DISTRIBUTION AND MOVEMENTS OF THE CENTRAL ARCTIC CARIBOU HERD, SUMMER 1983.

Final Report

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

1. A total of 1,205 locations of 34 radio-collared caribou were obtained between 23 May and 10 August 1983.

2. Twenty-three of the 27 radio-collared cow caribou had calves, for a ratio of 85 calves/100 cows. The first calf was observed on 23 May; most calves were born by 10 June.

3. Caribou were widely dispersed throughout the coastal plain during the calving season. Areas of relatively high numbers were:
   a. between Kalubik Creek and Beechey Point, to 12 miles inland (635 adult and yearling caribou observed on 8 June);
   b. between Mikkelsen Bay and the Canning River, to 14 miles inland (391 adult and yearling caribou observed on 10 June);
   c. lesser concentrations were observed in the White Hills (67), between Franklin Bluffs and the Kadleroshilik River (53), and the low hills east of the Kavik River (178).

4. The majority of the CAH separated into two distinct segments during mosquito season: an eastern segment that ranged between the Sagavanirktok and Katakturuk rivers (approximately 4,300 caribou) and a western segment that ranged between the Colville and Putuligayuk rivers (approximately 4,900 caribou).

5. The two segments of the herd generally remained on their respective sides of the Sagavanirktok River during calving, post-calving, and mosquito seasons. Thus, it appeared that the location of summer range was strongly influenced by calving location (that is, caribou that calved in a certain area tended to remain there for most of the summer).

6. Some areas were consistently used during mosquito season: the region between Milne Point and the Kuparuk River on the west, and on the east, the area between the Kadleroshilik and Shaviovik rivers, and the vicinity of the Canning River delta.

7. Caribou movements during mosquito season were largely influenced by mosquito activity and wind direction. Movements by both herd segments tended to be synchronous, with caribou traveling to the coast during periods of mosquito harassment and then into the wind. For instance, during easterly winds the western segment would travel from the Oliktok Point region toward the Kuparuk River delta, while the eastern segment would travel east toward the Shaviovik and Canning river deltas. A similar movement pattern in the reverse direction occurred during westerly winds.

8. The most heavily used areas for relief from mosquitoes were the Kuparuk, Shaviovik, and Canning river deltas.

9. The movements of caribou in the Kuparuk Oilfield were similar to the overall movement pattern of the CAH in 1983. Caribou usually were located north of the Kuparuk Pipeline during mosquito season, probably because of a lack of cyclic temperature variations and the resulting east-west movements. When southward movements did occur across the Spine Road and Kuparuk Pipeline they usually happened during late evening and early morning hours. It appears that weather, rather than petroleum development, was the primary factor influencing caribou distribution and movements.

10. Oestrid fly season was characterized by overlap of areas used by the eastern and western segments of the herd. The area used by caribou was greatly expanded compared to mosquito season. Dispersal due to oestrid fly harassment appeared to be the major factor influencing these movements.

11. The mean distance from the coast for all locations of radio-collared caribou was about 16 miles during calving and post-calving. The mean distance decreased to 4 miles for both eastern and western segments of the herd during mosquito season, and increased to 19 miles during oestrid fly season.

12. Sedge meadows were the most frequently used habitat type. Calving season was characterized by relatively high use of upland tussock tundra, possibly selected because it is well-drained, and by little use of riparian habitat, probably due to predator avoidance behavior. Use of riparian, gravel, and beach habitats increased during mosquito season; these habitats probably offered relief from mosquitoes. Bull groups used riparian habitat more often than cow groups. Use of upland tussock tundra increased during oestrid fly season as caribou dispersed inland. Use of gravel, riparian, man-made, and ridge/bank/pingo habitats increased as a result of caribou seeking relief from oestrid flies.

INTRODUCTION

The Central Arctic Herd (CAH) of caribou (Rangifer tarandus) ranges between the Colville and Canning rivers, north to the Beaufort Sea, and inland as far as the Brooks Range. In 1981, the CAH numbered about 9,000 animals (Cameron et al. 1983). Calving occurs throughout the Arctic Coastal Plain between the Colville and Canning rivers (Cameron and Whitten 1979), with areas of relatively high densities near Milne Point, the Canning River delta, Franklin Bluffs, the White Hills, and inland from the Colville River delta (Cameron and Whitten 1980a; Cameron et al. 1981, 1983). Productivity of the CAH has been high since at least 1978, with calf/cow ratios in June averaging 65-85/100 and the rate of annual increase averaging 13 percent (Whitten and Cameron 1983a; Curatolo and Murphy 1983; Cameron et al. 1983). After calving, the majority of the CAH spends the summer on the coastal plain, traveling to the coast during periods of mosquito harassment and moving inland during mosquito-free periods (Child 1973; Roby 1978; Cameron and Whitten 1980a; Curatolo et al. 1982). The CAH usually overwinters in the northern foothills of the Brooks Range, although several hundred animals have also been observed on the coastal plain during winter (Cameron and Whitten 1980b; Gavin 1982; Carruthers 1983). Migration routes between winter and summer ranges are oriented along major rivers, which flow north (Cameron and Whitten 1977). Summaries of the history and status of the CAH can be found in Child (1973), Roby (1978), and Cameron and Whitten (1979).

Although the CAH is relatively small, it has recently attracted attention because of petroleum-related development within its range. Concern over the effects of development on caribou has prompted the following research:

responses of caribou to a simulated pipeline (Child 1973) and operating drill sites (Fancy et al. 1981; Fancy 1982) in the Prudhoe Bay Oilfield; behavior (Roby 1978), distribution, and movements (Cameron and Whitten 1980a,b; Whitten and Cameron 1983b), along the Trans-Alaska Pipeline corridor; and distribution, movements (Cameron and Whitten 1979, 1980a; Cameron et al. 1981; Robus 1983; Robus and Curatolo 1983), and responses of caribou to pipelines and roads (Curatolo et al. 1982; Curatolo and Murphy 1983; Murphy and Curatolo 1984; Curatolo 1984) in the Kuparuk Oilfield. Some researchers have stated that the CAH, especially the cow-calf segment, tends to avoid the Prudhoe Bay Oilfield and Alyeska Pipeline complex (Roby 1978; Cameron and Whitten 1979; Smith and Cameron 1982).

Few studies have examined the overall movements and distribution of the CAH; instead, emphasis has been placed on responses of caribou to specific aspects of oilfield development. Recently, Cameron (1983) stressed the need for a region-wide plan to minimize future impacts of oil development on caribou. The study reported here was undertaken to determine the summer distribution and movements of the CAH, in an attempt to provide the data necessary for regional planning. Specifically, the objectives were:

- to collect data on distribution and movement patterns in relation to the Kuparuk and Prudhoe Bay oilfields;
- to examine the relationship between weather-induced changes in insect activity and the timing, rate, and destination of the resultant caribou movements;
- to describe, both spatially and temporally, areas of intensive use, including calving grounds, mosquito-relief habitat, movement zones, and oestrid fly-relief habitat;

- to compare movement patterns and the extent of interchange between caribou west of the Sagavanirktok River (in an area of industrial activity), and east of the Sagavanirktok River (in an undeveloped area); and,
- to determine the production and survival of calves born to radio-collared cows.

STUDY AREA

The study area was bounded on the north by the Beaufort Sea, on the east by the Katakturuk and upper Canning rivers, on the south by the northern flanks of the Brooks Range, and on the west by the Itkillik and lower Colville rivers. This area comprises portions of three physiographic provinces: the Arctic Coastal Plain, a smooth, poorly-drained plain, containing several widely-scattered groups of low hills, which rises from sea level to around 600 feet elevation at its southern edge; the Arctic Foothills, which consist of rolling plateaus and low mountains trending eastward, rising from an elevation of 600 feet on the north to over 3,000 feet on the south; and the central and eastern Brooks Range section of the Arctic Mountains province, consisting of rugged mountains that rise abruptly from the foothills to maximum elevations of 7,000-8,000 feet (Wahrhaftig 1965).

The climate of the region is severe, with long, cold winters and short, cool summers. Air temperatures in summer are lowest at the coast, increasing sharply with increasing distance inland; this gradient is especially steep within 10-12 miles of the coast (Brown et al. 1975, Walker et al. 1980). Prevailing winds in summer are from the east and northeast. Annual precipitation, at 6-8 inches, is low (Walker et al. 1980).

The entire region is underlain by continuous permafrost, and patterned ground and thaw lakes are common in areas of low relief. Wet and moist tundra vegetation types predominate on the coastal plain and in the foothills, with shrublands occupying riparian habitats. Alpine tundra vegetation occurs in the higher foothills and mountains. Detailed information on geology, permafrost, climate, landforms, soils, and vegetation is presented by Walker et al. (1980).

METHODS

Radio telemetry from fixed-wing aircraft was the principal method employed to determine distribution and movements of caribou. Survey routes were determined principally by weather conditions and the locations of radio-collared caribou. During each survey, data were recorded for all groups encountered, whether or not they included radio-collared caribou.

Collared animals had been captured and fitted with collars by Alaska Department of Fish and Game biologists (Whitten and Cameron 1983b); each collar consisted of a radio-transmitter attached to a neck collar that was numbered for visual identification. Frequencies of radio-collars ranged from 150.220 MHz to 151.594 MHz.

Piper PA-18 "Super Cub" and Cessna 185 "Skywagon" aircraft were used for surveys. A "side-looking" "H"-antenna (Model RA-2A, Telonics, Mesa, AZ) was mounted on the struts under each wing. Antenna leads were attached to a right/left switch box, which was coupled to a scanning receiver (Telonics TR-2/TS-1) that allowed rapid, sequential monitoring of all radio-collar frequencies. Initially, antennas were mounted in a horizontal configuration under the wings; midway through the study, however, they were changed to a vertical configuration slightly ahead of the wings, which dramatically improved signal reception and reduced tracking time. Maximum range of signal reception varied, depending on topography and aircraft altitude, but was usually 15-30 miles at normal survey altitudes (500-1,500 feet above ground level).

Prior to each survey, radio-collar frequencies were programmed into the scanning receiver. A broad search pattern was flown and all frequencies were

monitored until an individual signal was received; this signal was tracked to its source by balancing it between the two antennas while flying in the direction of maximum signal strength. After a collared animal was located, its frequency was deleted from the scanner memory. This process was repeated until all desired radio-collars were located. Not all radio-collared caribou were located on each survey flight.

During each survey the flight line and locations of all caribou groups encountered were recorded on 1:250,000 U.S. Geological Survey topographic maps; 1:63,360 maps were used in the Kuparuk Oilfield to record caribou locations as accurately as possible in relation to development structures. Locations were numbered sequentially during each flight, and a data form (Appendix A) was used to record observations.

Data recorded for each group included:

- date and time of observation;
- which radio-collars (if any) were in the group;
- group size;
- group type (cow and/or yearling-dominated, cow/calf-dominated; bull-dominated, mixed, unclassified adult, or unknown);
- group activity (feeding, lying, walking, trotting/running, standing, or unknown);
- habitat type (wet/dry sedge meadow, upland tussock, riparian willow, gravel/sand bar, ridge/bank/pingo, lake margin, ocean beach, water, man-made, or unknown);
- direction of movement (N, NE, E, SE, S, SW, W, NW, none, variable, or unknown);
- snow cover (estimated); and,
- disturbance (presence/absence and stimulus).

