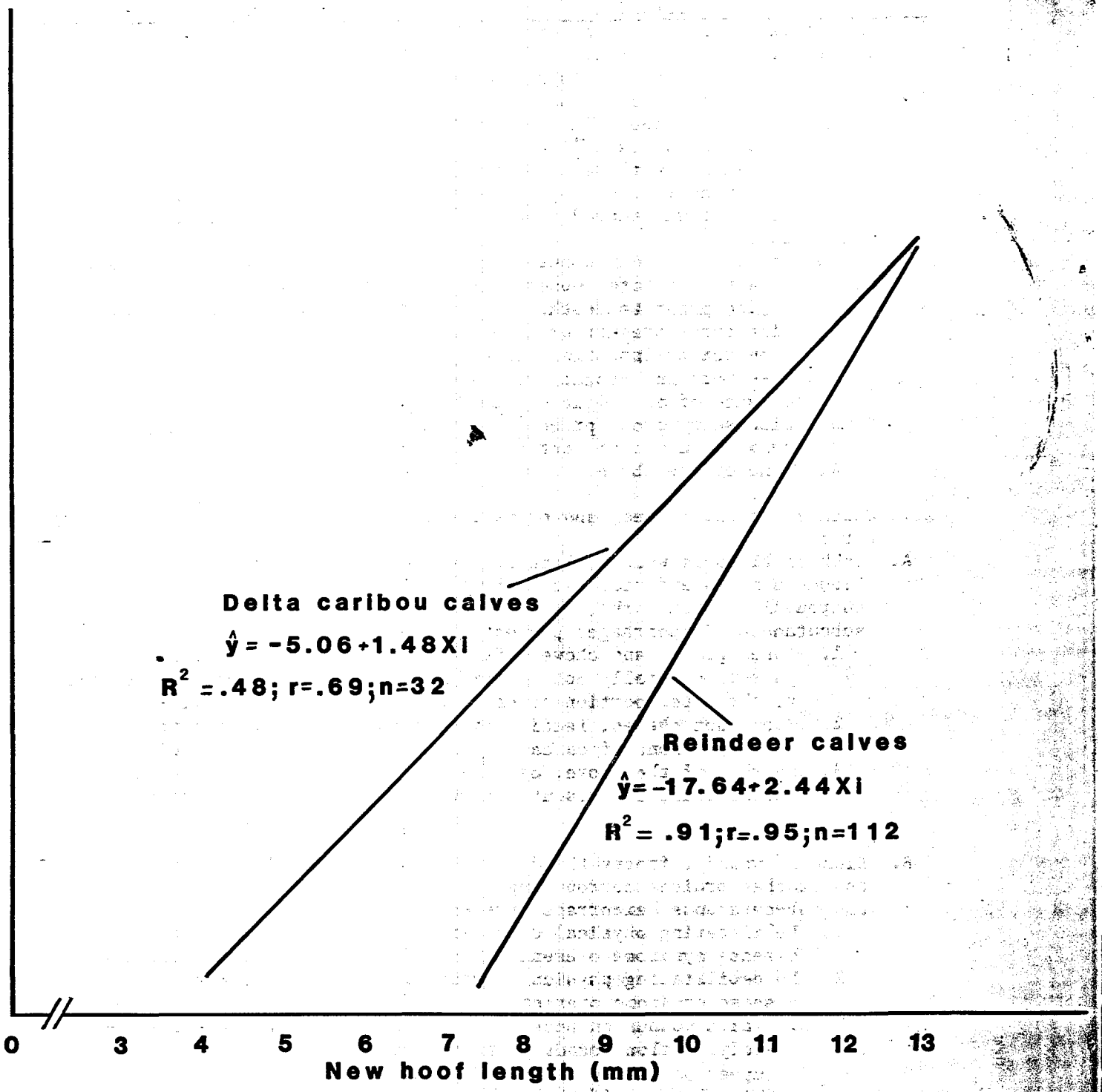

Fig.2 Relationships between new hoof growth (mm) and age in days of 3 captive reindeer calves and 6 captive caribou calves, University of Alaska-Fairbanks, 1983.

Table 1. Physical characteristics and survival related observations of radiocollared caribou calves, Arctic National Wildlife Refuge, 1983.

Calf no.	Date	Sex	Weight (kg)	Length (cm)	Hind foot length(cm)	New hoof length(mm)	Umbilicus condition	Hoof condition[a]	Estimated age[b]	Handling time(min)	Cow-calf reunion[c]	Status
1	4 June	F	5.7	80	33.0	7.1	Moist	PH/W	1	12	No	Dead (5 June)
2	4 June	F	6.1	81	32.4	7.4	Dry	PH/W	1	11	Yes(>3.52-7.77)	Alive (16 Oct)
3	4 June	M	6.0	83	33.0	7.3	Moist	PH/W	1	6	Yes(>3.25-7.68)	Unknown/collar cast(28 Oct)
4	4 June	F	5.2	72	31.0	7.3	Moist	PH/W	1	4	Yes(<4.18)	Alive(19 Oct)
5	4 June	M	8.4	87	36.0	9.2	Dry	AH/W	4	4	Yes(>8.43-49.95)	Unkown/collar cast(31 July)
6	4 June	F	6.0	81	33.4	8.1	Absent	AH/W	2	4	Yes(<2.77)	Mortality signal (19 Oct)
7	4 June	-	-	73	32.3	7.2	Dry	AH/W	1	3	Yes(>2.78-6.97)	Dead (16 Oct)
8	4 June	F	7.2	83	33.9	8.9	Moist	PH/W	3	4	Yes(<2.60)	Alive (16 Oct)
9	4 June	-	7.5	88	34.2	8.3	Dry	AH/W	3	3	Yes(<2.60)	Alive (17 Oct)
10	4 June	M	7.4	77	34.0	9.1	Dry	AH/W	4	4	Yes(<2.47)	Alive (17 Oct)
11	4 June	M	7.9	78	36.0	7.7	Dry	AH/W	2	5	Yes(<2.85)	Alive (7 July)
12	4 June	M	6.3	76	33.2	7.7	Absent	AH/	2	4	Yes(<3.78)	Alive (23 July)
13	4 June	M	8.5	87	35.2	9.2	Moist	AH/W	3	8	Yes(<3.65)	Alive (7 July)
14	4 June	F	7.8	81	34.0	8.5	Dry	AH/W	3	[illegible]	Yes(<3.65)	Dead (30 July)
15	4 June	F	6.5	77	35.5	8.2	Moist	AH/W	3	4	Yes(>7.45-22.2)	Alive (7 July)
16	4 June	F	7.7	88	35.5	8.7	Moist	AH/W	3	4	Yes(<2.93)	Alive (16 Oct)
17	4 June	M	7.1	77	32.5	9.1	Dry	AH/W	4	4	Yes(<0.08)	Alive (24 Oct)
18	4 June	M	7.1	74	33.0	8.4	Absent	AH/W	3	3	No	Dead (6 June)
19	4 June	-	6.2	77	33.0	7.7	Absent	AH/W	2	4	Yes(<2.73)	Alive (7 July)
20	4 June	M	9.3	82	35.0	9.5	Absent	AH/W	5	3	Yes(<0.08)	Dead (3 Aug)
21	4 June	F	7.3	84	34.0	8.5	Absent	AH/W	3	3	Yes(>3.30-18.00)	Alive (16 Oct)
22	4 June	M	6.6	73	32.3	8.4	Dry	AH/W	3	8	Yes(<3.35)	Alive (24 Oct)
23	4 June	F	5.7	76	32.5	7.2	Absent	AH/W	1	7	Yes(>3.27-17.85)	Alive (16 Oct)
24	4 June	F	5.6	75	30.5	7.5	Dry	AH/W	2	3	Yes(<3.32)	Alive (24 Oct)
25	4 June	F	6.7	82	34.5	7.5	Dry	AH/W	2	3	Yes(<3.23)	Mortality signal(16 Oct)
26	4 June	F	5.8	81	35.0	7.2	Moist	AH/W	1	3	Yes(>2.45-16.70)	Alive (26 Oct)
27	4 June	M	5.7	77	33.0	9.0	Moist	AH/W	3	3	Yes(>2.1?-16.48)	Alive (24 Oct)
28	4 June	F	8.4	83	33.5	9.1	Dry	-	4	3	No	Dead (6 June)
29	4 June	M	8.2	84	34.0	10.2	Absent	AH/W	5	4	Yes(<0.02)	Alive (7 July)
30	4 June	F	6.1	78	32.0	8.9	Dry	AH/W	4	3	Yes(>1.77-16.30)	Alive (24 Oct)
31	5 June	F	7.2	77	35.5	9.8	Moist	AH/W	3	4	Yes(<0.03)	Alive (16 Oct)
32	5 June	F	7.3	81	38.0	9.0	Absent	AH/W	4	4	Yes(<0.02)	Alive (24 Oct)
33	5 June	M	7.4	82	33.5	8.2	Dry	AH/W	3	3	No	Dead (6 June)
34	5 June	F	6.3	77	32.0	7.8	-	AH/W	2	4	No	Dead (6 June)
35	5 June	M	7.8	82	34.0	8.4	Moist	AH/W	3	3	Yes(<0.02)	Dead (16 Oct)
36	5 June	F	6.6	80	33.5	8.3	Absent	AH/W	3	3	Yes(<0.01)	Alive (16 Oct)
37	5 June	F	7.2	82	34.0	9.0	Absent	AH/W	4	5	Yes(<5.40)	Alive (24 Oct)

Table 1. Continued.

Calf no.	Date	Sex	Weight (kg)	Length (cm)	Hind foot length(cm)	New hoof length(mm)	Umbilicus condition	Hoof condition[a]	Estimated age[b]	Handling time(min)	Cow-calf reunion[c]	Status
38	5 June	M	7.8	78	36.0	9.3	Absent	AH/W	4	1	Yes(5.45)	Alive (19 Oct)
39	5 June	M	5.1	72	31.0	9.0	Moist	PH/W(slight)	3	4	Yes(≤0.02)	Dead (6 June)
40	5 June	M	7.4	80	35.0	8.0	Moist	AH/W	2	4	Yes(≤5.27)	Alive (24 Oct)
41	5 June	F	6.0	77	33.5	7.8	Moist	AH/W	2	4	Yes(≤0.02)	Alive (16 Oct)
42	5 June	M	7.6	84	34.0	9.1	Moist	AH/W	3	3	Yes(≤0.02)	Alive (24 Oct)
43	5 June	M	6.6	76	33.0	7.3	Part Dry	AH/W	1	3	Yes(≤0.02)	Alive (23 July)
44	5 June	F	6.7	83	35.0	7.0	Moist	AH/W	1	3	Yes(≤0.02)	Alive (7 July)
45	5 June	F	7.1	86	35.0	8.7	Moist	AH/W	3	3	Yes(≤0.02)	Alive (24 Oct)
46	5 June	M	7.2	82	32.0	8.5	Dry	AH/W	3	3	(Na)	Alive (24 Oct)
47	5 June	F	6.4	76	33.0	7.7	Dry	-	2	2	Yes(>3.13-47.23)	Alive (24 Oct)
48	5 June	F	7.3	87	32.0	8.1	Moist	AH/W(slight)	2	2	Yes(≤3.08)	Alive (16 Oct)
49	5 June	F	5.4	76	31.0	8.8	Absent	AH/W	4	3	Yes(>3.06-45.77)	Alive (24 Oct)
50	5 June	F	8.2	84	34.0	8.2	Dry	AH/W	3	4	Yes(≤3.02)	Dead (7 June)
51	5 June	F	6.7	77	33.0	8.8	Absent	AH/W	4	3	Yes(≤2.95)	Dead (13 June)
52	5 June	F	8.3	85	35.0	8.9	-	AH/W	4	4	Yes(≤2.95)	Alive (24 Oct)
53	5 June	M	7.4	83	34.0	9.4	Moist	AH/W	3	4	Yes(≤2.87)	Alive (7 July)
54	5 June	M	7.5	84	34.5	8.3	Moist	AH/W	3	3	Yes(≤0.08)	Alive (24 Oct)
55	5 June	M	8.1	88	35.0	8.6	Dry	AH/W	3	3	Yes(≤0.08)	Alive (7 July)
56	5 June	F	6.8	83	35.0	8.0	Moist	AH/W(slight)	2	3	Yes(Na)	Alive (24 Oct)
57	5 June	M	4.9	75	30.0	7.4	Moist	PH/W(slight)	1	2	Yes(Na)	Dead (13 June)
58	5 June	M	7.5	75	33.0	9.1	Bloody	PH/W(slight)	1	3	Yes(≤0.08)	Alive (7 July)
59	5 June	M	7.7	86	36.0	8.8	Moist	AH/W	3	4	Yes(≤2.00)	Dead (21 June)
60	5 June	M	-	86	34.0	8.1	Dry	PH/W	2	4	Yes(≤1.95)	Unknown/collar cast(18 Oct)
61	5 June	M	8.0	83	33.0	8.1	Absent	AH/W	2	3	Yes(≤0.05)	Alive (24 Oct)
62	7 June	F	4.8	77	32.0	7.3	Dry	AH/W	1	5	Yes(≤0.02)	Dead (23 June)
63	7 June	M	6.2	78	32.5	7.6	Bloody	PH/W(slight)	1	4	No	Dead (8 June)
64	7 June	F	5.9	79	32.5	8.5	Bloody	AH/W(slight)	1	4	No	Dead (9 June)
65	7 June	F	8.1	87	37.0	8.4	Moist	AH/W	3	5	Yes(≤16.92)	Dead (10 June)
66	7 June	F	7.1	73	31.5	8.7	Absent	AH/W	3	3	Yes(≤0.02)	Alive (7 July)
67	8 June	F	6.2	77	32.5	8.4	Absent	AH/W	3	4	Yes(≤0.05)	Unknown/collar cast(28 Oct)
68	8 June	F	5.1	89	32.0	8.4	Dry	AH/W	3	4	Yes(≤0.05)	Dead (16 Oct)
69	8 June	M	9.1	84	33.0	8.3	Dry	AH/W	3	4	No	Dead (11 June)
Male averages			7.30	80.43	33.69	8.54			2.77			
Female averages			6.63	80.42	33.55	8.21			2.53			
All			6.93	80.37	33.59	8.34			2.61	3.95		

