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# DISTRIBUTION AND MOVEMENTS OF CARIBOU IN RELATION TO THE KUPARUK DEVELOPMENT AREA

By

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Progress Report
Federal Aid in Wildlife Restoration
Project W-22-2, W-22-3, and W-22-4, Job 3.30





(Printed August 1985)

PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: None

Project No.: W-22-2, W-22-3, W-22-4 Project Title: Big Game Investigations

Job No.: 3.30 Job Title: Distribution and Movements of Caribou in Relation to the Kuparuk Development Area

Period Covered: 1 January 1983-31 December 1984

SUMMARY

In 1983 and 1984, caribou (Rangifer tarandus granti) in the Kuparuk Development Area (KDA) were surveyed systematically by air. Ground surveys along Spine Road (SR) and Oliktok Road (OR) were conducted periodically between May and August of both years. Calving surveys in 1983 and 1984 indicated excellent initial calf production in areas in the vicinity of the KDA. As in 1982, the calving concentration area north of the SR appeared to be split into 2 components, one on either side of the Milne Point Road.

Numbers of caribou and the proportion of calves observed during road surveys along the SR and OR also increased in 1983 and 1984. Fewer caribou were seen during the precalving and calving period than during midsummer. The lowest proportion of calves was again seen during the calving period, and, of those, most were seen after 15 June.

During May and June, caribou were concentrated near the eastern portion of the SR. In midsummer, fewer caribou than expected were seen along the SR except for the Kuparuk floodplain. Caribou concentrations occurred along the OR during all survey periods except June 1984. Fewer calves were seen in 2 areas of high construction activity, the Kuparuk floodplain and Oliktok Point, than in surrounding areas.

In both years, few caribou were observed crossing roads or pipelines in May and June. During midsummer 1983, more caribou attempted to cross a road/pipeline than in 1981 and 1982, and crossing success increased as well. Attempted crossing and crossing success increased again dramatically in midsummer 1984.

In 1983, large groups of caribou continued to avoid crossing the road/pipeline complex during insect-related movements. In 1984, however, we observed a number of large groups successfully crossing the Kuparuk pipeline between the Kuparuk River and the Central Processing Facility (CPF-1).

Key words: calving, caribou, insect-related movements, Kuparuk Development Area, roads/pipeline.

CONTENTS



## BACKGROUND

The Kuparuk Development Area (KDA) is located immediately west of the Prudhoe Bay oil field. The KDA is an active calving area and an important component of caribou (Rangifer tarandus granti) summer range. This report summarizes results of continued surveys of the Central Arctic Herd (CAH) calving grounds within the KDA and along the Spine Road (SR) and Oliktok Road (OR) during 1983 and 1984.

Included as appendices are 2 progress reports on companion studies near Milne Point and a manuscript on sampling errors which was presented at the Second North American Caribou Workshop (Montreal, 15-17 Oct 1984).

## OBJECTIVES

To describe annual variations in the distribution of CAH caribou on their calving grounds, with special reference to calving activity in the vicinity of the KDA.

To determine between-year differences in the distribution, movements, and sex/age composition of caribou within or near the KDA during summer.

To determine the locations of road and/or pipeline crossings by caribou.

To characterize the responses of caribou to local structures and disturbance.

## METHODS

The distribution of calving caribou in the Kuparuk region was determined 3 times in 1983 (3 Jun, 12-13 Jun, and 18 Jun) and once in 1984 (11-12 Jun). We sampled caribou along 12 north-south transects spaced at 3.2 km intervals and extending 40 km inland from the coast (Fig. 1). This area had been surveyed annually between 1978 and 1982 during June, although in some previous years we were able to extend coverage both east and west within the coastal plain (Cameron and Whitten 1979, 1980; Cameron et al. 1981, 1983).