When necessary, group size and type were determined with the aid of a hand-held counter and binoculars. Large groups were photographed to verify group size estimates, using a 35mm camera equipped with a "data-back" that recorded date and time directly onto the photographs. To avoid visibility bias (Caughley 1974), only groups containing radio-collared caribou were used to calculate mean group size.

For purposes of analysis, all locations of radio-collared caribou (including additional sightings made while on the ground) were plotted on 1:250,000 maps. These maps were used to determine, for each observation of radio-collared caribou, the shortest distance to the coast, the straight-line distance from the previous location, and the net direction of movement from the previous location. Distances were measured to the nearest fifth of a mile. All data were coded in a standardized format and entered into a Vector 4 micro-computer (Vector Graphic, Inc., Thousand Oaks, CA).

A level of mosquito harassment (none/light or moderate/severe) was assigned to each day during mosquito season (3 July - 25 July). These levels were based on ground observations at five sites in the Kuparuk and Prudhoe Bay oilfields.

RESULTS AND DISCUSSION

Radio-Collared Caribou - Overview

Locations were obtained for 36 radio-collared caribou during the 1983 field season. Two of these animals calved and summered in the foothills south of Sagwon Bluffs and were monitored irregularly. The remaining 34 spent the summer on the coastal plain and thus were monitored regularly. Two of the transmitters stopped in mid-July, reducing the number of regularly-monitored animals to 32 during the last month of field work. A total of 1,205 locations (1,151 from the air plus 54 ground observations) were obtained for the 34 regularly-monitored animals, for a mean of 35.4 relocations per animal.

The sex and age composition of the sample of radio-collared animals is presented in Table 1. The sample comprised 27 adult cows, 2 two-year-olds (1 female, 1 male), and 7 yearlings (5 females, 2 males). The yearlings were born in 1982 to the collared cows listed in Table 1. The two cows with YB collars were considered to be members of the Western Arctic Herd when collared near Umiat in 1982 (R. Cameron, pers. comm.). In addition, a cow collared near Teshekpuk Lake (YB39) was found dead on the eastern Sagavanirktok River delta on 10 June.

Radio-collared animals were found most often in cow-calf groups (Table 2) because most collared caribou were cows, and caribou usually segregate by sex (Cameron and Whitten 1979). The high percentage of lone caribou observed during oestrid fly season was a direct result of fly harassment (Curatolo 1975).

Table 1. Sex and age composition of radio-collared caribou tracked during 1983, Colville to Canning rivers, Alaska.

Collar[1]	Sex	Age[2]	Comments[3]
RY1	F	A	C; radio dead by 16 July
RY2	F	A	C
RY6	F	A	C
RY8	F	A	C
RY9	F	A	C
RY11	F	A	C
RY12	F	A	C
RY13	F	A	C; summered in foothills
RY14	F	A	C
RY15	F	A	C
RY17	F	A	C
RY19	F	A	No C
RY20	F	A	C
RY52	F	A	C
RY54	F	A	C
RY55	F	A	No C
RY56	F	A	C
RY57	F	A	C
RY58	F	A	C
RY59	F	A	C
RY60	F	A	C
RY61	F	A	No C
RY68	F	A	C; summered in foothills
RY82	F	A	C
RY83	F	A	C; radio dead by 15 July
YB17	F	A	C
YB48	F	A	No C
BY9	M	2-yr-old	
BY10	F	2-yr-old	
G2	F	Y	RY6
G3	F	Y	RY20
G4	M	Y	RY11
G5	F	Y	RY14
G6	F	Y	RY12
G7	F	Y	RY83
G8	M	Y	RY15

[1]RY=red collar/yellow numbers, YB=yellow/black, BY=blue/yellow, G=green.
[2]A=adult, Y=yearling (born 1982).
[3]C=calf born to cow in 1983; RY collars listed are dams of yearlings.

Table 2. Types of caribou groups containing radio-collared caribou, Colville to Canning rivers, Alaska, 1983.

	Group type[2] (Percent)								
Period	Mixed	Cow-calf[1]	Bull	Cow and/or yearling	Unclassified adult	Single cow	Single yearling	Single bull	Number of groups
Calving	0.0	31.0	0.0	58.0	0.0	6.0	4.0	1.0	100
Post-calving	2.9	85.7	8.6	0.0	2.9	0.0	0.0	0.0	35
Mosquito	44.6	48.8	5.5	0.0	0.3	0.0	0.8	0.0	379
Oestrid fly	21.6	53.3	5.0	3.0	0.0	9.0	7.5	0.5	199
Overall	29.9	49.4	4.8	9.0	0.3	3.4	3.1	0.3	713

[1]The high proportion of cow-calf groups is due to the fact that radio-collared caribou were predominantly cows.

[2]Groups were classified as cow-calf, bull, or cow and/or yearling if the majority of the caribou appeared to be in that category. Mixed groups contained relatively equal proportions of cow-calf pairs and bulls.

The activities of caribou groups located by radio telemetry are presented in Table 3. The percentages of activities totaled more than 100 because more than one activity could be recorded per group. Throughout the study period, the predominant activities were feeding and lying. The high percentage of walking observed during post-calving probably is due to small sample size, but may reflect movement occurring at that time. Running was highest during mosquito and oestrid fly seasons, as a result of insect harassment. The relatively high percentage of standing during oestrid fly season also reflects the behavioral reaction of caribou to oestrid fly attack (e.g., rigid standing, Espmark 1968).

Calving Season

Approximately 70 hours of aerial surveys were flown during the periods 23-28 May and 4-10 June. During these flights most of the study area within 30 miles of the coast was surveyed, as well as portions of the northernmost foothills.

Distribution and Movements

Caribou were widely dispersed throughout the coastal plain and northern foothills. However, several areas of higher density were evident by early June (Figure 1). The highest numbers were observed in two areas:

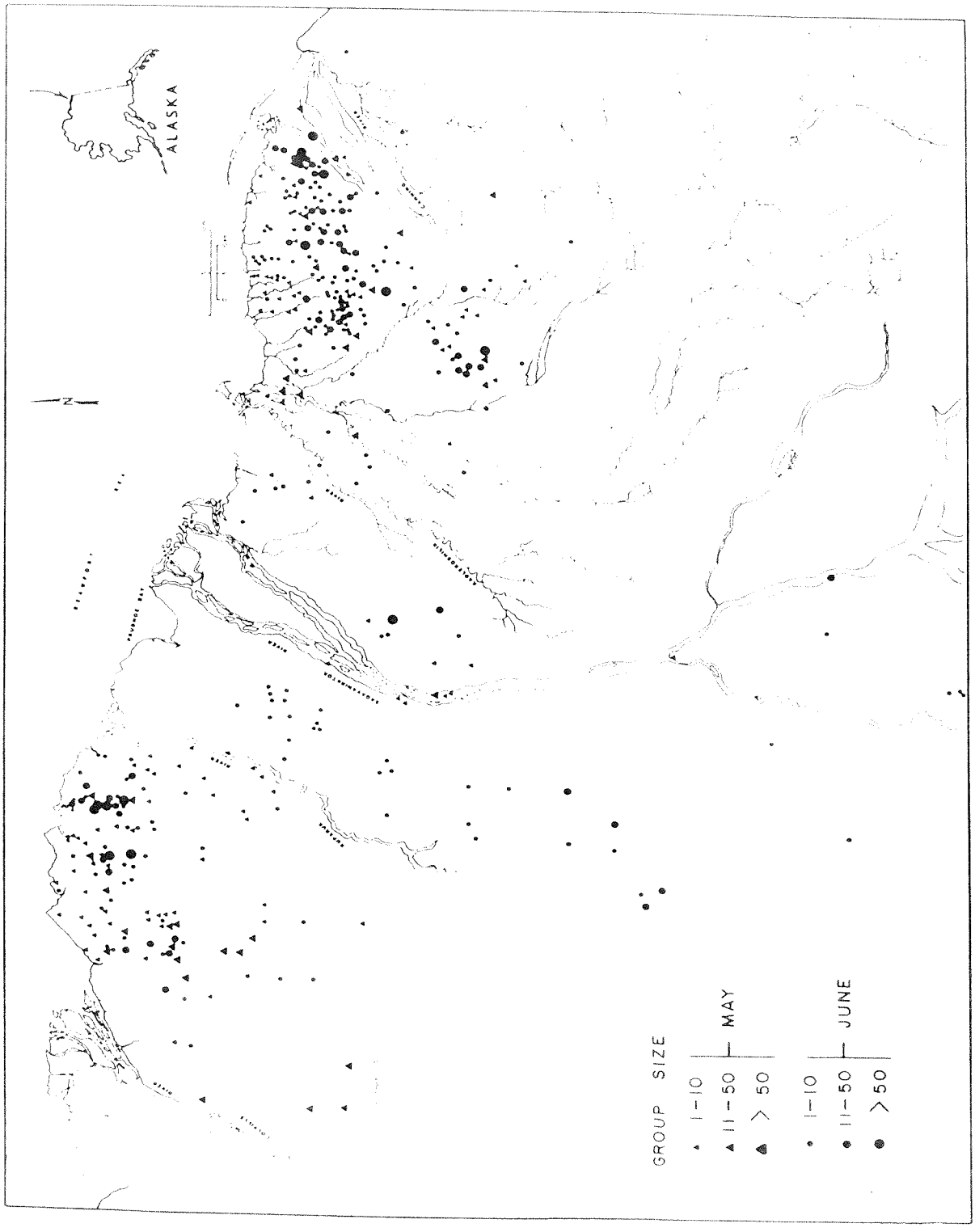
1) within the Kuparuk Oilfield, between Kalubik Creek and Beechey Point, extending inland approximately 12 miles (maximum of 635 adult and yearling caribou observed on 8 June); and,

Table 3. Activities of caribou groups containing radio-collared caribou, Colville to Canning rivers, Alaska, 1983.

	Activity[1] (Percent)					
Period	Feeding	Lying	Walking	Standing	Running	Number of groups
Calving	38.2	35.3	22.6	9.8	3.9	102
Post-calving	82.4	55.9	47.1	0.0	5.9	34
Mosquito	69.4	44.0	27.3	8.6	12.9	373
Oestrid fly	66.7	31.8	14.9	20.0	15.4	195
Overall	64.8	39.9	24.1	11.5	11.9	704

[1]One group can be represented in more than one category.

Figure 1. Composite of all locations of CAH caribou observed during calving season, 23 May - 10 June 1983. Numbers include repeated observations of the same individuals on different days.


ALASKA
N
GROUP SIZE
1–10
11–50
> 50
MAY
1–10
11–50
>50
JUNE

2) between Mikkelsen Bay and the Canning River, extending inland approximately 14 miles (maximum of 391 adult and yearling caribou observed on 10 June).