a AH = All hardened; PH = Partially hardened; W = Hooves worn

b Age rounded to nearest whole day.

c (xxx-xxx) = Range of time in hours for reunion.

Composition data from transects indicated that yearlings contributed considerably to the high density in the southern part of the Jago River foothills area and on the coastal plain between the Kongakut River and Komakuk Beach. Based on the density of calves along transects, the Jago hills were by far the most important calving area, followed by the Kongakut River-Komakuk Beach area.

All adult bulls, a 2-year-old cow, and most radio-collared yearlings were south of the Brooks Range during calving. Because female yearlings were not likely to have calves, no attempt was made to obtain visual relocations of yearlings on the calving grounds. Signals from approximately half of the 35 collared yearling females were heard during overflights of the calving grounds. All of these were near the mountains or east of the Aichilik River, which is consistent with the distribution of yearlings based on transect data. Four of 5 radio-collared 2-year-old females were on the calving grounds; 1 was in the southern part of the Jago foothills and 3 were found near Komakuk Beach. None were parturient.

The 1983 calving distribution of the Porcupine caribou herd was similar to that observed in 1976, 1978, and 1979, when high densities of calving also occurred in the Jago foothills and east of the Kongakut River (USF&WS 1982). In 1972, 1975, 1977, and 1981, concentrations of calving also occurred in the Jago foothills area. Thus, 8 of the past 11 years have had high density calving in the Jago foothills. One difference in the calving distribution of 1983 over that of recent years was the northern extension of calving concentrations onto the coastal plain areas as well as low density calving occurring to the coastline in some areas (Fig. 1). The rapid snow melt on the calving grounds immediately prior to peak of calving may have influenced this northern extension of calving.

Peak of calving occurred on approximately 4 June in the high density calving area of the Jago foothills. The chronology of calving for radio-collared females ranged from 30 May to 19 June, with 83% of the calves being born during the period of 30 May to 10 June (Fig. 3). The peak of calving may have been slightly earlier in 1983 than the average (5-9 June) reported for other years (U.S. Fish and Wildlife Service 1982). Difficulty in classifying adults during transect surveys prevented the determination of synchrony across the entire calving area. No obvious differences occurred in calving chronology between eastern (Kongakut/Komakuk) and western (Jago foothills) concentration areas. However, based on estimated ages at capture, there may have been a 1 day delay in peak of calving between the Jago foothills area (mean estimated age at capture 2.6 days) and areas on the coastal plain near Barter Island (mean estimated age at capture 2.7 days). The apparent uniformity of calving chronology in 1983 across the calving grounds was in contrast to that of 1982 when calving peaked earlier in leading (western or northern) groups and was later in following (eastern or southern) groups (Whitten and Cameron 1983).

There were 23 radio-collared 3+-year-old cows in the Porcupine herd during the summer of 1983, of which 22 were on the calving grounds (Fig. 4). The remaining collared cow arrived at the Firth River delta on 13 June; antler development and absence of a distended udder indicated she had not been pregnant. Four other adult cows on the calving grounds were evidently not pregnant. Five cows gave birth, but lost their calves within 2 to 7 days, and 13 cows still had viable calves at the end of June. Initial

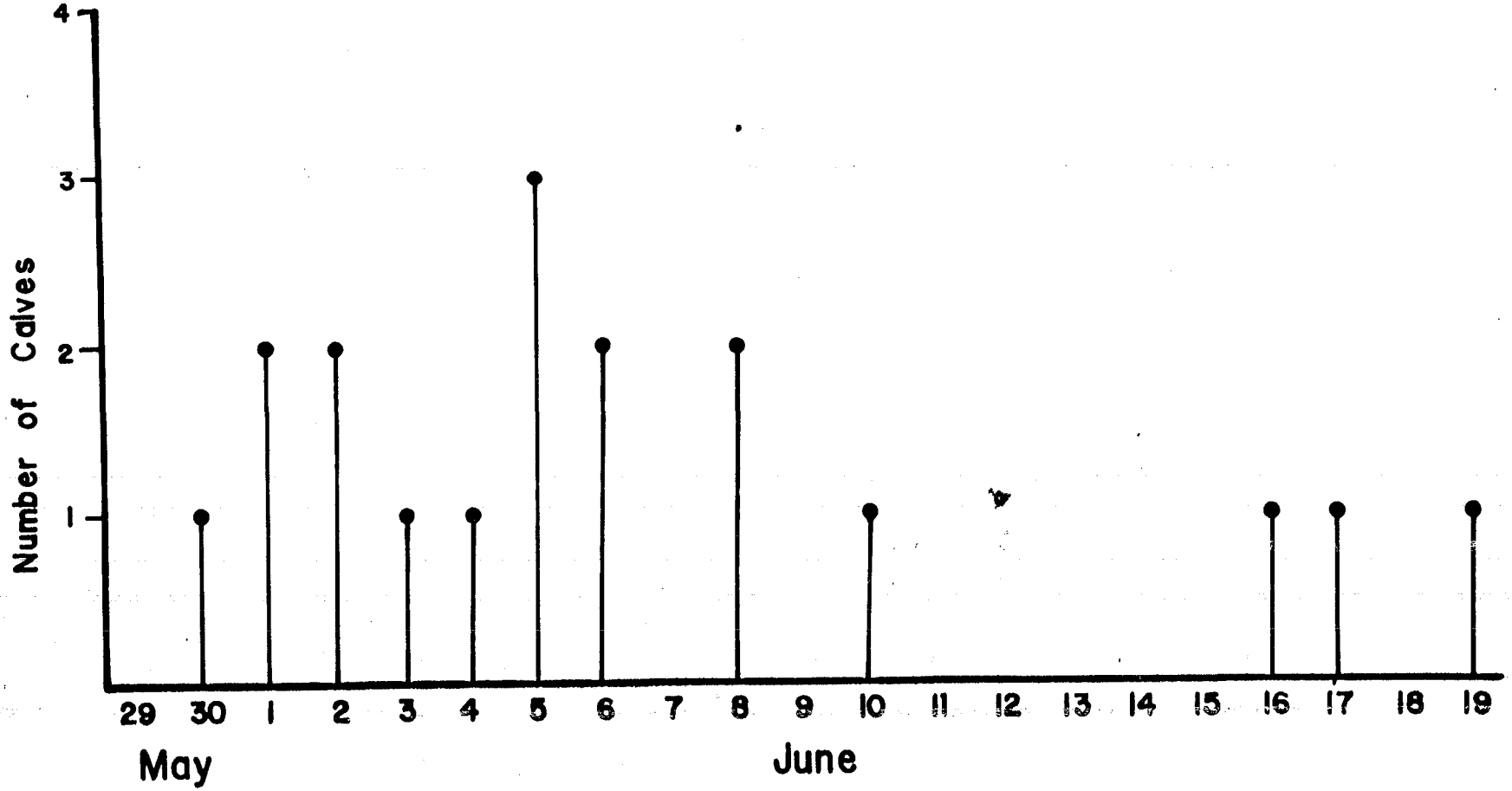

Fig. 3. Approximate dates of calving for 18 radio-collared control cows, Porcupine caribou herd, 1983.

productivity of radio-collared females was 78%. A summary of productivity status for radio-collared female caribou in 1983 is provided in Appendix Table A-1.

Composition surveys by helicopter on 6 June showed an average of 74 calves/100 cows and 24 yearlings/100 cows among 1,777 caribou counted. There were no bulls in this high density calving area. Density was higher in the southern portion of the survey area (the central Jago hills), due in part to a higher yearling/cow ratio; however, the lower calf ratio to the south suggested that barren cows near the mountains may also have contributed to higher density. In 1982, initial productivity for the Porcupine herd was an estimated 81% in an area of high density calving (Whitten and Cameron 1983). Bergerud (1980) reported an average initial productivity of 82% for 8 major North American herds. The 1983 productivity is slightly less than this reported average, however, sampling intensity was low and this estimate may not represent actual productivity.

Calf Capture

On 4 June 1983, 30 calves (# 1-20 in the foothill east area and # 21-30 in the foothill west area) were captured, processed, and released. An additional 30 calves were captured on 5 June 1983 (# 31-45 in the coastal plain north area and # 46-60 in the coastal plain south area). Both subgroups occurred within the overall area of high density calving (Fig. 1). Between 5 and 8 June 1983, 9 calves (# 61, 64 and 67 in the foothills east area, # 65 in the foothills west area; # 62, 63, 68 and 69 in the coastal plain north area; and # 66 in coastal plain south area) were captured, processed, and fitted with radiocollars that had been removed from mortality victims occurring among the initial sample of 60 (Table 1).

Cumulative time required for capture operations was 6 h, 40 min (3 h 35 min - 4 June; 3 h 5 min - 5 June and average processing time was 3.9 min. The use of ground observers to confirm reunion of cow/calf pairs was partially successful. When calves were captured from groups of caribou it was not possible to identify the dam whose calf was captured. Some reunions occurred in excess of 3 h post-capture, making it impractical to observe reunions and also achieve sampling goals during the peak of calving time interval. An alternative method using aircraft to periodically relocate each radio-collared calf and make visual observations during the first 24 hours was successful in documenting reunions and/or cases of study induced abandonment.

The estimated age of captured calves averaged 2.8 days (Table 1). A total of 30 male and 36 female calves were captured (the sex of 3 calves was inadvertently not recorded), which gives a sex ratio of 46 males: 54 females (Table 1). Sex ratios (at birth) of 53 males : 47 females (Kelsall 1968) and 51 males: 49 females (Skoog 1968) have been reported for Canadian and Alaskan caribou herds. The average weight for all calves captured was 6.9 kg (Table 1), which was 0.9 kg greater than the average weight of 23 calves measured from the same herd in 1982 (Mauer et al. 1983).