All transects were flown by Bell 206B helicopter, with the pilot and front-seat observer searching primarily in the direction of flight and 2 rear-seat observers searching to either side of the aircraft. USGS 1:63,360 maps were used for navigation and for recording locations of caribou groups; all groups within 1.6 km of each transect were used in the transect data analysis. Airspeeds of 110-130 km/hr and altitudes of 30-50 m were maintained until a group of caribou was sighted. Composition was ascertained by making a lower, slower pass or by hovering briefly at a distance of 50-300 m and using binoculars. Individuals were classified on the basis of genitalia, body size, and/or antler development as bulls, cows, calves, or yearlings.

The SR (Fig. 2) was surveyed systematically by light truck (Cameron and Whitten 1979), generally twice daily, during 3 separate phases of study: 10-25 May, 1-20 June, and 1 July-4 August (precalving, calving, and midsummer periods, respectively). In 1983 and 1984, these surveys were extended to include the OR from the Central Processing Facility (CPF-1) to Oliktok Point (Fig. 2).

For midsummer surveys, the level of insect harassment was estimated subjectively by direct observation as none, light, moderate, or severe. In addition, mean 4-hour insect levels were calculated using hourly weather reports from Deadhorse airport (obtained from the Arctic Environmental Information and Data Center, University of Alaska, Anchorage) and the weather/insect activity relationship of White et al. (1975). Caribou survey data obtained along the SR and OR (including location, observation distance, group composition, direction of movement, road/pipeline crossings, and insect levels) were

entered in a computer file (Honeywell Model 20, University of Alaska, Fairbanks).

## RESULTS AND DISCUSSION

### Calving Distribution

In June 1983, 3 aerial surveys were made during the calving period to monitor the progression of calving and changes in distribution during the calving period. By 3 June, nearly half the cows observed in the survey area had calved (Table 1). Within a week, the number of caribou had doubled and remained stable through the last survey on 18 June. The total number observed increased approximately 70% over the 1,103 seen during calving in 1982 (Smith et al. 1984), primarily due to more favorable spring weather conditions on the Milne calving grounds and increasing herd size. Final calf production was high (92 calves/100 cows), and yearlings averaged 23/100 cows. As usual, few bulls were present on the calving grounds.

As in previous years, a calving concentration area was observed between the SR and Milne Point (Fig. 2) (Whitten and Cameron 1985). Within this concentration area was a strip of relatively low caribou density which coincided roughly with the Milne Point Road (Appendices A and B).

In 1984 there was another increase in the number of groups and individuals sighted on the calving grounds within the KDA (Table 1). The proportions of calves, yearlings, and bulls were similar to those observed in 1983.

### Distribution of Caribou Along the Spine and Oliktok Roads

In both 1983 and 1984, fewer caribou were seen during May and June than during July/August (Table 2), similar to patterns noted in previous years (Smith et al. 1984). However, caribou sighting rates during May of both years were higher than reported for 1982 (Smith et al. 1984), probably due both to increasing herd size and to milder spring weather. Also, in 1984, a prominent dust shadow along the SR and OR attracted numerous caribou. During the midsummer period in 1983, the caribou sighting rate was more than double the 1982 rate and higher yet in 1984 (Table 2).

The proportions of calves (previous year's calf cohort) seen in May 1983 and 1984 (19.0 and 24.9, respectively; Table 2) were both higher than the 1982 value (17.5%; Smith et al. 1984). Many short yearlings were seen in small groups with few or no adult cows. This, and the fact that relatively few

newborn calves were seen from the road in June, suggest that parturient cows moved away from the road area to calve. During midsummer of both years the proportions of calves (17.5% and 23.2%, respectively) were higher than the 1982 value (16.0%; Smith et al. 1984).

In May 1983, there were 2 distinct peaks in caribou occupancy, one south of the Milne Point calving concentration and another along the OR near CPF-3 (Fig. 3). Also, 4 peaks in calf percentage were evident: the Kuparuk floodplain, the Milne Point Road, CPF-1, and Oliktok Point. During the calving period in June, peaks in caribou numbers were apparent east of Milne Point Road, in the CPF-3 area, and at Oliktok Point. In midsummer, caribou were concentrated within the Kuparuk floodplain and along the OR. Calf percentages in these concentration areas were relatively low, however. These data agree with our previous observations that although large numbers of caribou continue to use the Kuparuk floodplain, the proportion of calves has decreased since our 1st observations in 1978 (Smith et al. 1984). We attribute this decrease to relatively high construction activity in these areas during midsummer.