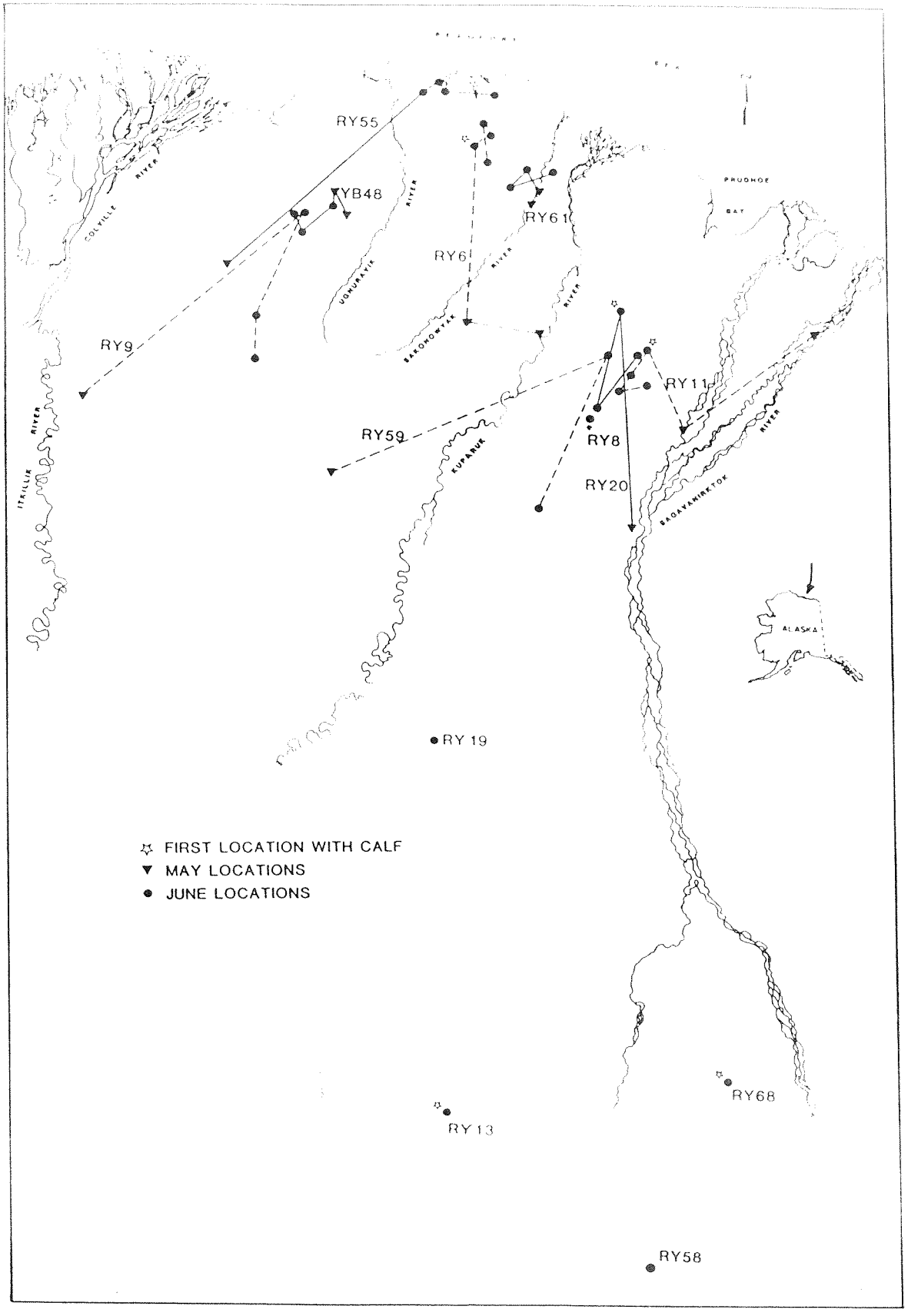
Lower-density concentrations were encountered in three upland areas:

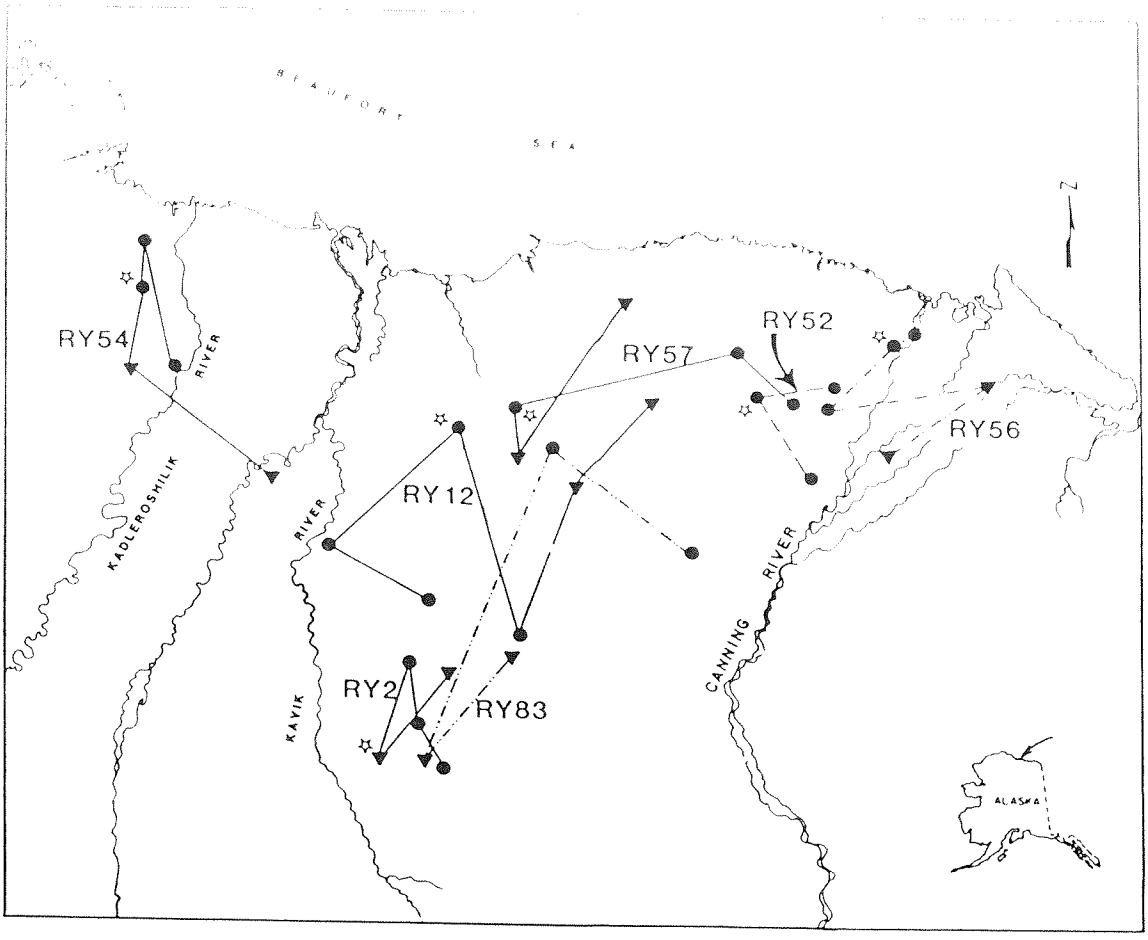
1) the White Hills (maximum of 67 adult and yearling caribou observed on 9 June);
2) the low hills between Franklin Bluffs and the Kadleroshilik River (maximum of 53 adult and yearling caribou observed on 8 June); and,
3) the low hills east of the Kavik River, approximately 20-25 miles south of Mikkelsen Bay (maximum of 178 adult and yearling caribou observed on 10 June).

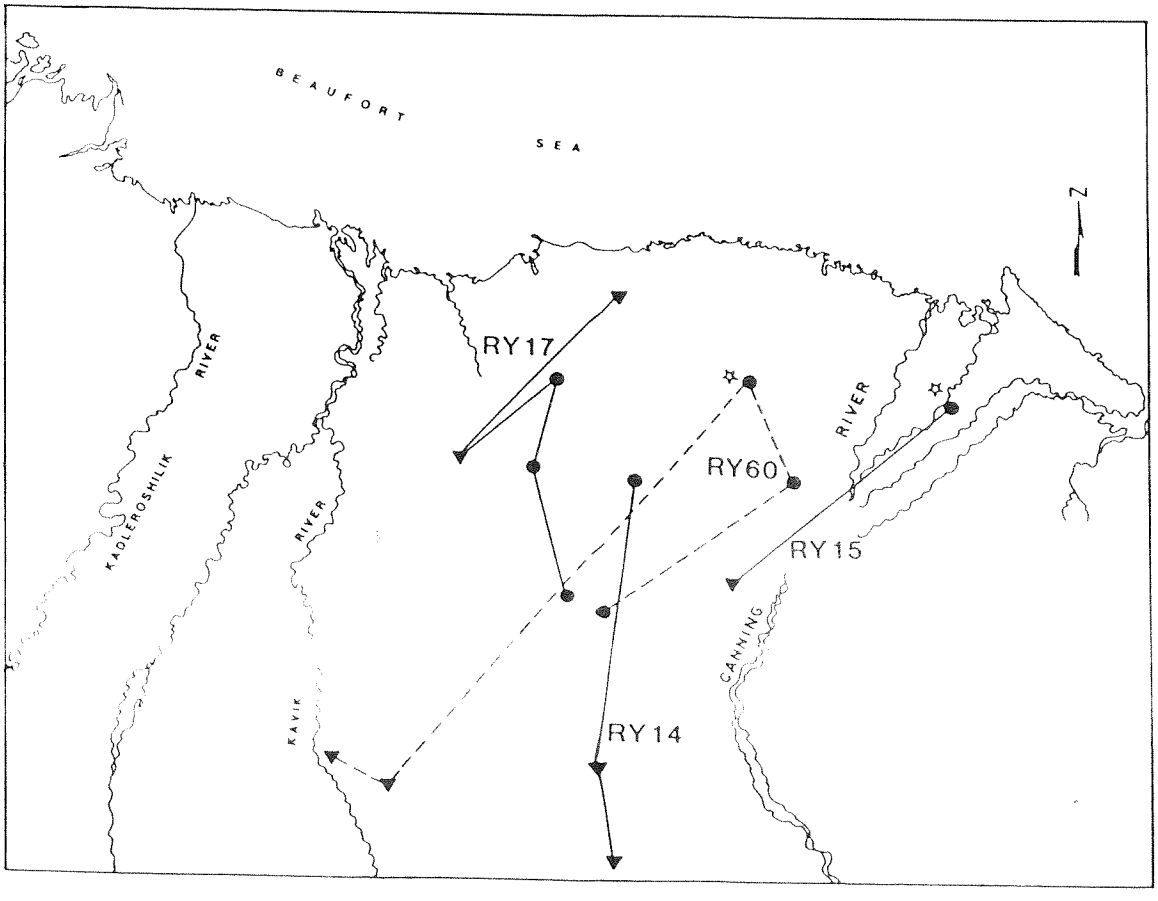
The area between the Kuparuk and Sagavanirktok rivers, southwest of Prudhoe Bay and north of Franklin Bluffs, hosted a diffuse, low-density aggregation in early June that included three collared cows. Observations in the remainder of the coastal plain portion of the study area revealed small, widely-scattered groups of caribou in no discernible pattern. An unknown, but probably small, number of cows calved relatively far inland, as evidenced by the locations of RY13, RY58, and RY68 in early June (Figure 2). Of these three animals, only RY58 spent the insect season on the coastal plain.