Neonatal Calf Mortality

Between 4 June and 3 August 1983, 17 calf mortalities were detected and investigated (Table 2). Case histories for each mortality are included in

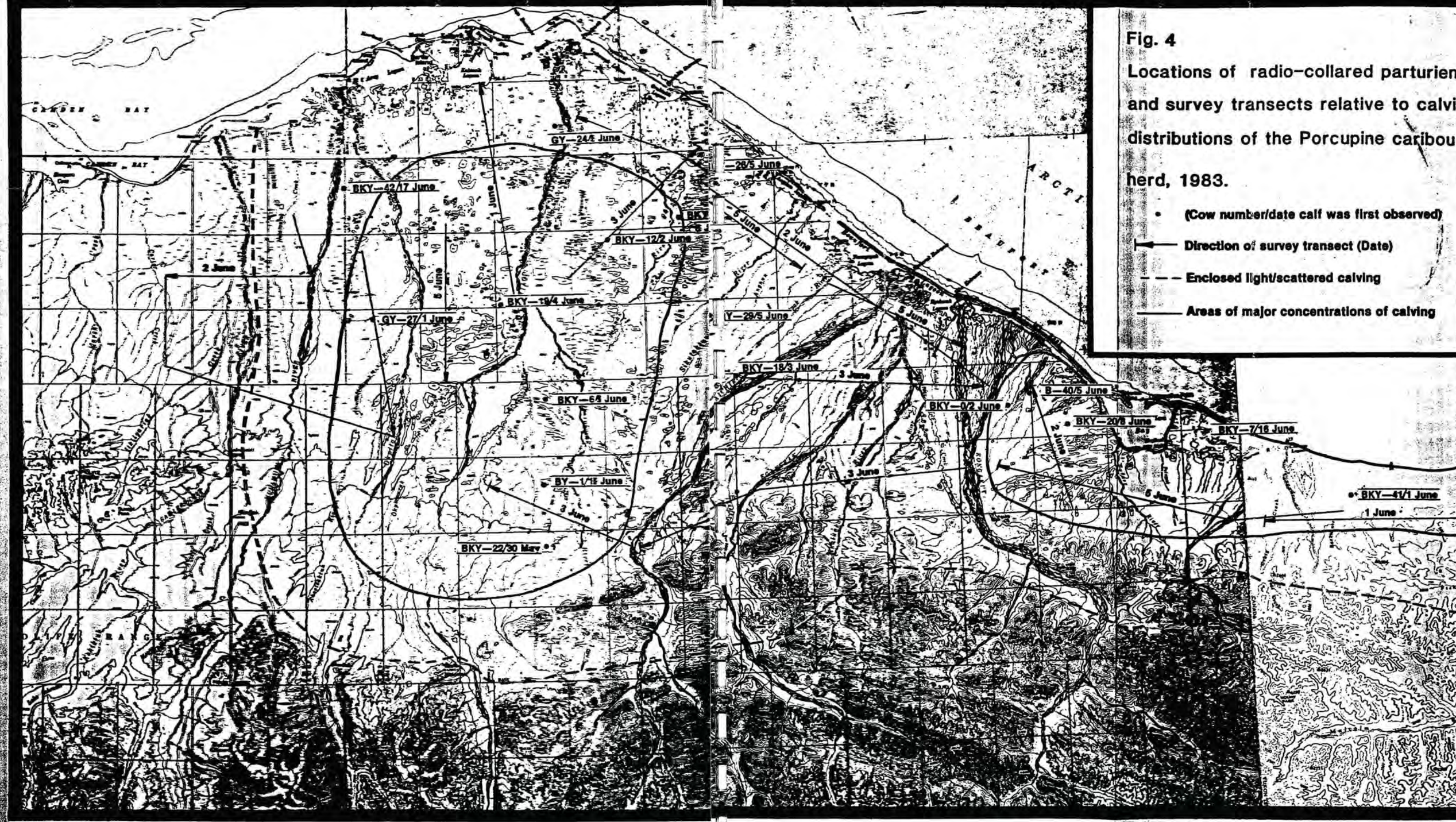

Fig. 4

Locations of radio-collared parturient and survey transects relative to calvin distributions of the Porcupine caribou herd, 1983.

- • (Cow number/date calf was first observed)
- ⟵ Direction of survey transect (Date)
- – – – Enclosed light/scattered calving
- ——— Areas of major concentrations of calving

the Appendix. Probable study-induced abandonment (6 cases) accounted for 35.3% of mortality among study calves. Probable natural abandonment was determined in cases of starvation due to desertion by the dam following an observed reunion. Since 2 cases of probable natural abandonment occurred within 24 hr of capture, it is possible that those abandonments may have been study-related.

Table 2. Probable causes of mortality for 17 of 69 radio-collared caribou calves between 4 June - 3 August 1983.

Category	Number of calves	Calf #'s	% Total mortality
I. Predation-excluded deaths			
1. Starvation			
a. probable study-induced abandonment	4	18,63,64,69	23.5
b. probable natural abandonment	2	34,50	11.8
2. Exposure			
3. Disease syndrome			
4. Undetermined cause of death	1	28	5.9
II. Predation and/or scavenging involved			
1. Scavenging involved			
a. avian scavenger			
i. probable study-induced abandonment			
ii. probable natural abandonment-gulls	1	39	5.9
iii. disease syndrome			
iv. undetermined cause of death			
b. mammalian scavenger			
i. probable study-induced abandonment			
ii. probable natural abandonment			
iii. disease syndrome			
iv. undetermined cause of death			
c. undetermined scavenger			
i. probable study-induced abandonment			
ii. probable natural abandonment			
iii. disease syndrome			
iv. undetermined cause of death	1	14	5.9
2. Predation involved			
a. avian predator			
i. predisposed to predation			
- golden eagle	1	33	5.9
ii. not predisposed to predation			
- golden eagle	3	57,59,65	17.6
b. mammalian predator			
i. predisposed to predation			
ii. not predisposed to predation			
- brown bear	2	51,62	11.8
c. undetermined predator			
i. predisposed to predation	1	1	5.9
ii. not predisposed to predation			
3. Undetermined if predation or scavenging			
i. predisposed to predation/scavenging			
ii. not predisposed to predation/ scavenging	1	20	5.9
Totals	17		100.1

Most calves captured from foothills areas were from large groups of cows and calves; whereas calves captured from coastal plain areas were from small groups of cows and calves or single cow/calf pairs. There was a tendency for the dams to more readily flee from the capture site when calves were taken from large groups than from small groups or single cow/calf pairs. Thus, on coastal plain areas, the capture crew observed reunions of cows and calves immediately following release in 18 instances versus 3 for the foothill groups. Mortality cases indicate that probable study-induced abandonment occurred with equal frequency among foothills groups (n=2) and coastal plain groups (n=2). However, there were 3 cases of probable natural abandonment in the coastal plain groups and in 2 cases both calves died within 1 day following capture. These calves had abandonment-related symptoms and the reunions observed by the capture crew could not be confirmed through aerial relocation and observation. Although there were less immediate reunions observed in the foothills groups, those groups had a lower abandonment rate (study-induced and natural-3) the coastal plain groups (6). Apparently a majority of dams that fled the capture site ultimately returned and successfully reunited with their young.

Excluding confirmed cases of study-induced mortality, the natural mortality rate for the remaining sample group of 63 calves was 17.5%. These mortalities can be partitioned into 4 mortality categories (Table 3). Predation accounted for approximately half the observed mortality, with golden eagles and brown bears being the predators involved in these mortalities. Predation/scavenging was involved in 2 mortalities but insufficient evidence at the carcass site did not permit identifying the cause of death. Natural abandonment accounted for 27.3% of observed mortality among sample calves. This rate is higher than the proportion of detected mortality attributed to natural abandonment for calving grounds of the Kaminuriak (21%) and Beverly (6%) caribou herds in Canada (Miller and Broughton 1974, and Miller et al. 1983 respectively). Apparently natural abandonment of calves occurs for a number of possible reasons: young females lack experience and may tend to abandon their young to join other migrating adults; disturbance by predators on the calving grounds may result in some permanent separations; and physiological disorders such as mastitis may lead to abandonment or starvation of the calf (Miller and Broughton 1974). Lent (1961) documented only 1 (1%) case of study-induced abandonment resulting from a capture and ear-tagging study of neonatal caribou calves.

Table 3. Proportion of observed natural mortalities occurring among neonatal caribou calves on the Arctic National Wildlife Refuge. 1983

Mortality category	Number of calves	Proportion (%) of sample calves	Proportion (%) of natural mortality
Probable natural abandonment	3	4.8	27.3
Undetermined-predation/ scavenging excluded	1	1.6	9.1
Undetermined-predation/ scavenging involved	2	3.2	18.2
Predation	5	7.9	45.5
a. golden eagle	3	4.8	27.3
b. brown bear - probable	2	3.2	18.2
Totals	11	17.5	100.1

Golden eagles killed 4 study calves (Tables 2 and 3) during the study, however, 1 calf was abandoned and predisposed to predation.. In addition, golden eagles killed 2 unmarked calves (see mortality case histories-Appendix) and were observed feeding on other calf carcases; however, it was not possible to obtain access to these carcass sites to determine if these calves were scavenged or killed by eagles.

A partial compilation of golden eagle sightings by field personnel working in the northern part of the Arctic National Wildlife Refuge in 1983 contains 51 observations totaling 60 birds (23 adults, and 18 immatures and 9 unidentified age) during 14 May to 4 August. In previous years a preponderance of immature eagles has been observed (D. Roseneau, pers. comm.). Most golden eagle sightings were made during June (28) and were most often recorded in areas associated with caribou concentrations. No attempt was made to systematically survey golden eagle distributions and determine abundance. These sightings are biased by observer effort and location and do not represent abundance and distribution of golden eagles on the coastal plain of ANWR.

Abandonment-related mortality rates among the original sample of 60 calves was 10%, while it was 33% among calves collared with radios removed from dead calves. Replacement of collars was halted when this anomaly was detected. Reasons for the elevated abandonment rate among re-collared individuals are undetermined; however, scent may have caused the dam to reject its young.

Probable predation of study calves by brown bears was determined in 2 cases. In addition, 3 unmarked calves were killed by brown bears (see mortality case histories - Appendix). During 4-16 June, brown bears were observed killing or feeding upon unmarked calves in 11 different cases which involved a total of 11 calves (P. Miller pers. comm., G. Garner pers. comm., M. Phillips 1984). Of 25 brown bears captured in the foothills and coastal plain of ANWR during 8-16 June, 7 had either dried blood or fresh blood on their muzzle. Data gathered during concurrent studies of radio-collared brown bears indicates that bears appear to move towards areas of caribou concentration and frequent calving grounds during calving and post-calving season (Garner et al. 1983, 1984, Phillips 1984). It is apparent that caribou calves are important food items to some brown bears during the calving season; however, the magnitude of predation by brown bears on caribou calves is not known.

One unmarked calf drowned on 4 June 1983 in a meltwater drainage having perpendicular ice walls. The dam crossed the drainage successfully, however when the calf followed it was unable to climb out of the water and subsequently drowned.

There was no documented wolf predation of study calves. One black wolf was observed on 9 June 1983 being chased by the dam of a study calf in the foothills near the Okerokovik River. The observation was made from the radio-tracking aircraft (PA-18) flying towards the cow/calf pair at approximately 200 m AGL. The observation began when the wolf was seen running directly away from the female caribou. After running a short distance (50 m), the cow stopped the pursuit and allowed her calf to approach her. The wolf continued to run at a moderate speed directly away from the caribou. It is possible that the approaching aircraft caused the wolf to flee from the cow and calf at the time the observation was

initiated. An active wolf den was located near Whale Mountain on the Kongakut River. At least 4 wolves, believed to be associated with this den were observed on several occasions on the coastal plain and in the foothills between the Kongakut River and Demarcation Bay, a distance of 25-35 km from the den (Phillips 1984).

Between 4 June and 3 August, 76.5% of the observed mortalities for study calves occurred within the first 9 days (Fig. 5). Six of these mortalities were study-induced, therefore 63.6% of the detected natural mortality occurred within the first 9 days of the study. Natural mortality was concentrated in calves that were estimated to be 12 days of age or less (Fig. 6). The 2 mortalities occurring in late July - early August occurred in mountains and foothills south of the coastal plain during emigration from the coastal plain and adjacent foothills of ANWR. Note that these 2 calves were last monitored on 6 July and both were in large aggregations that were emigrating from the coastal plain. They were not monitored again until late July. Therefore, timing of actual mortality is between 6 July and 3 August. All other mortalities occurred on the coastal plains or adjacent foothills during calving and post-calving aggregations.