In May 1984, caribou were distributed relatively evenly along the SR and OR except for a single peak near CPF-3 (Fig. 4). There were 3 peaks in percentages of calves, similar to the pattern in 1983. During June 1984, relatively high numbers of caribou were observed south of the Milne Point calving area and near Oliktok Point. However, only 1 peak in calf percentage was discernible, again south of the Milne Point calving concentration. Calf proportions along the OR in June 1984 were lower than in 1982 (Smith et al. 1984) or 1983, possibly reflecting a response to a marked increase in construction activity and helicopter traffic along the OR. During summer 1984 the distribution of both caribou numbers and calves was similar to that in 1983.

During our 1st 3 years of midsummer surveys (1978-80), the proportion of calves observed along the SR was similar to regional values (Cameron et al. 1981). However, in 1981 and 1982, the local calf percentage was substantially lower than regional estimates (Smith et al. 1984). In midsummer 1983, the calf proportion was 17.5%, again lower than the regional estimate of 21.3% obtained during counts of postcalving aggregations on 23 July 1983 (unpubl. data). In 1984, the midsummer proportion of calves along the road system increased to 23.2%, similar to our estimate of the CAH. Furthermore, there was little difference in the proportion of calves seen near the SR/pipeline complex (22.3%) vs. the OR (24.4%). These comparisons suggest that caribou are habituating to local activity and man-made structures.

As in 1982, few caribou were seen crossing the road, pipelines, or road/pipeline complexes during May and June in 1983 and 1984 (Table 3). Although caribou gathered in the prominent dust shadow along the road system in May and June 1984, the number of crossings observed was similar to 1983.

In 1983, both the number of caribou attempting to cross a structure and crossing success were higher than in 1981 and 1982, and the values were higher yet in 1984 (Smith et al. 1984; Table 3). In 1981 and 1982, large (>100) insect-harassed groups had the greatest difficulty crossing road/pipeline complexes (Smith and Cameron, in press), a trend which continued in 1983. In midsummer 1984, however, 61% of the individuals in large groups successfully crossed the road/pipeline complex. This change may be attributable to habituation to construction activity and/or a change in the insect-related movement patterns (see below).

Insect-induced Movements

During 1981 and 1982, a recurrent pattern of insect-related movements was apparent (Fig. 5). Under insect harassment, caribou generally moved north toward insect relief habitat on the coast from west of CPF-1 or within the Kuparuk floodplain. When insect harassment ceased, caribou moved south until within a few kilometers of the SR, paralleled the SR until west of CPF-1, and then turned south. This pattern continued in 1983 and 1984 when large numbers of caribou, moving to and from insect relief habitat, were seen from the road (Fig. 6, 7). Except for the road segment within the Kuparuk floodplain, there were few southbound crossings of the SR when insect activity abated. However, in 1984, we also observed a number of large southbound groups crossing the SR between the Kuparuk River and CPF-1. These southbound crossings occurred in the evening when low traffic levels favored increased crossing success.

During both summers, large, insect-harassed, postcalving aggregations (ca. 6,000 in 1983, 7,000 in 1984) moved from the Kuparuk Delta toward the West Dock area, west of Prudhoe Bay. Although some caribou penetrated the pipeline/road complex, their eastward movements were apparently blocked, and the groups returned to the west.

## ACKNOWLEDGMENTS

Primary funding of this study was provided through Federal Aid in Wildlife Restoration (Projects W-22-2, W-22-3, and W-22-4). Additional support was provided by Habitat Division and

Conoco, Inc. We are grateful to Jim Dau, Jay Smith, Carol Burns, Randy Rice, and Carl Hemming for valuable technical assistance. We also thank Arctic Slope/Alaska General, Inc. for aid in field logistics.