Distribution of caribou during the calving season was not static. Virtually all collared cows moved north between the late May and early June survey periods (Figure 2). Surveys of concentration areas also revealed an increase in the number of animals between these periods. Near the end of the June survey period an inland shift was noted, especially in the area between the Shaviovik and Canning rivers; this shift occurred after a fresh snowfall

Figure 2. Locations of radio-collared CAH caribou cows during calving season, 1983, including first observations with calves.


RY55
YB48
RY61
RY6
RY9
RY11
RY59
RY8
RY20
RY 19
RY68
RY13
RY58
COLVILLE RIVER
ITKILLIK RIVER
KUPARUK RIVER
SAGAVANIRKTOK RIVER
PRUDHOE BAY
ALASKA
FIRST LOCATION WITH CALF
MAY LOCATIONS
JUNE LOCATIONS


BEAUFORT
SEA
N
RY54
RIVER
KADLEROSHILIK
RIVER
RY12
RY57
RY52
RY56
CANNING
RIVER
KAVIK
RY2
RY83
ALASKA


BEAUFORT
SEA
N
RY17
RIVER
KADLEROSHILIK
RIVER
RY60
RIVER
RY15
CANNING
KAVIK
RY14

(R. Ritchie, pers. comm.). In general, movements during this season were largely in northeast-southwest and north-south directions (Figure 3). The highest rate of movement between successive locations during the calving season occurred between 8 and 9 June, when RY12 and her calf moved nine miles in 19 hours. For eight other cows, the mean distance moved between locations obtained one day apart during 7-10 June was 3.1 ± 2.6 miles (n=11). This value suggests that there was an appreciable amount of daily movement during early June, when calves were quite young.

The mean distance from the coast for all locations during calving season was 16.2 miles (Table 4).

Timing

The first calf of the 1983 season was observed south of Bullen Point on 23 May. The peak of calving occurred during the first week of June, judging from the first observations of calves with radio-collared cows (Table 5), and general observations on numbers of calves in maternal cow groups. Most calves probably were born by 10 June, which was the last survey during this period.

Numbers

On a survey west of the Sagavanirktok River on 8 June, 928 caribou were classified, of which 33.2 percent were calves. On a survey east of the Sagavanirktok River on 10 June, 744 caribou were classified, of which 36.6 percent were calves. These percentages represent minimums due to low

Figure 3. Direction of movement from previous location for radio-collared caribou, Colville to Canning rivers, Alaska, 1983. For calving, post-calving, and oestrid fly seasons, all locations were used. For mosquito season, only locations obtained within 2 days of each other were used.

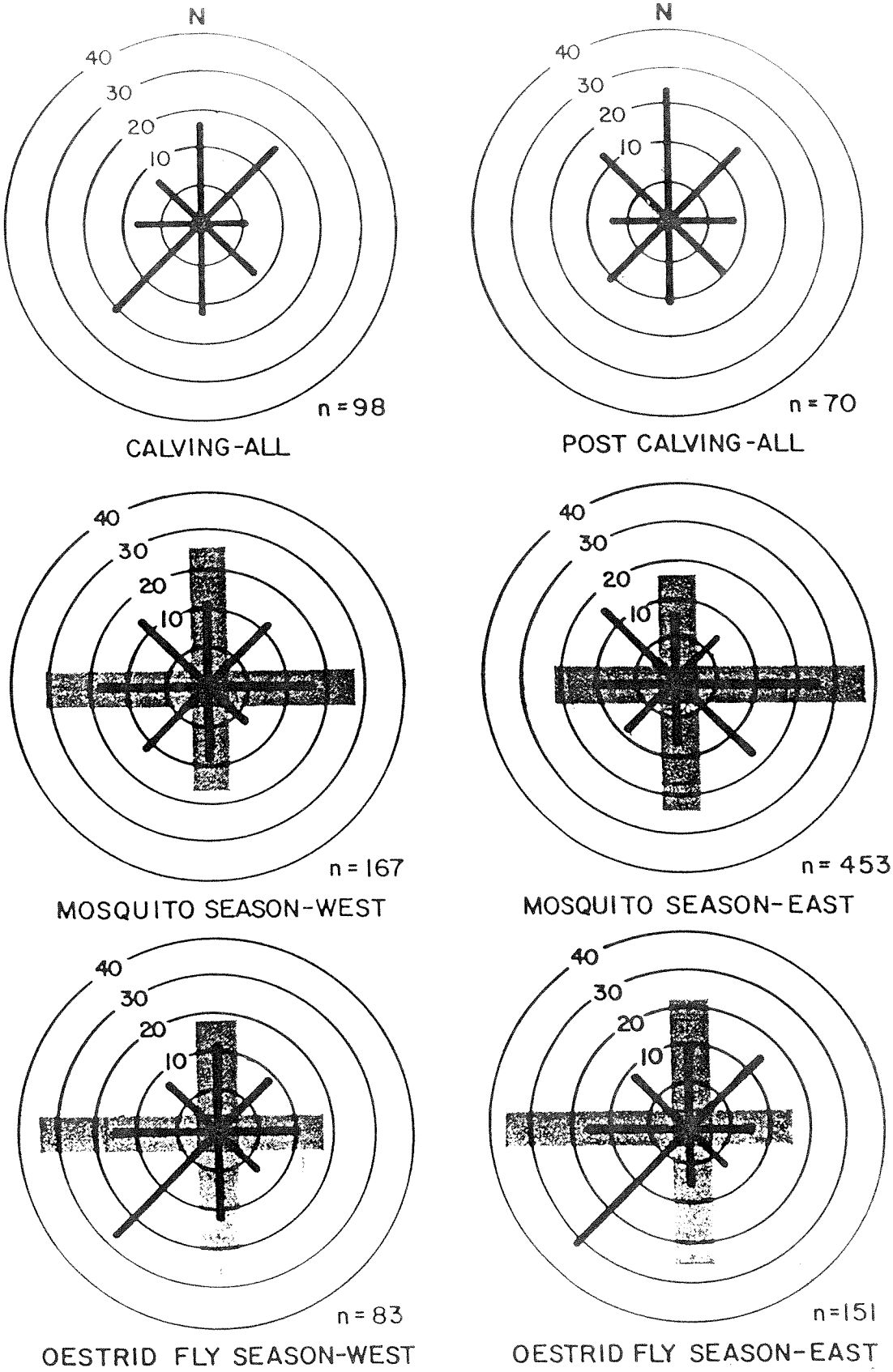

N
40
30
20
10
n = 98
CALVING-ALL
N
40
30
20
10
n = 70
POST CALVING-ALL
40
30
20
10
n = 167
MOSQUITO SEASON-WEST
40
30
20
10
n = 453
MOSQUITO SEASON-EAST
40
30
20
10
n = 83
OESTRID FLY SEASON-WEST
40
30
20
10
n = 151
OESTRID FLY SEASON-EAST
MOVEMENTS IN FOUR CARDINAL DIRECTIONS

Table 4. Mean distance from the coast for locations of radio-collared caribou, Colville to Canning rivers, 1983.

Period	Mean distance from coast (miles)	S.D.	n
Calving	16.2	14.0	132
Post-calving	15.7	12.3	72
Mosquito season			
overall	4.1	4.4	764
west[1]	3.7	3.4	224
east[2]	4.3	4.8	540
No mosquitoes, overall	6.2	4.8	402
west	5.5	3.8	98
east	6.5	5.1	304
Mosquitoes present, overall	1.7	2.3	362
west	2.3	2.3	126
east	1.5	2.2	236
Oestrid fly season/ August dispersal	18.6	12.4	237

[1]Locations of radio-collared caribou west of the Sagavanirktok River.
[2]Locations of radio-collared caribou east of the Sagavanirktok River.

Table 5. Dates when radio-collared cows were first observed with calves during 1983 calving season surveys, Colville to Canning rivers, Alaska.

Collar	Survey date
RY2	28 May
RY6	4 June
RY11	4 June
RY20	4 June
RY54	5 June
RY57	5 June
RY60	5 June
RY12	8 June
RY52	8 June
RY56	8 June
RY13	9 June
RY15	9 June
RY68	10 June

sightability of young calves. Of the 27 radio-collared adult cows, 23 had calves in 1983 (Table 1), for a ratio of 85 calves/100 cows. The mean size of 104 groups observed during calving season was 17.7 ± 55.3; group sizes ranged from 1 to 425, the latter representing an unusually large group south of Milne Point on 8 June.

We observed no association of radio-collared caribou with mature bulls (Table 2); the single bull recorded was a collared 2-year-old, BY9. The majority of the observations were of cow and/or yearling-dominated groups and, as calving progressed, cow-calf-dominated groups.

Habitat Use

Sedge meadow was the predominant habitat used during calving (Table 6); this is primarily because it is the most common habitat type in the study area (Walker et al. 1980), but also because sedges are important forage species (Whitten and Cameron 1980). The use of upland tussock habitat during calving may reflect selection for a habitat that is well-drained. Use of riparian habitat was not often observed, probably due to avoidance by cow-calf pairs during this period (Miller et al. 1972, Curatolo 1975).

Post-Calving Season

Comparatively little effort was expended on surveys during this two- to three-week period between the end of calving and the beginning of mosquito season. Alaska Department of Fish and Game biologists flew surveys on 22 and 23 June, and we flew on 27 June, 29 June, and 2 July, for a total of approximately 30 hours of flying.

Table 6. Frequency of occurrence of caribou groups observed in different habitats, Colville to Canning rivers, Alaska, 1983.

Habitat Type[1]	Season (Percent)				
	Calving	Post-calving	Mosquito	Oestrid fly	Overall
Sedge meadow	59.1	100.0	84.3	71.1	77.5
Upland tussock	27.8	0.0	1.3	8.1	7.3
Riparian	5.2	8.8	23.4	34.0	22.7
Gravel	5.2	0.0	15.2	10.7	11.6
Ridge/pingo/bank	8.7	2.9	4.0	10.7	6.5
Lake margin	0.9	0.0	10.1	9.6	8.0
Beach	0.0	0.0	7.4	0.5	4.0
Water	1.7	0.0	4.0	0.5	2.5
Man-made	0.9	0.0	2.7	3.6	2.5
Aufeis/snowbank	0.0	0.0	0.0	1.0	0.3
Total number of groups	115	34	376	197	723

[1]More than one habitat type could be recorded per group.

Group Size

Mean group size rose throughout this period, increasing from 28.6 ± 27.4 (n=31) for 22-23 June, to 64.7 ± 56.3 (n=35) for 27 June-2 July. Thus, some aggregation was occurring prior to the emergence of mosquitoes near the coast.

Distribution and Movements

Caribou shifted southward between the last of our calving surveys and 22-23 June. For 17 animals that showed a net movement southward over this 12 to 14 day period, the mean distance between locations was 11.2 miles. Eight other animals moved north, three moved east, and one moved west.

Between 22 and 27 June, 22 of 27 radio-collared caribou that were located moved northward, with a mean distance of 13.7 miles between locations. Thus, by the onset of mosquito season in early July, most collared animals were again relatively far north. The mean distance from the coast for all locations during the post-calving period was 15.7 miles (Table 4).