Mortality rate (excluding study-induced mortality) were higher (21.9%-7 mortalities of 32 calves) among calves originally captured on coastal plain areas (18.8%-coastal plain north, 25.0%-coastal plain south), than mortality (12.9%-4 mortalities of 31 calves) among calves captured in the foothills areas, (10%-foothills east, 18.2%-foothills west). Most of the natural mortality of the study group, however, occurred in foothills and mountain areas (60%) compared to (40%) on the coastal plain. This was primarily due to movement of most of the coastal plain-south group to the foothills soon after capture. All documented golden eagle kills occurred in the foothills region. The 3 cases of probable natural abandonment occurred on coastal plain areas. Only one undetermined mortality occurred on the coastal plain.

Of the 18 productive females in the control group, 5 lost their calves between 30 May to 21 June (see Appendix). Chronology of this mortality was 1 June, 11 June, 16 June, 17 June, and 21 June and is in general agreement with the chronology of mortalities among study calves (Fig. 5). Assuming that all lost calves died, the calf mortality rate for the control group was 27.8%. The mortality rate for the study group (excluding study-induced mortality) between 4 June-3 August was 17.5%. These mortality rates are significantly different ($X^2 = 3.82$, df = 1, $0.05 < P < 0.10$), however, small sample size may bias these data. Also, the majority of control cows did not calve in the areas where study calves were captured (Fig. 3) and may have been exposed to different mortality risks in these areas.

Comparison of estimated initial productivity of 74 calves/100 cows with limited composition data collected during early July 1983 (72-74 calves/100 cows) indicates a high initial calf survival rate (Whitten 1984). Similar comparisons in an earlier year (1972) indicated a decline of 17% of calves between peak of calving and early July (Calef and Lortie 1973). This decline agrees with the observed natural mortality rate (17.5%) of study calves during 4 June to 3 August 1983. More extensive composition data are necessary to improve the validity of these comparisons.

During 7-30 June 1982 a natural mortality rate of 45% was measured among 23 study calves which were captured and processed on the coastal plain south of

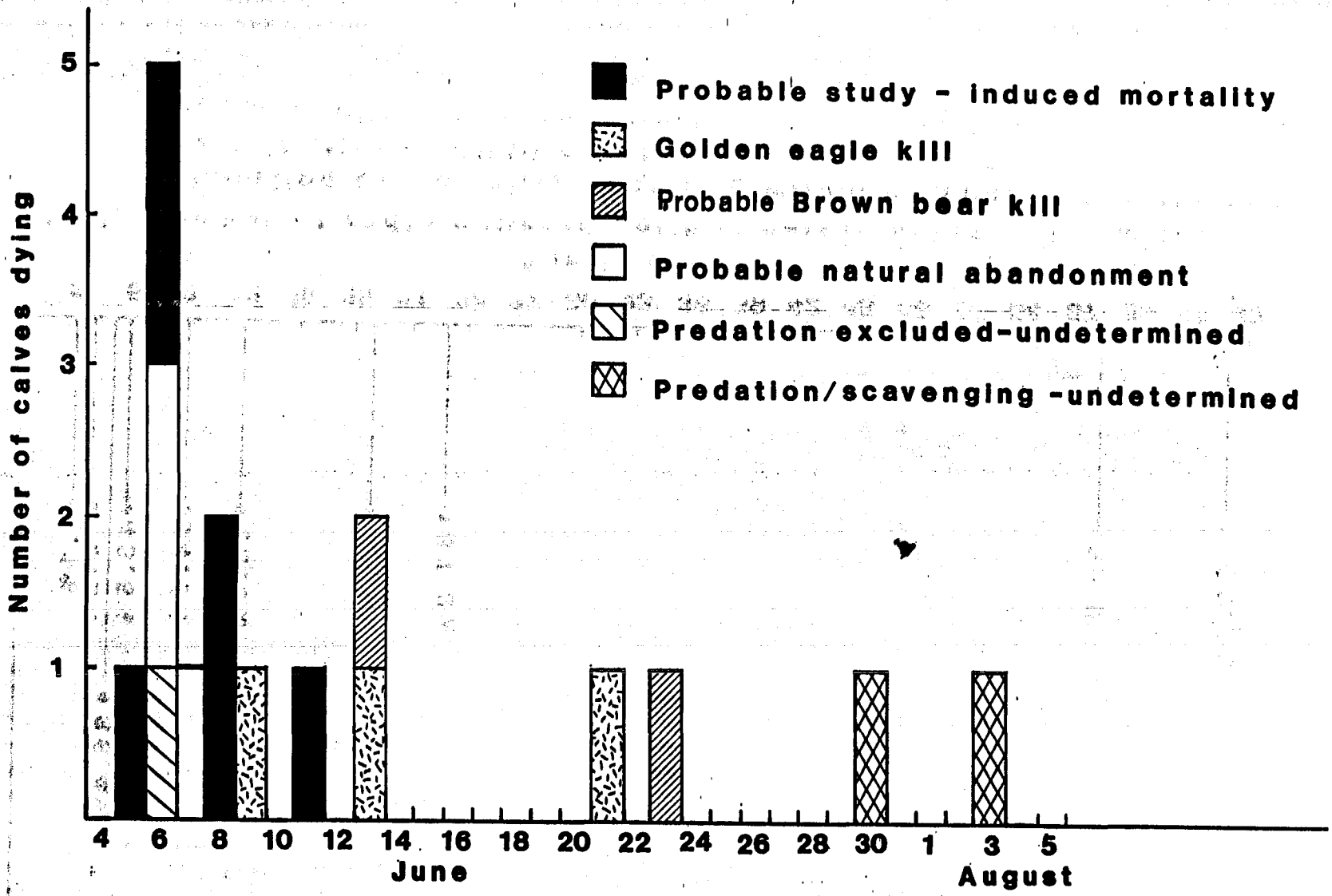

Fig.5. Chronology of observed mortalities among 17 radio-collared caribou, Arctic National Wildlife Refuge, 1983.

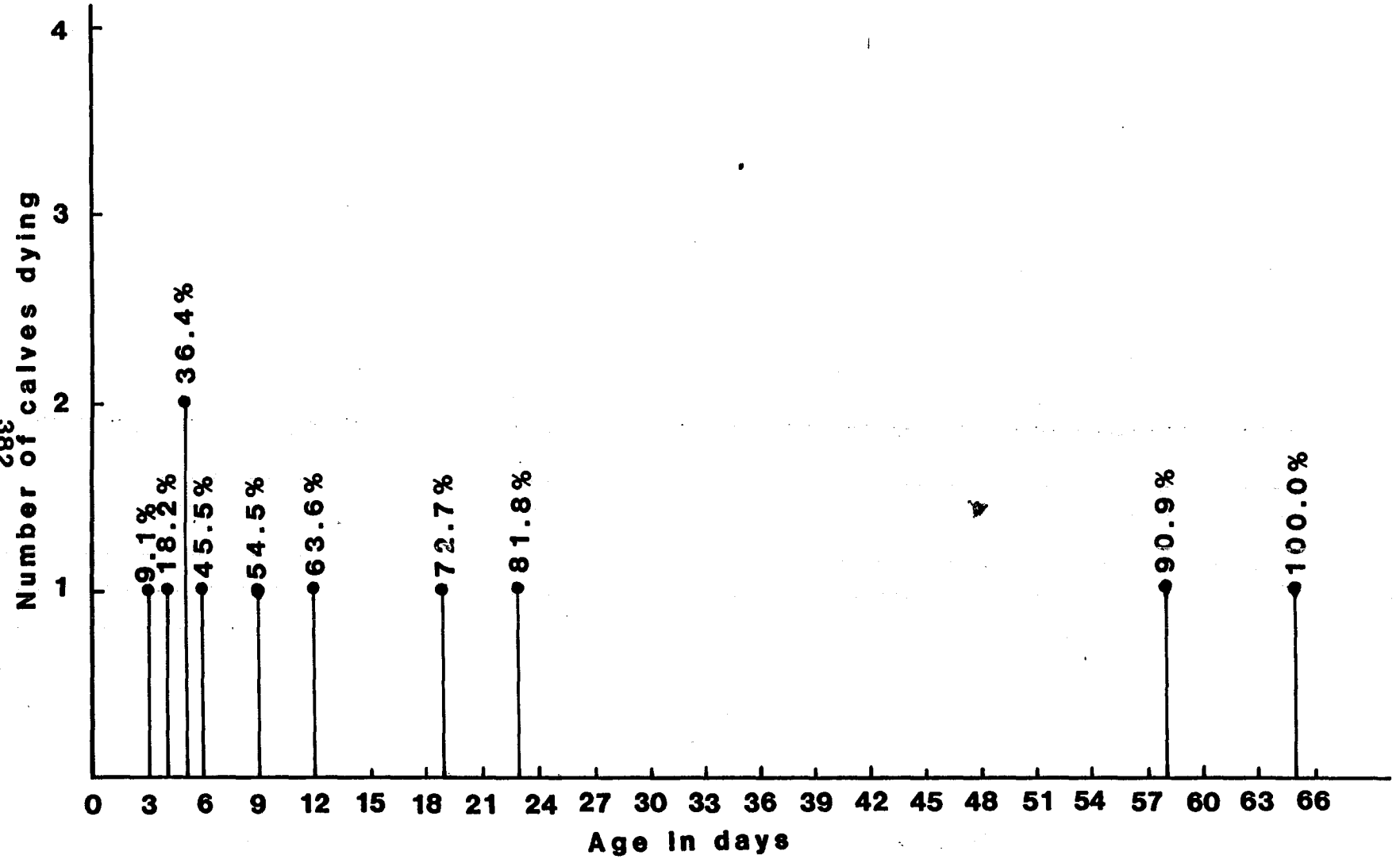

Fig.6. Number of radio collared caribou calves dying and cumulative proportion of mortality occurring within estimated age classes, Arctic National Wildlife Refuge, 1983.

Note that mortalities detected for estimated ages 23, 58, and 65 are ages when mortality was detected.

Herschel Island, Yukon Territory (Mauer et al. 1983). This rate was considerably higher than the 1983 rate of 17.5%. In the first 10 days after capture, 50% of the 1982 mortality occurred, while 81% occurred in the same period in 1983 (Mauer et al. 1983). In 1982 33% of study calf mortality occurred during late June when there was a rapid westward movement of cows and calves (Mauer et al. 1983). Rapid movement also occurred during late June 1983 in both eastern and later in western directions, however, no increase in calf mortality were apparent. Logistical limitations encountered in 1982 precluded establishment of conclusive mortality categories, however, golden eagles were associated either as a predator or as a scavenger in 75% of the natural mortalities in 1982. In 1982, calving occurred in extreme eastern and southeastern portions of the herd's traditional calving grounds (approximately 160 km from 1983 study areas). Geographic distribution of calving, post-calving movement patterns, and other factors may have influenced mortality rates between the 2 years.

Movements

Following capture there was a gradual southward shift of most study calves towards the upper foothills near the northern base of the Brooks Range (Figs. 7 and 8). This movement was consistent, directional, and coincided with increasing group size and net movement rates (Fig. 9). Most calves captured in the coastal plains-south area moved south and mixed with general distributions of the foothills study groups (Fig. 7). Those study calves which moved towards the coast did so at a slower rate and with less consistency in direction of movement. The coastal distributions tended to show lower net movement rates (4.12 km/24 hrs) than the foothills distributions (6.55 km/24 hrs) during 8-26 June. A similar relationship was observed among coastal and foothills distributions of the control cows.

Beginning 20 June, movement rates of foothills and mountain distributions increased two-fold or more, and direction of movement shifted to the east (Figs. 8 and 9). On 24 June, there was a rapid, general evacuation of the mountains and foothills, spreading onto the coastal plain along the Egaksrak and Kongakut Rivers (Fig 7 and 8). Movement continued across the Kongakut River and proceeded into Canada by 2-3 July. On 4 July, the herd shifted directions 180° and moved rapidly back into Alaska. Some groups went into the foothills and northern mountains, while the majority remained on the coastal plain. During this same period, considerable numbers of caribou also remained on the coastal plain from the Niguanak River to the Egaksrak River. These groups generally included the study calves which had shown a previous affinity to coastal areas. A mixing of groups again occurred between 4-6 July as large groups containing the original foothills study calves moved westwards. During 6-8 July, there were numerous, rapid movements of large groups on the coastal plain between the Jago and Aichilik Rivers. Many caribou moved to coastal fringes, and some groups were seen on ice pans on the lagoons. Harassment by mosquitos was apparent during this period. After 8 July, large numbers of caribou moved eastward along the coastal plain and entered Canada on 10 July. Other groups moved higher into the mountains in a southeasterly direction up the Aichilik and Egaksarak river valleys. Some scattered groups remained on the coastal plain and foothills through July and August.