INSECT SEASON

The dominant factor influencing the movements of CAH caribou during midsummer is harassment by insects (Child 1973, White et al. 1975). Mosquitoes emerge in late June or early July and persist until early August. The level of mosquito activity, and thus harassment of caribou, is determined by air temperature and wind speed (Gjullin et al. 1961, White et al. 1975). Activity levels are highest on warm, calm days and are lowest on cool, windy days. Movements of caribou harassed by mosquitoes are directed upwind to "mosquito-relief habitat" at or near the coast. When mosquito activity decreases, caribou move inland; the reasons for this inland movement are not understood, but they may relate to selection of foraging areas.

Oestrid flies emerge about mid-July and persist until mid-August. Caribou react to flies differently than they do to mosquitoes. Long periods of rigid standing punctuated by sudden bursts of running typify caribou behavior under fly harassment (Curatolo 1975). Relief habitat consists of a variety of elevated sites, such as pingos, ridges, banks, and gravel pads. Use of coastal habitat decreases considerably and animals disperse over a wide area, signalling the end of the large aggregations formed during mosquito season.

The period during which insects influence caribou movements can thus be subdivided into two parts: mosquito season and oestrid fly season. These two seasons are not mutually exclusive, inasmuch as both mosquitoes and oestrid flies are present during the second half of July and early August. Instead, as used here, the names refer to the insect species that are most important in influencing caribou behavior and movements during each season. For our analyses, we designated 3-25 July as mosquito season and 26 July-10 August

(the end of our surveys) as oestrid fly season.

The most intensive tracking effort of the study period was devoted to mosquito season, during which we flew approximately 115 hours of surveys and Alaska Department of Fish and Game biologists flew approximately 30 hours. During oestrid fly season, we flew 72 hours of surveys.

Mosquito Season

Group Size and Type

The emergence of mosquitoes caused caribou to aggregate and move to the northernmost portions of the coastal plain. The mean size of 392 groups containing radio-collared animals was 375.1 ± 547.4 over the entire mosquito season. For all days when mosquitoes were not harassing caribou, mean group size was 220.9 ± 237.4 (n=254). For days when caribou were harassed, this value increased to 659.0 ± 729.5 (n=138), indicating the powerful effect mosquitoes have on group dynamics. These aggregations allowed us to locate the majority of the CAH consistently during this season simply by tracking the radio-collared caribou.

The onset of mosquito season also marked a dramatic reduction in sexual segregation of CAH caribou. When harassed by mosquitoes, cow-calf groups and bull groups often coalesced into mixed groups containing relatively equal proportions of cow-calf pairs and mature bulls. Nearly half of the groups in which we found radio-collared caribou were of this type (Table 2).

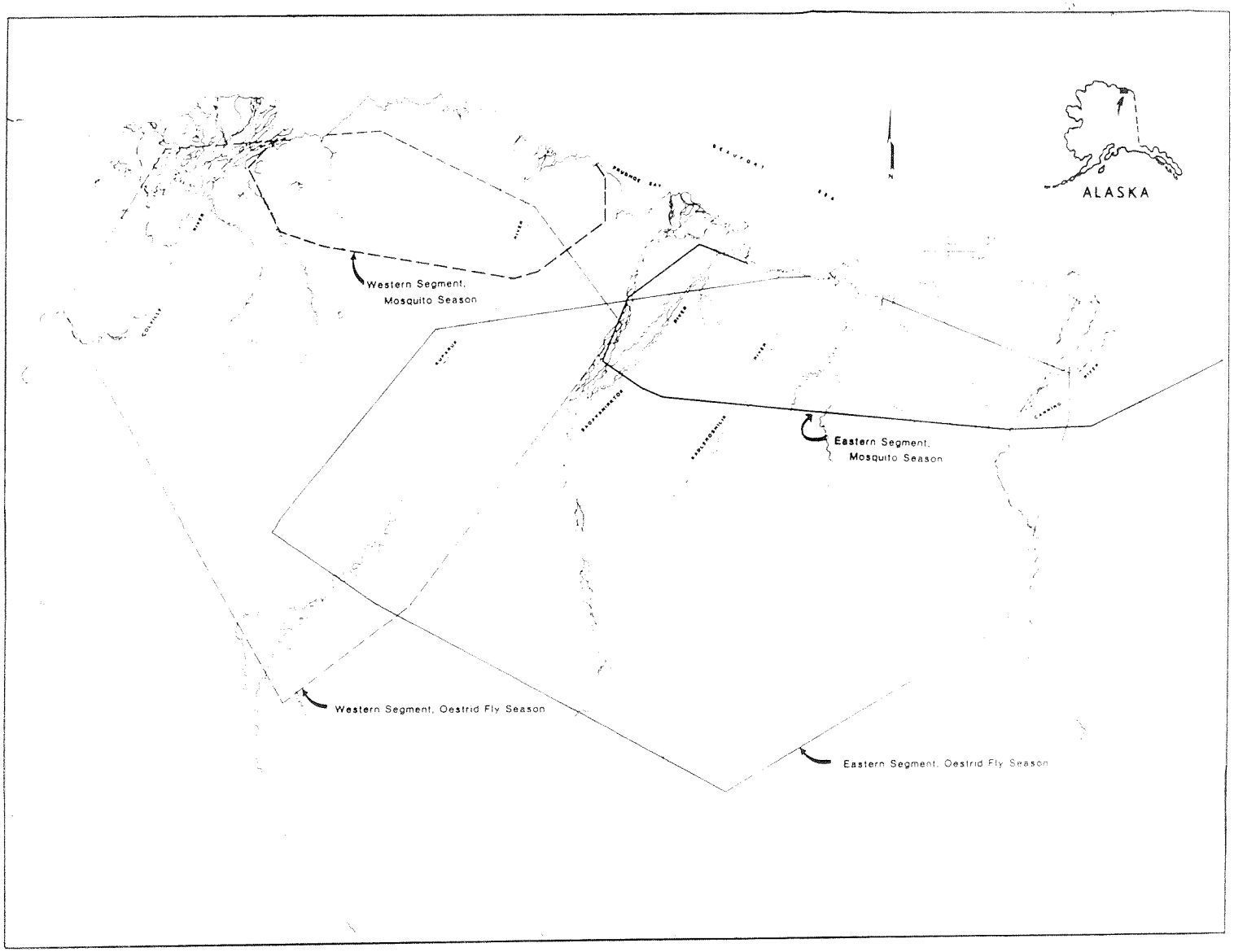
Distribution and Movements

The general northward shift of the CAH during mosquito season is clearly shown by the mean distance from the coast for locations of radio-collared caribou (Table 4). The overall mean for this season was 4.1 miles, the lowest of the study period. For all days with no mosquito harassment, the mean distance was 6.2 miles; this value decreased to 1.7 miles for days when mosquitoes harassed caribou.

The sample of radio-collared caribou that were regularly monitored were separated into two distinct segments during mosquito season: one to the west and one to the east of the Sagavanirktok River (Figure 4). Based on our ability to locate the majority of the CAH during this season by tracking collared caribou, and on the consistency of total numbers of animals observed during successive surveys, we concluded that this division of the collared animals reflected a separation of the majority of the herd into western and eastern segments. The ranges of these segments during mosquito season enclosed the two areas of heaviest concentration observed during calving season. With the exception of three animals, collared caribou in these two segments remained on their respective sides of the Sagavanirktok River during calving, post-calving, and mosquito seasons. The three animals mentioned (RY11, RY59, G5) crossed the Sagavanirktok from west to east late in the post-calving season and spent mosquito season with the eastern segment of the herd.

The western segment of the herd ranged between the Colville and Putuligayuk rivers, and, based on repeated estimates, numbered between 4,500 and 4,900 caribou. Ten collared caribou were included in this portion of the

Figure 4. Areas used by radio-collared CAH caribou during mosquito and oestrid fly seasons, 1983. Areas are delineated according to the minimum-area method (Mohr 1947).


ALASKA
Western Segment,
Mosquito Season
Eastern Segment,
Mosquito Season
Western Segment, Oestrid Fly Season
Eastern Segment, Oestrid Fly Season

Katakturuk rivers, and numbered at least 4,300 animals. This portion included 24 collared caribou. Not all CAH caribou were included in these two major segments of the herd. At least several hundred caribou, virtually all of which were bulls, resided along the lower Sagavanirktok River and its delta during summer 1983 (Kuropat and Curatolo 1983). In addition, an unknown, but probably small, number of caribou summered in the northern foothills of the Brooks Range, including the two collared cows mentioned earlier, RY13 and RY68. These inland animals sought relief from insect harassment on snowbanks, patches of aufeis, and elevated terrain, rather than joining the great majority of the herd at the coast.

Weather conditions during the 1983 mosquito season were somewhat unusual. In a typical summer, several days of warm, calm weather are followed by several days of cool, windy weather; this cycle persists throughout mosquito season (Gjullin et al. 1961). Mosquito activity fluctuates according to this weather pattern, causing caribou to move to the coast and remain there during fair weather, then return inland during cool weather (White et al. 1975). In 1983, this pattern was less pronounced than usual. The distinction between extremes of the cycle was not well-marked during the first half of July; instead, most days were characterized by air temperatures and wind speeds at or near the lower threshold of mosquito activity. Under these conditions of marginal harassment, caribou did not seek out relief habitat at the coast, but moved north only as far as was necessary to reach lower temperatures and/or stronger winds.

Mosquitoes emerged in early July and were numerous enough by 3 July to have a minor effect on caribou movements. Moderate to high levels of mosquito activity during the period of 4-6 July caused movements to relief habitat at

and near the coast, where large aggregations formed. Most of the eastern segment of the herd was located between the Kadleroshilik and Shaviovik rivers at this time, with the remainder being farther east, between Bullen Point and the Canning delta. The western segment of the herd made heavy use of the area between the Milne Point Road and the Kuparuk River. Observations from an ABR camp near the Kuparuk River revealed southward movements of sizeable groups in the late evening and early morning hours, followed by returning movements northward as mosquito activity increased during the late morning hours (L. Smith, pers. comm.). Because we did not normally fly surveys until late morning or afternoon, we were unable to determine the extent of these nocturnal movements. It is highly unlikely, however, that they exceeded the seasonal range limits shown in Figure 4.

Mosquito activity generally diminished over the period of 7-17 July. It was during this time that low levels of mosquito harassment were noted, especially 7-10 and 15 July. The effect of these marginal conditions during 7-10 July was to keep caribou relatively near relief habitat that had been used from 4 to 6 July. A survey east of the Sagavanirktok on 9 July revealed approximately 2,400 caribou between the Kadleroshilik and Shaviovik rivers, and about 1,800 caribou in the vicinity of the Canning delta. The western segment of the herd continued to use the area east of the Milne Point Road. Early on the morning of 10 July, the wind changed from an easterly to a westerly direction and, under light to moderate harassment by mosquitoes, caribou moved northwest. This movement brought caribou from the Kadleroshilik to the Sagavanirktok delta, and caribou from the Canning moved to the vicinities of Point Hopson and Brownlow Point. The western segment of the herd moved toward Oliktok Point.