Periodic radio-telemetry surveys during August, October, November, and December indicated general herd distributions in traditional fall and winter

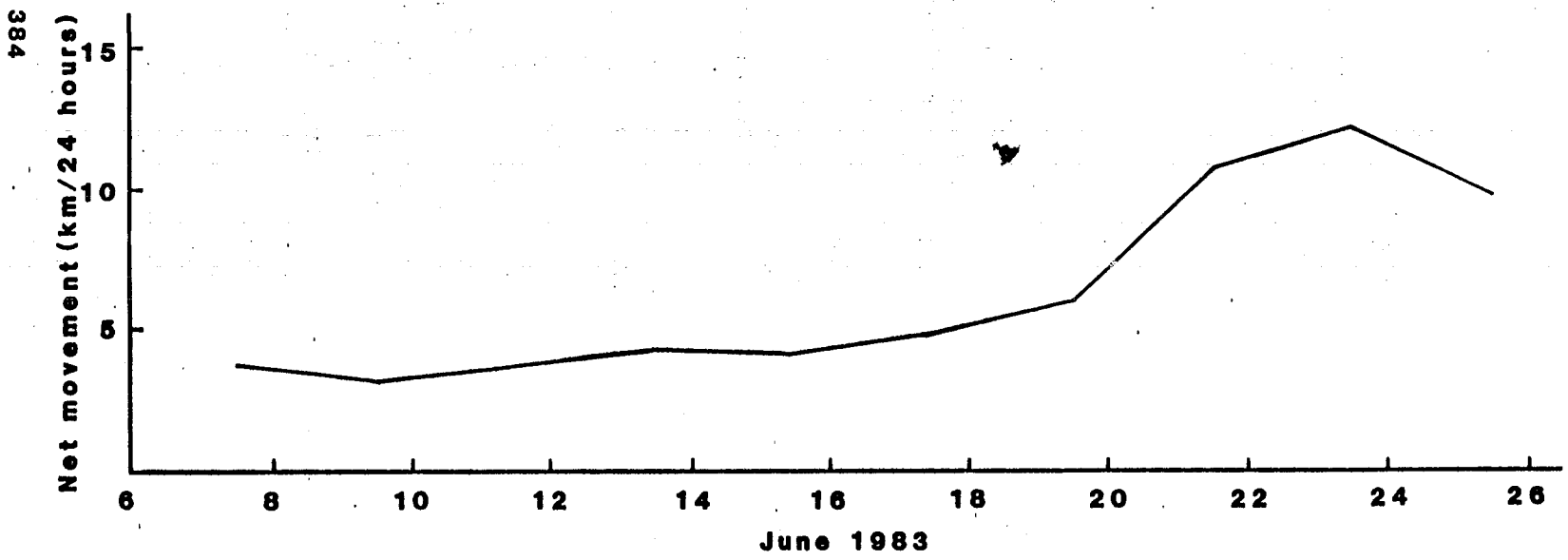

Fig. 9 Net movement rates for radio-collared caribou calves (8-25 June 1983).

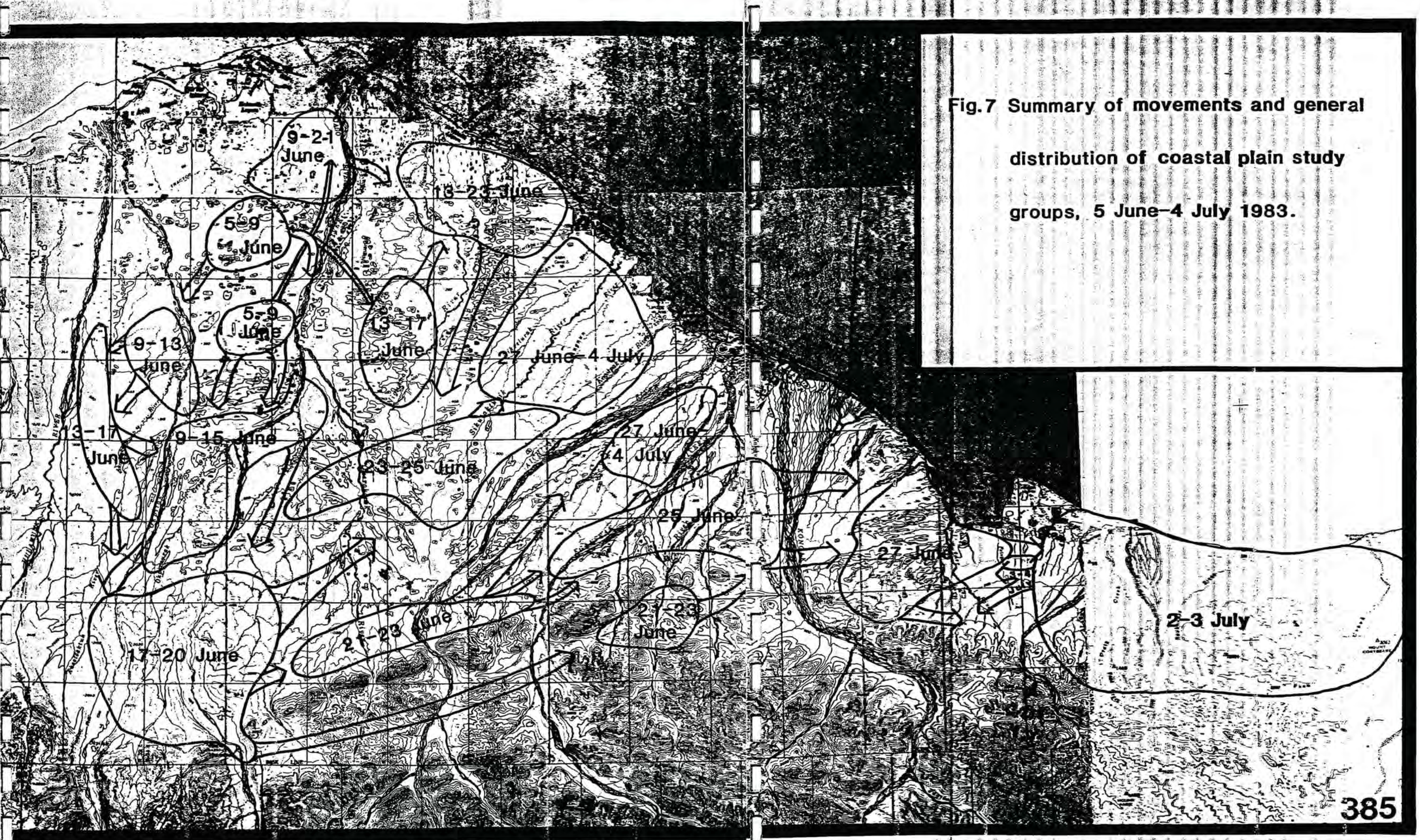

Fig. 7 Summary of movements and general distribution of coastal plain study groups, 5 June–4 July 1983.

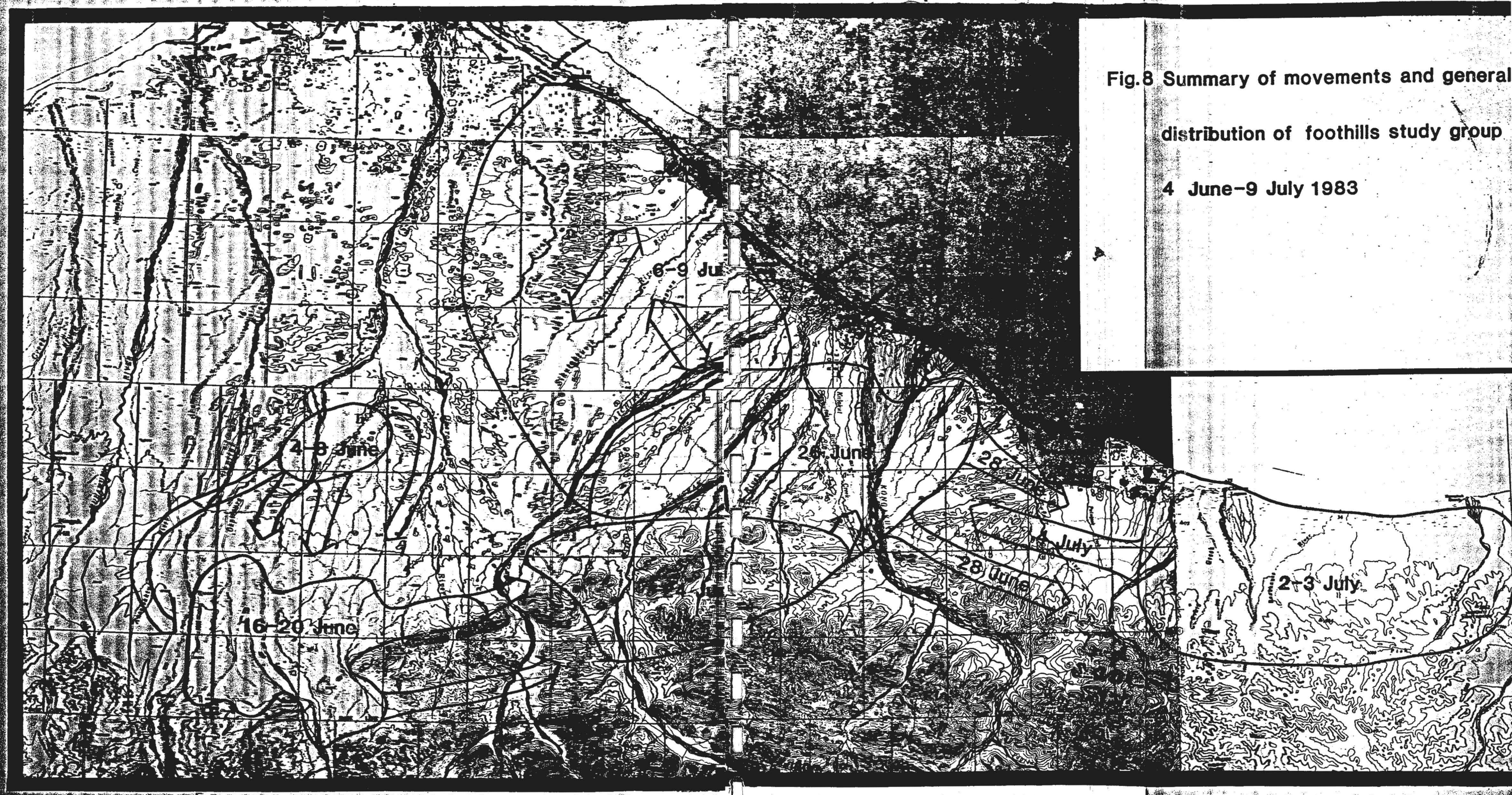

Fig.8 Summary of movements and general distribution of foothills study group 4 June-9 July 1983

areas of Alaska and Canada. It was not possible to locate all frequencies and/or detect, locate and investigate mortalities rapidly enough to collect conclusive data on causes of subsequent mortalities. During the period of 5 August to 8 December 1983, 4 mortalities were confirmed, (Appendix 1) and 4 other mortality signals were received but not investigated on the ground. A total of 17 calf frequencies were not received during this period and their status is unknown. In 4 cases radio-collars wre found dropped from the calf as a result of fraying of the elastic at rivet points. This may have been aggravated by failure of some collars to expand properly with increased neck size.

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APPENDIX
ANWR Progress Report Number FY84-12

Mortality Case History

Calf No: 1
Captured: 4 June 1983

Sex: female
Location: foothills, east of Jago River

Weight: 5.7 kg
Umbilicus condition: moist
Hoof condition: partially hardened/worn
Health status: appeared healthy at capture
Processing time: 12 min

Total length: 80.0 cm
Right hind foot length: 33.0 cm
New hoof length: 7.1 mm

Estimated age at capture: 1 day old

Cow-calf reunion: No reunion observed. Calf observed unattended by dam 5.8 hours following release.