Gradual inland movements to the west and south occurred in the general absence of mosquito harassment during 11-15 July, with large aggregations dispersing somewhat. A minor pulse of northward movement occurred on 15 July but was not sustained, and most caribou remained inland until 18 July. Several hundred animals in the eastern segment, including four collared caribou, moved eastward from the Shaviovik during this period.

Mosquito harassment resumed on 18 July, causing most caribou to seek relief at or near the coast; the wind was from the northwest. Most of the western segment was located between the Miluveach River and Kalubik Creek. The portion of the eastern segment that had been near the Canning River moved to the coast near Point Gordon. The remainder of the eastern segment did not move to the coast, but was found moving west between the Kadleroshilik and Shaviovik rivers. Pronounced eastward movement occurred the next day, under continuing harassment and easterly winds.

The period of 20-25 July brought generally low winds and the warmest temperatures, and consequently the most intense insect harassment, of the summer. Although both mosquitoes and oestrid flies were active during this period, the former exerted the dominant effect on caribou movements and behavior. Caribou sought relief in large aggregations on and near the deltas of the Kuparuk, Shaviovik, and Canning rivers. On 21 July, the western segment of the herd moved east of the Kuparuk delta and into the northwestern portion of the Prudhoe Bay Oilfield. The following morning the entire western segment was located in one aggregation between Point McIntyre and Term Well A; by evening this assemblage had broken up into several groups, extending from Point Storkersen to the Putuligayuk River gravel mines. By 23 July the majority of this segment of the herd had moved back to the Kuparuk delta, although several

hundred animals continued to use the area between the Kuparuk delta and West Dock through 25 July. The eastern segment of the herd was separated into two portions during this period. From 20 to 23 July, approximately 2,600 caribou used the Shaviovik delta as relief habitat, while about 1,600 animals used the Canning delta. Observations from the ground at Bullen Point on 20 and 23 July, and at the west end of the Prudhoe Bay Oilfield on 21 and 22 July, confirmed the occurrence of large-scale movements inland during evening hours, as had been noted earlier in the month. The trend of these nocturnal movements was south and east from the Shaviovik delta to Bullen Point, and south and west from the northwestern portion of the Prudhoe Bay Oilfield to the Kuparuk River. Observations in the Prudhoe field indicated that at least some of this westward movement resulted from caribou being deflected by low feeder pipelines and traffic on the Spine Road. The movement by caribou from the Shaviovik delta to Bullen Point on 23 July was the beginning of a major movement, involving approximately 1,400 animals, from the Shaviovik to the Canning delta. Most of this distance was traversed on 24 July, after winds increased and depressed mosquito activity levels. On 25 July, the majority (about 2,900 animals) of the eastern segment of the herd was along the coast between Brownlow Point and the mouth of the main channel of the Canning; only about 1,200 caribou remained near the Shaviovik delta.

Comparison of Movements of Herd Segments

In comparing the movements of the western and eastern segments of the CAH, we examined two variables derived from relocations of collared caribou: net direction of movement between successive locations and shortest distance

to the coast.

The data on direction of movement between relocations depend strongly on the time interval between relocations. We therefore stratified the data according to time interval and used only those values derived from relocations obtained within two days of each other.

Distance to the coast is influenced by the time of day at which observations are made. For instance, on days of harassment by mosquitoes, caribou are closest to the coast during the warmest part of the day, which is usually afternoon. Two-thirds of our observations were made between 1100 and 1800 ADST, so our data are based primarily on afternoon locations.

The fact that both sides of the Sagavanirktok were not necessarily surveyed on each flight-day makes detailed comparisons of daily movements impossible. Our comparisons, therefore, are based on summaries of movement data.

Examination of the frequency of movements in each of eight directions (Figure 3) shows a strong tendency for east-west movements by the western segment of the herd and a net eastward movement by the eastern segment. This eastward shift was largely a result of the movement of animals from the Shaviovik delta to the Canning delta during 23-25 July. The eastern segment showed more of a tendency for northwest and southeast movements than did the western segment, which had stronger northeast and southwest components; no explanation for this difference is apparent.

To further reduce the variability resulting from the lack of same-day relocations for collars in both segments of the herd, we next partitioned the data into the four cardinal directions. The value for each intermediate direction (NE, SE, SW, NW) was divided in half, and the halves were added to

the values for the appropriate cardinal directions. This procedure weighted the cardinal directions according to the magnitude of the movements in the four intermediate directions, thereby allowing comparisons of the total amount of movement in north-south and east-west directions. This analysis shows that east-west movements predominated over north-south movements in both segments of the herd. The western segment showed a slightly higher tendency for north-south movement, whereas the eastern segment's tendency for eastward movement was quite marked. Overall, the relative proportions of east-west and north-south movements for both segments of the herd were remarkably similar.

The maximum rates of movement between successive locations were similar for both herd segments. The highest rate recorded during mosquito season was 27.8 miles in 24.2 hours, by a yearling (G2) in the western segment. The maximum rate recorded in the eastern segment was for RY54. From 6 to 8 July, this cow and her calf moved 42.8 miles in 56.2 hours; this value includes a movement of 26.4 miles in 25.7 hours. All of these movements were directed to the east, and occurred on days when mosquitoes were at least marginally active.

Mean values for measurements of distance to the coast were likewise similar for both herd segments (Table 4). On days when mosquitoes were active, collared caribou in the eastern portion of the herd tended to be located nearer the coast than those in the western segment. On days with no mosquito activity, this situation was reversed. The western segment of the CAH thus showed a smaller range of variation in response to fluctuations in mosquito activity.

Habitat Use

Sedge meadows were the predominant habitat used during mosquito season (Table 6). Use of riparian, gravel, and beach habitats increased, however, as caribou sought habitats where mosquitoes were relatively less abundant than in sedge meadows. Indeed, use of beach habitat occurred almost exclusively during mosquito season (Table 6).

During insect season as a whole, bull groups used riparian habitat proportionately more often than cow-calf groups (Table 7). This apparent selection parallels observations by Murphy and Curatolo (1984) and Curatolo (1984). Cow-calf groups rarely were found on gravel, whereas the apparent selection of gravel habitat by bull groups probably reflects use of riparian gravel. Mixed groups also used gravel habitats frequently, usually along the coast, because mixed groups resulted from the coalescing of bull and cow-calf groups during mosquito harassment.

Mosquito-Relief Habitat

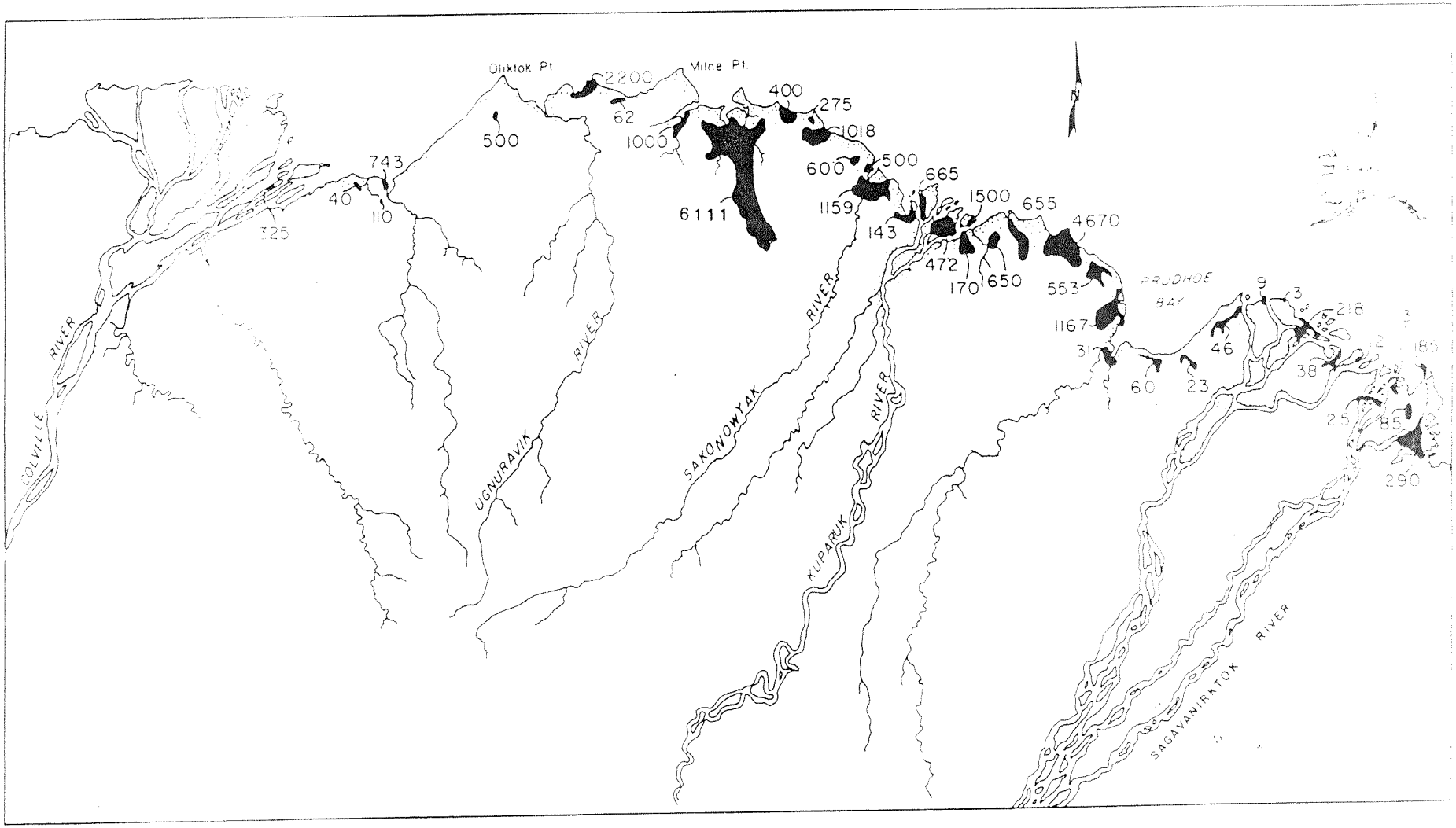
Caribou groups generally used the coast from Oliktok Point to the Canning River delta as mosquito-relief habitat (Figure 5). Within this zone, however, caribou used river deltas during periods of intense harassment by mosquitoes; the Kuparuk, Shaviovik, and Canning deltas were used most often. The majority of the herd was on or near these three river deltas during 20-25 July, the period of most intense mosquito harassment in 1983. Caribou were rarely found on the Colville River delta even though animals consistently used the coastal plain immediately to the east of this river. This occurrence is probably

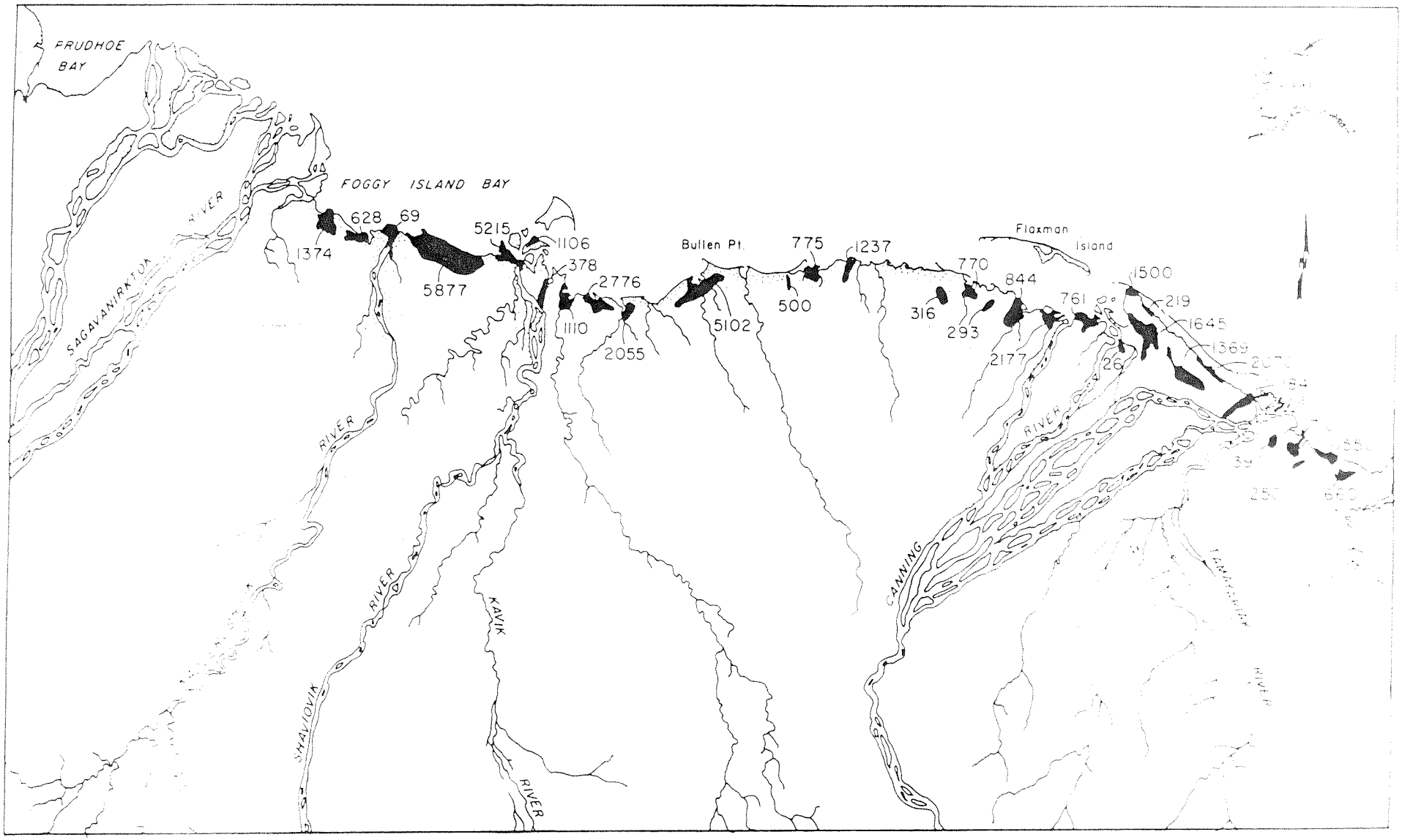
Table 7. Habitat use, by group type, for all caribou groups observed between the Colville and Canning rivers, Alaska, 3 July–10 August 1983.

	Group type					
	Mixed		Cow-calf		Bull	
Habitat	Number[1]	Percent	Number	Percent	Number	Percent
Sedge	232	81.1	408	83.3	113	59.8
Upland tussock	9	3.1	15	3.1	7	3.7
Riparian	100	35.0	105	21.4	83	43.9
Gravel	58	20.3	37	7.6	53	28.0
Ridge/bank/pingo	19	6.6	29	5.9	12	6.3
Lake margin	18	6.3	41	8.4	9	4.8
Beach	24	8.4	9	1.8	12	6.3
Water	13	4.5	5	1.0	9	4.8
Man-made	11	3.8	14	2.9	2	1.1
Aufeis/snow	0	0.0	1	0.2	7	3.7
Total number of groups	286		490		189	

[1]More than one habitat type could be recorded per group.

Figure 5. Composite of all locations of CAH caribou seen near the coast during insect season, 3 July - 10 August 1983. The number for each black area represents the total number of caribou observed within that area throughout the period. Numbers include repeated observations of the same animals on different days.


Oliktok Pt.
Milne Pt.
2200
62
1000
400
275
1018
500
600
500
665
1159
6111
1500
655
4670
143
472
170
650
553
1167
31
60
23
46
9
3
218
38
25
85
290
743
40
110
725
PRUDHOE BAY
COLVILLE RIVER
UGNURAVIK RIVER
SAKONOWYAK RIVER
KUPARUK RIVER
SAGAVANIRKTOK RIVER


PRUDHOE BAY
FOGGY ISLAND BAY
SAGAVANIRKTOK RIVER
Bullen Pt.
Flaxman Island
CANNING RIVER
SHAVIOVIK RIVER
KAVIK RIVER
1374
628
69
5877
5215
1106
378
1110
2776
2055
5102
775
500
1237
770
316
293
844
2177
761
1500
219
1645
1369
26
20
84
39
25
55

related to the extent of the CAH's summer range and the prevailing wind direction. The Colville River is the western boundary of CAH summer range; the prevailing wind direction is ENE. During periods of mosquito harassment, caribou travel into the wind toward the coast. Thus, by the time they reach the coast, they usually miss the extreme western portion of the coastline, although westerly winds occasionally coincide with periods of mosquito harassment.

Wind speed increases and temperature decreases as one nears the coast (Walker et al. 1980). As temperatures rise inland, mosquitoes become active and harass caribou, stimulating them to travel toward the coast, where windier and cooler conditions prevail. Caribou move upwind only as far as is necessary to escape mosquitoes. Hence, the location of mosquito-relief habitat is dynamic, depending on temperature, wind speed, and wind direction.

When mosquito harassment is severe and caribou reach the coast, they often continue to travel into the wind along the coast (White et al. 1975). Such movements are usually directed eastward because of the prevailing winds. In traveling east, caribou tend to use eastward-pointing gravel spits and north-south oriented shorelines, moving to the ends of the spits and often standing in the water for up to several hours at a time. North-south oriented shorelines are nearly perpendicular to the prevailing wind, and provide excellent areas for mosquito relief. Caribou tend to linger on river deltas, probably because these areas project into the ocean and are less vegetated than other coastal areas, and thus harbor few mosquitoes.

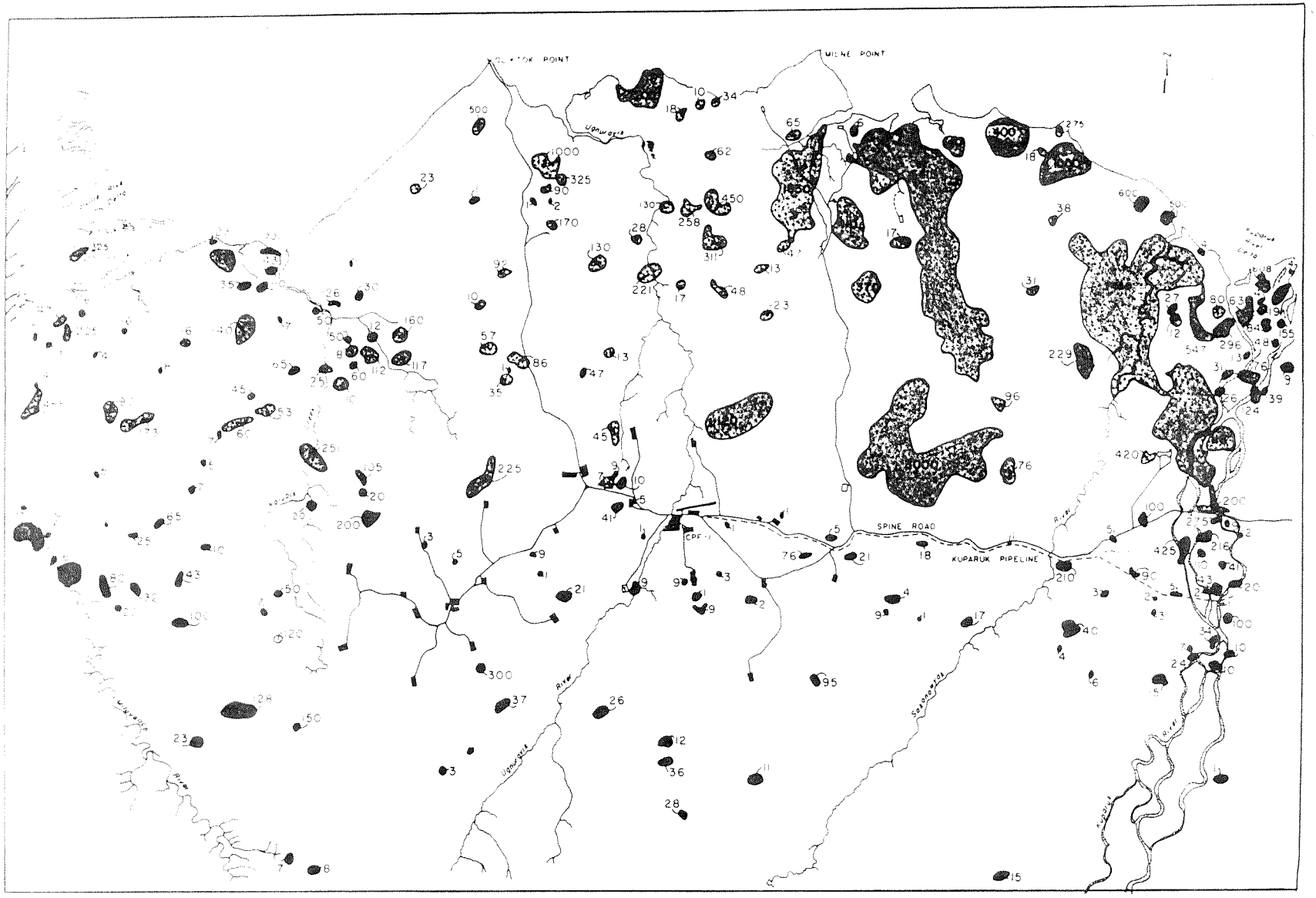
Caribou Distribution and Movements in the Kuparuk Oilfield

The overall summer distribution of caribou in the Kuparuk Oilfield reflected the east-west movement pattern that was characteristic of the CAH in 1983. Caribou tended to use the eastern portion of the Kuparuk Oilfield for mosquito relief and the western portion of the oilfield during mosquito-free periods (Figure 5). The large numbers of caribou observed inland from the coast between Milne Point Road and the Kuparuk River occurred during days when levels of mosquito activity were light to moderate. Caribou appeared to move toward the coast and stop when they reached mosquito-free areas, which were usually inland from the coast on such days.

The Kuparuk River delta evidently provided sufficient insect relief until 21-22 July, when an extended period of high mosquito levels and east winds resulted in many animals moving east into the northwestern portion of the Prudhoe Bay Oilfield.