Signal monitored: 5 times/ 2 day period
Mortality detected: 5 June 1983
Carcass collected: 5 June 1983
Carcass weight: 3.2kg
Total length:
Right hind foot length: 32.5 cm
New hoof length 7.2 mm

Number of visual relocations: 2
Location: near capture site
Distance from capture site:
Response time: 6.1 hours

Carcass condition and disposition: 60% consumed. Skeleton intact, limbs articulated and hide attached, remainder of carcass including head & neck are skinned and hide is missing, all viscera removed, back and hind leg flesh removed, lower portion of ribs are missing but ribs are not broken, tendons are stripped of flesh but they remain as string-like, puncture wound with subcutaneous hemmorrhages on right mandible (behind eye). Avian scats and scavengers (Jaegers) present.

Necropsy findings:

Mortality category: Predation and scavenging involved, undetermined predator, avian scavenger (Jaeger), starvation, probable study-induced abandonment, predator kill and subsequently scavenged by birds.

Mortality Case History

Calf No: 7
Captured: 4 June 1983

Sex:
Location: foothills, east of Jago River

Weight:
Umbilicus condition: dry
Hoof condition: hard/worn
Health status: appeared healthy at capture
Processing time: 3 min

Total length: 73 cm
Right hind foot length: 32.3 cm
New hoof length: 7.2 cm

Estimated age at capture: 1 day old

Cow-calf reunion: Reunion not observed by capture crew. Calf observed unattended by dam 6.97 hours after release and was attended 27.8 hours after release.

Signal monitored: 33 times/ 134 day period Number of visual relocations: 3
Mortality detected: 16 October 1983 Location: Upper Kongakut River
Carcass collected: Distance from capture site: 106 km
Carcass weight: Response time:
Total length:
Right hind foot length:
New hoof length

Carcass condition and disposition: Over 2 weeks old, only bone fragments and hair were found near collar and transmitter.

Necropsy findings:

Mortality category: Predation/scavenging involved. Predator/scaveger-probable mammalian.

Mortality Case History

Calf No: 14
Captured: 4 June 1983

Sex: female
Location: foothills east of Jago River

Weight: 7.8 kg
Umbilious condition: dry
Hoof condition: hard/worn
Health status: appeared healthy at capture
Processing time: 4 min

Total length: 81 cm
Right hind foot length: 34 cm
New hoof length: 8.5 mm
Estimated age at capture: 3 days

Cow-calf reunion: Reunion not observed by capture crew. Calf observed attended by dam 3.65 hr following release.

Signal monitored: 30 times/ 56 day period
Mortality detected: 30 July 1983
Carcass collected: 31 July 1983
Carcass weight:
Total length:
Right hind foot length:
New hoof length

Number of visual relocations: 5
Location: Pagilak River
Distance from capture site:
Response time:

Carcass condition and disposition: 97% consumed, rib cage and leg bones and lower jaw found scattered. Bear scats (5) in the vicinity.

Necropsy findings:

Mortality category: Predation/scavenging involved. Predator/scavenger probable brown bear.

Mortality Case History

Calf No: 18
Captured: 4 June 1983

Sex: male
Location: foothills east of Jago River

Weight: 7.1 kg
Umbilicus condition: absent
Hoof condition: hard/worn
Health status: appeared healthy at capture
Processing time: 3 min

Total length: 74cm
Right hind foot length: 33.0 cm
New hoof length: 8.4 mm
Estimated age at capture: 3 days

Cow-calf reunion: Capture crew did not observe reunion. Calf observed unattended by dam 5.2 and 18.3 hrs. following release.

Signal monitored: 5 times/ 2 day period
Mortality detected: 6 June 1983
Carcass collected: 6 June 1983
Carcass weight: 6.3 kg.
Total length: 83.5 cm
Right hind foot length: 34 cm
New hoof length 6.5 mm

Number of visual relocations: 2
Location: Near capture site
Distance from capture site:
Response time: 43 min

Carcass condition and disposition: Lying on right side - no signs of trauma, carcass intact. No caribou in the area.

Necropsy findings: Vegetation in abomasum and rumen, milk absent. All other internal organs normal. No marks on carcass, no trauma.

Mortality category: Predation excluded, starvation, probable study induced abandonment.

Mortality Case History

Calf No: 20
Captured: 4 June 1983

Sex: male
Location: foothills, east of Jago River

Weight: 9.3 kg
Umbilicus condition: absent
Hoof condition: hard/worn
Health Status: appeared healthy at capture
Processing time: 3 min

Total Length: 82 cm
Right hind foot length: 35.0 cm
New hoof length: 9.5 mm

Estimated age at capture: 5 days old

Cow-calf reunion: Capture crew observed reunion immediately after release.

Signal Monitored: 33 times/ 60 day period
Mortality detected: 3 August 1983
Carcass collected:
Carcass weight:
Total length:
Right hind foot length:
New hoof length:

Number of Visual relocations: 4
Location: Table Mtn.
Distance from capture site:
Response time:

Carcass condition and disposition: No carcass was found. Collar partially torn.

Necropsy findings:

Mortality category: Predation/scavenging involved. Predator/scavenger undetermined.

Mortality Case History

Calf No: 28
Captured: 4 June 1983

Sex: female
Location: foothills west of Jago River

Weight: 8.4 kg
Umbilicus condition: dry
Hoof condition:
Health status: appeared healthy at capture
Processing time: 3 min
Cow-calf reunion: Capture crew did not observe reunion. Calf observed with dam 16.3 hr following its release.

Total length: 83 cm
Right hind foot length: 33.5 cm
New hoof length: 9.1 mm

Estimated age at capture: 4 days

Signal monitored: 5 times/ 2 day period
Mortality detected: 6 June 1983
Carcass collected: 6 June 1983
Carcass weight: 9.0 kg
Total length: 90 cm
Right hind foot length: 36.8 cm
New hoof length: 9.0 mm

Number of visual relocations: 2
Location: Near capture site
Distance from capture site:
Response time: 20 min

Carcass condition and disposition: Intact, lying on right side, cow with antlers and udder standing over carcass. No indication of trauma.
Necropsy findings: All internal organs normal, milk curds and vegetation in abomasum.

Mortality category: Predation excluded, undetermined cause-natural.

Mortality Case History

Calf No: 33
Captured: 5 June 1983

Sex: male
Location: coastal plain south of Barter Island.

Weight: 7.4 kg
Umbilicus condition: dry
Hoof condition: hard/worn
Health status: scouring - otherwise appeared normal
Processing time: 3 min
Cow-calf reunion: Capture crew did not observe reunion. Calf observed unattended by cow twice prior to death.
Signal monitored: 3 times/ 2 day period
Mortality detected: 6 June 1983
Carcass collected: 6 June 1983
Carcass weight: 1.7 kg
Total length:
Right hind foot length:
New hoof length: 8.6 mm

Total length: 82 cm
Right hind foot length: 33.5 cm
New hoof length: 8.2 mm
Estimated age at capture: 3 days
Number of visual relocations: 2
Location: Near capture site
Distance from capture site:
Response time: 7 hrs

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Carcass condition and disposition: 75% consumed, viscera removed, tongue and right eye removed head and vertebrae attached, ribs broken. Small wounds with hemorrhage in throat region, lower maxilla broken, hind legs and sacrum missing.

Necropsy findings:

Mortality category: Predation involved, probable golden eagle kill, probable study-induced abandonment.

Mortality Case History

Calf No: 34
Captured: 5 June 1983

Sex: female
Location: coastal plain south of Barter Is.

Weight: 6.3 kg
Umbilicus condition:
Hoof condition: hard/worn
Health status: scours - otherwise appeared healthy.
Processing time: 4 min
Cow-calf reunion: Capture crew observed reunion.

Total length: 77 cm
Right hind foot length: 32.0 cm
New hoof length: 7.8 mm
Estimated age at capture: 2 day

Signal monitored: 2 times/ 1 day period
Mortality detected: 6 June 1983
Carcass collected: 6 June 1983
Carcass weight: 5.8 kg
Total length: 87 cm
Right hind foot length: 32.5 cm
New hoof length: 6.9 mm

Number of visual relocations: 0
Location: Near capture site.
Distance from capture site:
Response time: 11 min

Carcass condition and disposition: Intact, lying on right side, no visible indication of trauma. A single cow within area and 2 other caribou.

Necropsy findings: Bruised lumbar region and right rib cage. Lungs clouded and bloody. Abomasum and rumen packed with vegetation, no milk present. All other internal organs and structures normal.

Mortality category: Predation excluded, pneumonia probable, capture related injuries or injuries due to rejection by cow, starvation, probable natural abandonment.

Mortality Case History

Calf No: 35
Captured: 5 June 1983

Sex: male
Location: coastal plain west of Barter Island.

Weight: 7.8 kg
Umbilicus condition: moist
Hoof condition: hard/worn
Health status: appeared healthy at capture
Processing time: 3 min
Cow-calf reunion: Capture crew observed reunion.

Total length: 82 cm
Right hind foot length: 34.0 cm
New hoof length: 8.4 mm

Estimated age at capture: 3 days

Signal monitored: 31 on times/ 133 day period
Mortality detected: 16 October 1983
Carcass collected:
Carcass weight:
Total length:
Right hind foot length:
New hoof length

Number of visual relocations: 7
Location: East fork of Sheenjek River
Distance from capture site: 168 km
Response time:

Carcass condition and disposition: No carcass remains, collar intact but had tooth marks.

Necropsy findings:

Mortality category: Predation/scavenging involved. Predation/scavenger undetermined.

Mortality Case History

Calf No: 39
Captured: 5 June 1983

Sex: male
Location: coastal plain south of Barter Is.

Weight: 5.1 kg
Umbilicus condition: moist
Hoof condition: partially hard/worn slightly
Health status: appeared healthy at capture
Processing time: 4 min
Cow-calf reunion: Capture crew observed reunion.

Total length: 72 cm
Right hind foot length: 31.0 cm
New hoof length: 9.0 mm

Estimated age at capture: 3 days

Signal monitored: 2 times/ 1 day period
Mortality detected: 6 June 1983
Carcass collected: 6 June 1983
Carcass weight: 4.1 kg
Total length: 78 cm
Right hind foot length: 31.5 cm
New hoof length: 7.8 mm

Number of visual relocations: 0
Location: Near capture site.
Distance from capture site:
Response time: 38 min

Carcass condition and disposition: Lying on right side, 10% of carcass consumed, rump skinned open, sacrum flesh partially removed. Two glaucous gulls seen feeding on carcass. No cow in vicinity.

Necropsy findings: Slight congestion in lungs. Liver, heart, kidneys and bone marrow normal. Stomach and intestines not present.

Mortality category: Scavenging involved, avain scavengers (gulls), probable natural abandonment.

Mortality Case History

Calf No: 50
Captured: 5 June 1983

Sex: female
Location: coastal plain south of Barter Is.

Weight: 8.2 kg
Umbilicus condition: dry
Hoof condition: hard/worn
Health status: appeared healthy at capture
Processing time: 4 min

Total length: 84 cm
Right hind foot length: 34.0 cm
New hoof length: 8.2 mm
Estimated age at capture: 3 days

Cow-calf reunion: Capture crew observed reunion. Calf observed with dam 3 hrs after release.

Signal monitored: 4 times/ 2 day period
Mortality detected: 7 June 1983
Carcass collected: 7 June 1983
Carcass weight: 7.2 kg
Total length: 88 cm
Right hind foot length: 35.0 cm
New hoof length: 6.6 mm

Number of visual relocations: 2
Location: Near capture site.
Distance from capture site:
Response time:

Carcass condition and disposition: Intact - no external indication of trauma. No cow in vicinity.

Necropsy findings: No wounds on carcass. Vegetation in rumen and abomasum - no milk present. All other internal organs normal.

Mortality category: Predation excluded, starvation, probable natural abandonment.

Mortality Case History

Calf No: 51
Captured: 5 June 1983

Sex: female
Location: coastal plain south of Barter Is.

Weight: 6.7 kg
Umbilicus condition: absent
Hoof condition: hard/worn
Health status: Scouring - otherwise appeared healthy.
Processing time: 3 min

Total length: 77 cm
Right hind foot length: 33.0 cm
New hoof length: 8.8 mm
Estimated age at capture: 4 days

Cow-calf reunion: Calf attended by dam 2.95 hours after release.