Caribou usually were located north of the Kuparuk Pipeline during mosquito season, probably because of the general lack of cyclic temperature variations and the east-west movement pattern that resulted. As mentioned earlier, southward movements across the Spine Road and Kuparuk Pipeline occurred during late evening and early morning hours. Similar movement patterns were observed east of the Sagavanirktok River, suggesting that caribou movements were related primarily to weather rather than to the petroleum development in the area. As caribou moved west of the oilfield they generally remained as close to the coast as when they were in the oilfield. Caribou were not located much farther inland until oestrid fly season.

Figure 6. Composite of all locations of CAH caribou seen during telemetry surveys in the vicinity of the Kuparuk Oilfield, 27 June - 10 August 1983. The number for each stippled area represents the total number of caribou observed within that area throughout the period. Numbers include repeated observations of the same animals on different days. The maximum number observed on any single day was approximately 4,900.


MILNE POINT
SPINE ROAD
KUPARUK PIPELINE
CPF-1
Upper Kuparuk River
Lower Kuparuk River
Sagavanirktok River

Oestrid Fly Season

Group Size and Type

Mean group size during oestrid fly season was 65.3 ± 189.6 (n=197). The smaller groups observed relative to mosquito season were presumably a result of oestrid fly harassment, which tends to disperse caribou groups (Curatolo 1975). The number of sightings of lone caribou increased greatly (Table 2). Even though oestrid flies were the dominant factor influencing caribou behavior and movements, mosquitoes continued to exert an effect into early August. The largest groups encountered during this season were observed on days when mosquitoes were still active. On 2 August, an unusually large, mixed group, containing approximately 2,500 caribou, was observed moving northward along a wide front about 15 miles south of Point Sweeney.

The incidence of mixed groups decreased during this period because, as caribou dispersed, segregation by sex increased.

Distribution and Movements

The CAH's distribution and movement patterns were distinctly different during oestrid fly season than during mosquito season. Most of these differences were associated with the reactions of caribou to oestrid fly harassment. Caribou dispersed over a large portion of the coastal plain (Figure 4). This dispersal began during the evening of 25 July, the last day that mosquito-relief habitat along the coast was heavily used by caribou. Caribou in both segments of the herd moved inland during cool, windy weather from 26 to 31 July. These movements were substantial, exceeding the limits of range used during mosquito season. Inclement weather precluded flying on 26

July and interfered with surveys east of the Sagavanirktok on 27 and 28 July. The mean distance between successive locations for 10 collared caribou in the western segment of the herd was 20.2 ± 4.5 miles, from 25 to 27 July; for five animals in the eastern segment, relocated after the same time interval, the mean distance was 19.0 ± 8.7 miles. For seven other collars in the eastern segment that we could not relocate until 28 July, the mean distance was 29.7 ± 3.0 miles, and for the nine collars that were not relocated until 29 July, this value was 36.3 ± 5.7 miles.

The direction of movement between successive locations over the period 25-29 July was southwest for 28 collared caribou, and west for three others located during this period. As is evident from Figure 3, the net movement of collared animals during oestrid fly season was to the southwest.

Caribou shifted northward during the first few days of August as fair weather resumed and mosquitoes became active again. Very little use was made of relief habitat at the coast, however, because periods of harassment were relatively brief. Caribou evidently achieved relief from harassment simply by moving upwind until weather conditions changed and mosquito activity abated; these changes usually occurred before groups reached the coast.

The general dispersal of caribou during oestrid fly season resulted in mean distance to the coast increasing to 18.6 miles, the highest value for this statistic during the entire study period (Table 4). In addition, the maximum rate of movement between successive locations was greatest during this period: cow RY52 and her calf moved 56.8 miles in 42.7 hours from 6 to 8 August, including 35.2 miles in 24.3 hours.

As caribou dispersed, there was overlap between the areas used by the eastern and western segments of the herd, for the first time since the

post-calving period (Figure 4). Six collared caribou from the eastern segment (G7, BY9, RY52, RY58, RY59, RY82) moved west across the Sagavanirktok River during the first week of August. Of these, all but one remained west of the river through the end of our field season; RY52 recrossed and moved far to the east by 10 August. The only one of this group that had begun the summer west of the Sagavanirktok was RY59. Judging from the locations of these animals prior to and following their crossings of the river and Trans-Alaska Pipeline corridor, all crossed between Deadhorse and Franklin Bluffs. No collared caribou from the western segment were found east of the Sagavanirktok, although RY20 was located on a gravel bar in one of the western channels on 1 August; she subsequently moved westward.

Habitat Use

Sedge meadows were again the predominant habitat used during oestrid fly season, although use of upland tussock habitat increased as caribou dispersed inland (Table 6). Some selection for upland habitat apparently occurred during late July; after collared caribou left the coast on 25 July, most moved directly to rolling upland areas. Groups remained in these areas, especially in and near riparian willow habitat along small creeks, until warmer weather in early August. The use of riparian, gravel, man-made, and ridge/bank/pingo habitats probably resulted from caribou seeking relief from fly harassment in less vegetated sites that were exposed to the wind.

Behavioral Effects of Oestrid Fly Harassment

The behavioral responses of caribou to harassment by oestrid flies are reflected in the data on activities of groups (Table 3). Although the amount of feeding remained relatively high, the percentages of lying and walking were the lowest observed during the entire study period. In contrast, the amounts of standing and running were the highest of the study period.

Wild running in response to oestrid fly harassment may result in an increase in injuries to caribou. Lame caribou were observed more often during this period than at any other time, although the number seen was small. One of the collared yearlings (G3) was limping on 27 July, quite possibly as a result of an injury sustained while running from flies; the animal had fully recovered by 8 August.

Wild running may also separate cow-calf pairs, at least on a temporary basis (pers. obs.). By 9-10 August, collared cows YB17, RY11, RY12, RY13, RY14, RY15, RY54, RY58, RY59, and RY60 had either lost their calves or become distantly separated from them.

Interchange of Radio-Collared Caribou Between Herd Segments

In 1983 only three of 27 adult cows calved with one segment of the herd and summered with the other segment. Radio-collared caribou in the eastern and western segments of the CAH did not cross the Sagavanirktok River during the mosquito season. Five animals did cross the Sagavanirktok River during oestrid fly season.

Collared yearlings tended to remain in the same segment of the herd as their dams in 1983, although they were often separated by relatively great distances and showed no inclination to travel together. Although two yearlings (G5, G7) crossed the Sagavanirktok River, they nevertheless spent mosquito season with the same segment as their dams. Only one yearling (G3) out of seven summered on the opposite side of the Sagavanirktok from its dam.

A comparison of 1983 locations of radio-collared caribou with 1982 locations (Robus 1983; Cameron et al. in press) provides some insight into the annual variation in use of summer range by individual animals.

Five caribou (RY1, RY17, RY58, RY60, RY64) that summered with the eastern segment of the herd in 1983 were found west of the Sagavanirktok River during summer 1982; one of these collars (RY64) had a dead transmitter, but was sighted several times. One other cow with a dead transmitter (RY46) was sighted in the Kuparuk Oilfield in 1982 and in the eastern portion of the Prudhoe Oilfield in 1983. One animal (RY60) crossed the Sagavanirktok at least three times during summer 1982, including once during mosquito season. Two caribou (RY8, RY20) that summered with the western segment in 1983 were found east of the Sagavanirktok in summer 1982.

In 1983, 89 percent of the adult radio-collared caribou summered in the same general region in which they calved. In addition, 74 percent of the adult radio-collared caribou monitored in 1983 spent the calving and insect seasons in the same region as they did in 1982. These figures indicate that, although crossings are not uncommon, most CAH caribou tend to remain on one side or the other of the Sagavanirktok River during any one summer. They also suggest that range fidelity is not absolute and that more interchange occurs between years than within years.

CONCLUSIONS

Results of our radio-telemetry study suggest that caribou traditionally return to two general regions to calve, and remain in those respective regions during the summer months. Summer movements and distributions appear to be affected by the preference of caribou for certain areas and habitats within these regions and by the level of insect activity as mediated by weather conditions.

The majority of the CAH used two distinct regions during calving, post-calving, and mosquito seasons: an eastern region, where caribou ranged between the Sagavanirktok and Katakturuk rivers (approximately 4,300 caribou) and a western region, where caribou ranged between the Colville and Putuligayuk rivers (approximately 4,900 caribou).

Caribou were widely dispersed during calving with areas of relatively high density between Kalubik Creek and Beechey Point, and between Mikkelsen Bay and the Canning River; and with lesser concentrations in the White Hills, between Franklin Bluffs and the Kadleroshilik River, and in the low hills east of the Kavik River.

Some areas were consistently used during mosquito season, including the region between Milne Point and the Kuparuk River on the west, and on the east, the area between the Kadleroshilik and Shaviovik rivers, and the vicinity of the Canning River delta.

Caribou movements during mosquito season were largely influenced by mosquito activity and wind direction. The most heavily used areas for relief from mosquitoes were the Kuparuk, Shaviovik, and Canning river deltas. Movements by both herd segments tended to be synchronous, with caribou traveling

to the coast during periods of mosquito harassment. Upon reaching the coast caribou traveled into the prevailing wind. Thus, the direction of travel of both segments of the herd (i.e., caribou to the east and west of the Sagavanirktok River) was highly dependent on weather conditions.

The weather-induced movement patterns help to explain the use or lack of use of the Prudhoe Bay region. Because the prevailing wind was from the ENE, caribou usually traveled east along the coast during periods of mosquito harassment and congregated in river deltas. Only when a prolonged period of mosquito harassment occurred in late July did caribou in the western segment continue to travel east beyond the Kuparuk River delta, finally reaching the vicinity of West Dock at Prudhoe Bay. Many caribou in the eastern segment left the Shaviovik River delta and traveled to the Canning River delta during this same period. For caribou in the eastern segment to reach Prudhoe Bay, a prolonged west wind during mosquito harassment would have to occur. This did not happen in 1983, although many animals reached the eastern portion of the Sagavanirktok River delta on 10 July.

Oestrid fly season was characterized by overlap of areas used by the eastern and western segments of the herd. The area used by caribou was greatly expanded compared with mosquito season. Dispersal due to oestrid fly harassment appeared to be the major factor influencing these movements.

Thus, we conclude that the distribution and movements of the Central Arctic Herd during the summer of 1983 were related to:

1. areas which caribou selected for calving, primarily the Milne Point area (Kalubik Creek to Beechey Point) on the west and the Point Thomson area (Mikkelsen Bay to the Canning River) on the east; and,

2. the effects of weather conditions on mosquito and oestrid fly activity.

The Kuparuk Oilfield overlaps with the general summer range of the western segment of the CAH. As discussed earlier, movements of these animals were synchronized with movements of the eastern segment of the herd. Caribou usually were located north of the Kuparuk Pipeline during mosquito season, probably because of a lack of cyclic temperature variations, which resulted in east-west movements. When southward movements did occur, caribou usually crossed the Spine Road and Kuparuk Pipeline during late evening and early morning hours. Southward movements of the eastern segment also occurred during late evening hours. Thus, it appears that weather, rather than petroleum development, was the primary factor influencing caribou distribution and movements in the Kuparuk Oilfield.

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