Signal monitored: 13 times/ 9 day period
Mortality detected: 13 June 1983
Carcass collected: 13 June 1983
Carcass weight: 3.3 kg
Total length:
Right hind foot length: 36 cm
New hoof length: 10.1 mm

Number of visual relocations: 3
Location: Lake south of VABM Bitty.
Distance from capture site:
Response time: 110 min

Carcass condition and disposition: 90% consumed, hair, skin and bones scattered, skull crushed. Two immature golden eagles observed at carcass.

Necropsy findings: Round puncture wounds 11.4 to 22.7 mm diameter through skin of thoracic region.

Mortality category: Predation involved, mammalian predation (bear probable) and scavenging by golden eagles.

Mortality Case History

Calf No: 57
Captured: 5 June 1983

Sex: male
Location: coastal plain south of Barter Island.

Weight: 4.9 kg
Umbilicus condition: moist
Hoof condition: partially hard/worn slightly
Health status: appeared healthy at capture
Processing time: 2 min
Cow-calf reunion: Capture crew observed reunion.

Total length: 75 cm
Right hind foot length: 30.0 cm
New hoof length: 7.4 mm

Estimated age at capture: 1 day

Signal monitored: 12 times/ 9 day period
Mortality detected: 13 June 1983
Carcass collected: 13 June 1983
Carcass weight: 4.5 kg
Total length:
Right hind foot length: 33 cm
New hoof length: 8.4 mm

Number of visual relocations: 4
Location:
Distance from capture site:
Response time: 1.5 hr

Carcass condition and disposition: Head and neck intact, viscera removed, 20% of carcass consumed. One immature golden eagle at carcass.

Necropsy findings: Skull fractured below right eye, jaws broken at point of articulation. Puncture wounds and subcutaneous hemorrhages on right and left sides of skull and on right & left scapula. Flesh removed from right rib cage.

Mortality category: Predation involved, golden eagle kill.

Mortality Case History

Calf No: 59
Captured: 5 June 1983

Sex: male
Location: coastal plain south of Barter Is.

Weight: 7.7 kg
Umbilicus condition: moist
Hoof condition: hard/worn
Health status: appeared healthy at capture.
Processing time: 4 min
Cow-calf reunion: Calf observed with dam 2 hrs after release.

Total length: 86 cm
Right hind foot length: 36.0 cm
New hoof length: 8.8 mm

Estimated age at capture: 3 days

Signal monitored: 22 times/ 17 day period
Mortality detected: 21 June 1983
Carcass collected: 21 June 1983
Carcass weight: 5.6 kg
Total length:
Right hind foot length: 39 cm
New hoof length: 14.5 mm

Number of visual relocations: 2
Location: Foothills east of Jago River.
Distance from capture site:
Response time: 1.27 hr

Carcass condition and disposition: 65% consumed, tongue missing, left eye and ear missing, skeleton connected by skin, rumen and intestines 1-2 m from carcass, internal organs removed, right side of head not fed upon. Cow observed near carcass. Two immature golden eagles feeding on carcass.

Necropsy findings: Puncture wounds (3-9mm dia) on right scapula and hide of shoulder region. 3 ribs on left side removed (broken off near vertebrae). Hemorrhage in nasal cavity and around left side of skull.

Mortality category: Predation involved, golden eagle kill.

Mortality Case History

Calf No: 62
Captured: 7 June 1983

Sex: female
Location: coastal plain south of Barter Is.

Weight: 4.8 kg
Umbilicus condition: dry
Hoof condition: hard/worn
Health status: appeared healthy at capture.
Processing time: 5 min

Total length: 77 cm
Right hind foot length: 32 cm
New hoof length: 7.3
Estimated age at capture: 1 day

Cow-calf reunion: Capture crew observed reunion - subsequent monitoring not possible (transmitter not activated prior to release).

Signal monitored:_____ times/ 16 day period
Mortality detected: 23 June 1983
Carcass collected: 24 June 1983
Carcass weight: 1.5 kg
Total length:
Right hind foot length: 32.5 cm
New hoof length: 6.5 cm

Number of visual relocations: 0
Location: Near capture site
Distance from capture site:
Response time: 24 hr

Carcass condition and disposition: Lying on left side. Upper maxilla, rostrum and nose missing. Flesh and internal organs removed from right side of carcass, 80% consumed. Right zygomatic arch crushed. Tongue, ears and eyes removed. Bird scats present.

Necropsy findings:

Mortality category: Predation involved (probable brown bear), avian scavengers and (probable golden eagle and ravens).

Mortality Case History

Calf No: 63
Captured: 7 June 1983

Sex: male
Location: coastal plain south of Barter Is.

Weight: 6.2 kg
Umbilicus condition: bloody
Hoof condition: partially hard/worn
Health status: appeared healthy at capture
Processing time: 4 min

Total length: 78 cm
Right hind foot length: 32.5 cm
New hoof length: 7.6 mm

Estimated age at capture: 1 day

Cow-calf reunion: No reunion observed. Calf observed unattended by dam after release.

Signal monitored: _____ times/ 1 day period
Mortality detected: 8 June 1983
Carcass collected: 8 June 1983
Carcass weight: 5.4 kg
Total length: 81 cm
Right hind foot length: 33.5 cm
New hoof length: 8.5 mm

Number of visual relocations:
Location: Near capture site
Distance from capture site:
Response time:

Carcass condition and disposition: Sacrificed by project investigators when abandonment/starvation was apparent.

Necropsy findings: Abomasum empty - organs normal.

Mortality category: Predation/scavenging starvation (sacrifice) excluded, probable study-induced abandonment.

Mortality Case History

Calf No: 64
Captured: 7 June 1983

Sex: female
Location: foothills near Jago River.

Weight: 5.9 kg
Umbilicus condition: bloody
Hoof condition: hard/worn (slt)
Health status: appeared healthy at capture.
Processing time: 4 min.
Cow-calf reunion: Capture crew did not observe reunion.

Total length: 79 cm
Right hind foot length: 32.5 cm
New hoof length: 8.5 mm

Estimated age at capture: 1 days
Calf was abandoned by dam.

Signal monitored: 2 times/ 2 day period
Mortality detected: 8 June 1983
Carcass collected: 8 June 1983
Carcass weight: 5.5 kg
Total length: 80 cm
Right hind foot length: 32.5 cm
New hoof length: 7.5 mm

Number of visual relocations: 0
Location: Near capture site.
Distance from capture site:
Response time:

Carcass condition and disposition: Sacrificed by project investigators when abandonment was apparent and starvation imminent.

Necropsy findings: Abomasum empty - all other organs normal.

Mortality category: Predation/scavenging excluded, starvation (sacrifice), probable study induced abandonment.

Mortality Case History

Calf No: 65
Captured: 7 June 1983

Sex: female
Location: foothills near Jago River.

Weight: 8.1 kg
Umbilicus condition: moist
Hoof condition: hard/worn
Health status: appeared healthy at capture.
Processing time: 5 min
Cow-calf reunion: Capture crew did not observe reunion. Calf observed with dam 16.5 hours after release.

Total length: 87 cm
Right hind foot length: 37.0 cm
New hoof length: 8.4 mm

Estimated age at capture: 3 days

Signal monitored: 4 times/ 2 day period
Mortality detected: 9 June 1983
Carcass collected: 9 June 1983
Carcass weight: 3.7 kg
Total length:
Right hind foot length: 38 cm
New hoof length: 7.8 mm

Number of visual relocations: 1
Location: Near capture site.
Distance from capture site:
Response time: 2 hr

Carcass condition and disposition: 80% consumed, flesh and viscera removed. Tongue and 1 eye removed. Bird feathers and droppings present. No caribou in area.

Necropsy findings: Puncture wounds and hemorrhage above left eye and below left ear. Right side of rib cage intact. Left side of rib cage intact. Left side of rib cage partially missing.

Mortality category: Predation involved-golden eagle kill. Scavenging involved-gulls.

Mortality Case History

Calf No: 68
Captured: 8 June
Sex: female
Location: coastal plain S. of Barter Island.

Weight: 5.1 kg
Umbilicus condition: dry
Hoof condition: hard/worn
Total Length: 89 cm
Right hind foot length: 32.0 cm
New hoof length: 8.4 mm
Health Status: scouring-otherwise appeared normal.
Processing time: 4 min
Estimated age at capture: 3 days old.
Cow-calf reunion: Not observed by capture crew.

Signal Monitored: 25 times/ 130 day period
Number of Visual relocations: 2
Mortality detected: 16 Oct. 1983
Location: Upper Firth River
Carcass collected: 29 Oct. 1983
Distance from capture site:
Carcass weight:
Response time: 13 days
Total length:
Right hind foot length:
New hoof length:

Carcass condition and disposition: Only partially intact skeleton remaining. Located in small stream bed embedded in ice. 80% of carcass missing.

Necropsy findings:

Mortality category: Predation/scavenging involved.

Mortality Case History

Calf No: 69
Captured: 8 June 1983

Sex: male
Location: coastal plain south of Barter Is.

Weight: 9.1 kg
Umbilicus condition: dry
Hoof condition: hard/worn
Health status: appeared healthy at capture.
Processing time: 4 min

Total length: 84 cm
Right hind foot length: 33 cm
New hoof length: 8.3 mm

Estimated age at capture: 3 days

Cow-calf reunion: Capture crew did not observe reunion. Calf was observed unattended by a dam @ 13 and 47 hr after reunion.

Signal monitored: 4 times/ 3 day period
Mortality detected: 11 June 1983
Carcass collected: 11 June 1983
Carcass weight: 7.5 kg
Total length: 87 cm
Right hind foot length: 35.5 cm
New hoof length: 10.0 mm

Number of visual relocations: 1
Location: Near capture site.
Distance from capture site:
Response time: 6 hr

Carcass condition and disposition: Intact, no external indication of trauma. No attending cow at carcass site.

Necropsy findings: Rumen and abomasum packed with vegetation, no milk present. All other internal organs normal.

Mortality category: Predation/scavenging excluded, starvation, probable study-induced abandonment.

Mortality Case History

Calf No: unmarked 01
Captured:

Sex: undetermined
Location:

Weight:
Umbilicus condition:
Hoof condition:
Health Status:
Processing time:
Cow-calf reunion:

Total Length:
Right hind foot length:
New hoof length:

Estimated age at capture:

Signal Monitored:_____ times/____day period
Mortality detected: 4 June 1983
Carcass collected: 4 June 1983
Carcass weight:
Total length:
Right hind foot length:
New hoof length: 7.3 mm

Number of Visual relocations:
Location: southeast of VABM Bitty
Distance from capture site:
Response time:

Carcass condition and disposition: Brown bear feeding on carcass. Upper portion of head, mid-back and all viscera were missing. Carcass warm.

Neoropsy findings:

Mortality category: Predation involved - brown bear kill.

Mortality Case History

Calf No: unmarked 02
Captured:

Sex: male
Location:

Weight:
Umbilicus condition:
Hoof condition:
Health Status:
Processing time:
Cow-calf reunion:

Total Length:
Right hind foot length:
New hoof length:

Estimated age at capture:

Signal Monitored:_____ times/____day period
Mortality detected: 5 June 1983
Carcass collected: 5 June 1983
Carcass weight: 5.3 kg
Total length: 76 cm
Right hind foot length: 34 cm
New hoof length: 7.5 mm

Number of Visual relocations:
Location: near VABM Willa
Distance from capture site:
Response time:

Carcass condition and disposition: Three brown bears on 2 calf carcasses (unmarked 02 & 03). Calf dead. All viscera and lower portion of rib cage missing. 15% carcass consumed.

Necropsy findings: Skull broken and large wounds on shoulders. Shoulders are also bruised. Wound below right eye. Bruises on neck and behind left ear.

Mortality category: Predation involved-brown bear kill.

Mortality Case History

Calf No: unmarked 03
Captured:

Sex: female
Location:

Weight:
Umbilicus condition:
Hoof condition:
Health Status:
Processing time:
Cow-calf reunion:

Total Length:
Right hind foot length:
New hoof length:

Estimated age at capture:

Signal Monitored:_____ times/____day period
Mortality detected: 5 June 1983
Carcass collected: 5 June 1983
Carcass weight: 6.3 kg
Total length: 89 cm
Right hind foot length: 35 cm
New hoof length: 8.8 mm

Number of Visual relocations:
Location: near VABM Willa
Distance from capture site:
Response time:

Carcass condition and disposition: Calf still alive. Appears to be scouring. Three bears were on carcasses (unmarked 02 and 03). Carcass intact, sacrificed.

Necropsy findings: Lumbar region bitten as well as neck and head. Left scapula punctured. Abomasum full of mulk curds.

Mortality category: Predation involved-brown bear kill.

Mortality Case History

Calf No: unmarked 04
Captured:

Sex: undetermined
Location:

Weight:
Umbilicus condition:
Hoof condition:
Health Status:
Processing time:
Cow-calf reunion:

Total Length:
Right hind foot length:
New hoof length:

Estimated age at capture:

Signal Monitored:_____ times/____day period
Mortality detected: 9 June 1983
Carcass collected: 9 June 1983
Carcass weight: 6.9 kg
Total length: 81 cm
Right hind foot length: 35.4 cm
New hoof length: 8.2 mm

Number of Visual relocations:
Location: upper Okerokovik River
Distance from capture site:
Response time:

Carcass condition and disposition: Carcass lying on left side. Only right side had been fed upon. Cow standing over carcass. Golden eagle sitting 30 m from carcass. Eagle casting near carcass.

Necropsy findings: Puncture wounds behind rib cage on left side. Abomasum full of milk curds. Bruise on left shoulder. Right lung missing.

Mortality category: Predation involved-golden eagle kill.

Mortality Case History

Calf No: unmarked 05 Sex: undetermined
Captured: Location:

Weight: Total Length:
Umbilicus condition: Right hind foot length:
Hoof condition: New hoof length:
Health Status:
Processing time: Estimated age at capture:
Cow-calf reunion:

Signal Monitored:_____ times/____day period Number of Visual relocations:
Mortality detected: 13 June Location: S. VABM Bitty
Carcass collected: 13 June Distance from capture site:
Carcass weight: 9.9 kg Response time:
Total length:
Right hind foot length: 39 cm
New hoof length: 15.9 mm

Carcass condition and disposition: 15% of carcass missing. Puncture wound at rear of right orbit. Hole into body cavity right rib cage. Subcutaneous hemmorrhages around wounds.

Necropsy findings: Lung partially consumed. Milk curds in abomasum.

Mortality category: Predation involved-probable golden eagle kill. Two eagles nearby on another dead calf (#51).

Table A-1. Chronology of calving, calf mortality, udder distention, and antler drop (#) of 23 radio-collared control cows in the Porcupine caribou herd, 1983[a]

Cow # and Status	May		June																													
	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
BKY-0:																																
calf	-	-	N	Y	Y	-	Y	-	-	Y	-	Y	Y	Y	-	-	-	Y	-	-	Y	-	Y	-	-	Y	-	-	Y	-	-	-
udder	-	-	U	U	U	-	U	-	-	U	-	U	U	U	-	-	-	U	-	-	U	-	U	-	-	U	-	-	U	-	-	-
antlers	-	-	2	2	2	-	2	-	-	1	-	U	0	-	-	-	-	0	-	-	0	-	0	-	-	0	-	-	0	-	-	-
BKY-1:																																
calf	-	-	N	N	N	-	N	N	-	-	-	-	N	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	U	N	N	-	N	N	-	-	-	-	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	2	2	2	-	0	0	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKY-2:																																
calf	-	-	N	N	N	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	N	N	U	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	0	0	U	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKY-3:																																
calf	-	-	N	N	N	N	N	Y	-	Y	Y	Y	-	Y	-	-	Y	Y	-	-	Y	-	Y	-	-	Y	-	-	Y	-	-	-
udder	-	-	U	Y	Y	N	N	U	-	U	U	U	-	U	-	-	U	U	-	-	U	-	U	-	-	U	-	-	U	-	-	-
antlers	-	-	2	2	2	2	2	2	-	2	2	2	-	2	-	-	U	0	-	-	0	-	0	-	-	0	-	-	0	-	-	-
BKY-6:																																
calf	-	-	N	N	N	N	N	Y	Y	Y	Y	Y	-	-	-	Y	-	-	Y	-	-	Y	-	-	-	Y	-	-	Y	-	-	-
udder	-	-	U	U	U	U	N	U	U	U	U	U	-	-	-	U	-	-	U	-	-	U	-	-	-	U	-	-	U	-	-	-
antlers	-	-	2	2	2	2	2	2	2	2	2	2	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	-
BKY-7:																																
calf	-	-	N	N	N	-	N	-	-	N	-	N	N	N	-	-	-	Y	-	N	N	-	N	-	-	N	-	-	-	-	-	-
udder	-	-	U	U	Y	-	Y	-	-	U	-	Y	Y	Y	-	-	-	U	-	Y	Y	-	Y	-	-	U	-	-	-	-	-	-
antlers	-	-	2	2	1	-	1	-	-	1	-	1	0	0	-	-	-	0	-	0	0	-	0	-	-	0	-	-	-	-	-	-
BKY-10:																																
calf	-	-	N	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	N	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKY-12:																																
calf	-	-	N	Y	Y	Y	Y	-	-	Y	Y	Y	Y	Y	-	N	-	Y	-	-	Y	-	Y	-	-	Y	-	-	N	Y	-	-
udder	-	-	U	U	U	U	Y	-	-	U	U	U	U	U	-	U	-	U	-	-	U	-	U	-	-	U	-	-	U	U	-	-
antlers	-	-	2	2	2	2	2	-	-	2	1	1	U	1	-	U	-	U	-	-	U	-	U	-	-	U	-	-	U	U	-	-
BKY-16:																																
calf	-	-	N	N	N	-	-	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	U	N	U	-	-	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	2	0	0	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKY-18:																																
calf	-	-	N	-	Y	-	Y	-	-	Y	Y	Y	-	Y	-	-	-	-	Y	-	Y	-	Y	-	-	Y	-	-	Y	-	-	Y
udder	-	-	U	-	U	-	Y	-	-	U	U	U	-	U	-	-	-	-	U	-	U	-	U	-	-	U	-	-	U	-	-	U
antlers	-	-	2	-	2	-	2	-	-	2	2	0	-	0	-	-	-	-	0	-	0	-	0	-	-	0	-	-	0	-	-	0

Table A-1, (Ccontinued).

Cow # and Status	May 29	May 30	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
BKY-19:																																
calf	-	-	N	N	N	Y	Y	-	Y	-	-	Y	-	-	-	Y	-	-	Y	-	Y	-	Y	-	-	Y	-	-	Y	-	-	Y
udder	-	-	U	U	U	U	Y	-	U	-	-	U	-	-	-	U	-	-	U	-	U	-	U	-	-	U	-	-	U	-	-	U
antlers	-	-	2	2	2	2	2	-	2	-	-	2	-	-	-	0	-	-	0	-	0	-	0	-	-	0	-	-	0	-	-	0
BKY-20:																																
calf	-	-	N	N	N	-	N	-	-	Y	-	Y	Y	Y	-	-	-	Y	-	-	Y	-	Y	-	-	Y	-	-	-	-	-	-
udder	-	-	U	Y	U	-	Y	-	-	U	-	U	U	U	-	-	-	U	-	-	U	-	U	-	-	U	-	-	-	-	-	-
antlers	-	-	2	2	2	-	2	-	-	2	-	2	2	0	-	-	-	0	-	-	0	-	0	-	-	0	-	-	-	-	-	-
BKY-22:																																
calf	N	Y	N	N	N	N	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-
udder	U	Y	U	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	U	-	-	-	-	-	-	-	-	-	-	-	-
antlers	2	2	U	U	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
BKY-26:																																
calf	-	-	N	N	N	-	Y	-	Y	-	Y	Y	-	Y	-	-	Y	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	U	U	Y	-	Y	-	U	-	U	U	-	U	-	-	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	2	2	2	-	2	-	0	-	0	U	-	0	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKY-41:																																
calf	-	-	Y	Y	Y	-	Y	-	-	Y	Y	-	Y	Y	-	-	-	Y	-	-	Y	-	Y	-	-	Y	-	-	Y	-	-	-
udder	-	-	U	U	U	-	U	-	-	U	U	-	U	U	-	-	-	U	-	-	U	-	U	-	-	U	-	-	U	-	-	-
antlers	-	-	2	2	2	-	0	-	-	0	0	-	0	0	-	-	-	0	-	-	0	-	0	-	-	0	-	-	0	-	-	-
BKY-42:																																
calf	-	-	N	N	N	N	N	N	N	-	N	N	-	N	N	N	N	N	Y	Y	Y	-	N	-	-	N	-	-	-	-	-	-
udder	-	-	U	U	U	N	N	N	Y	-	Y	Y	-	Y	N	N	Y	Y	U	U	U	-	U	-	-	U	-	-	-	-	-	-
antlers	-	-	2	2	2	2	2	2	2	-	2	2	-	1	1	1	1	1	1	1	1	-	0	-	-	0	-	-	-	-	-	-
B-40:																																
calf	-	-	N	N	N	-	Y	-	-	Y	-	Y	Y	Y	-	-	-	Y	-	-	Y	-	Y	-	-	Y	-	-	-	-	-	-
udder	-	-	U	U	U	-	U	-	-	U	-	U	U	U	-	-	-	U	-	-	U	-	U	-	-	U	-	-	-	-	-	-
antlers	-	-	2	2	2	-	2	-	-	0	-	0	0	0	-	-	-	0	-	-	0	-	0	-	-	0	-	-	-	-	-	-
BY-1:																																
calf	-	-	N	N	N	N	N	N	-	-	N	N	N	N	N	-	N	N	N	N	Y	Y	Y	-	-	Y	-	-	-	-	-	Y
udder	-	-	U	U	U	U	U	U	-	-	Y	Y	Y	Y	U	-	Y	Y	U	Y	U	U	U	-	-	Y	-	-	-	-	-	Y
antlers	-	-	2	2	2	2	2	2	-	-	2	2	2	2	2	-	2	2	2	2	2	2	2	-	-	U	-	-	-	-	-	U
RY-4:																																
calf	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y	Y	-	-	Y	-	-	Y	-	Y	-	-	Y	-	-	Y	-	-	-
udder	-	-	-	-	-	-	-	-	-	-	-	U	U	U	U	-	-	U	-	-	U	-	U	-	-	U	-	-	U	-	-	-
antlers	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	-	0	-	-	0	-	0	-	-	0	-	-	0	-	-	-
RY-29:																																
calf	-	-	N	N	N	-	Y	-	-	N	N	Y	N	N	N	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
udder	-	-	U	Y	Y	-	Y	-	-	Y	Y	U	Y	Y	U	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
antlers	-	-	2	2	2	-	2	-	-	2	2	2	2	2	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A-1. (Continued).

Cow # and Status	May 29	May 30	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GY-24:																																
calf	–	–	N	N	N	N	N	N	N	Y	Y	Y	–	Y	–	–	Y	Y	–	–	–	–	Y	–	–	Y	–	–	Y	–	–	Y
udder	–	–	U	U	U	Y	U	Y	Y	U	U	U	–	U	–	–	U	U	–	–	–	–	U	–	–	U	–	–	U	–	–	U
antlers	–	–	2	2	2	2	2	2	2	2	2	2	–	2	–	–	U	U	–	–	–	–	U	–	–	U	–	–	U	–	–	U
GY-25:																																
calf	–	–	–	–	–	–	–	–	–	–	–	–	–	–	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
udder	–	–	–	–	–	–	–	–	–	–	–	–	–	–	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
antlers	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
GY-27:																																
calf	–	–	Y	Y	Y	Y	Y	–	Y	–	Y	Y	–	Y	–	–	Y	–	Y	–	Y	–	Y	–	–	Y	–	–	Y	–	–	–
udder	–	–	U	U	U	U	U	–	U	–	U	U	–	U	–	–	U	–	U	–	U	–	U	–	–	U	–	–	U	–	–	–
antlers	–	–	2	2	2	2	0	–	0	–	0	0	–	0	–	–	0	–	0	–	0	–	0	–	–	0	–	–	0	–	–	–

[a]N=no; Y=yes; U=undetermined.