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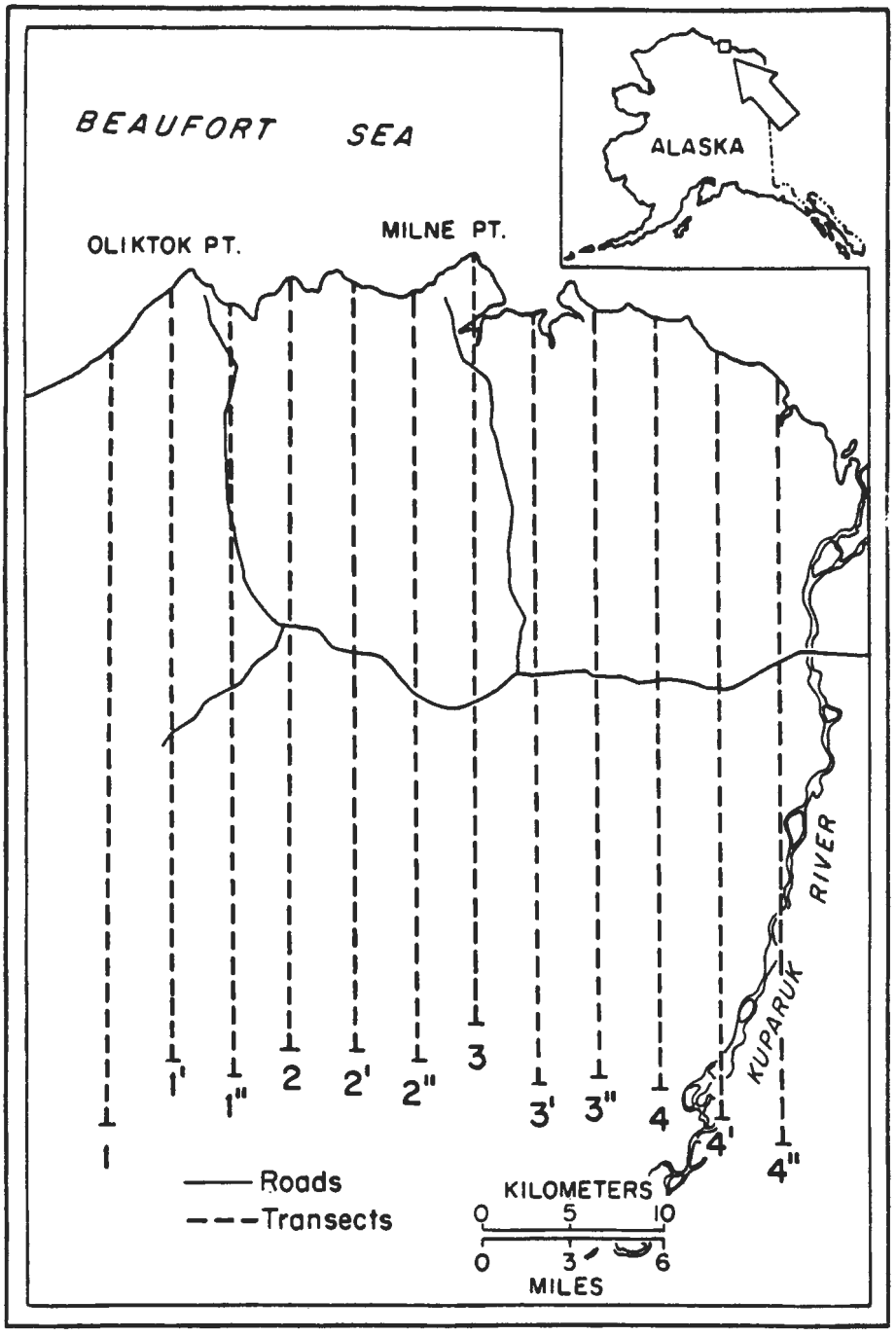


Fig. 1. Aerial survey transects within the Kuparuk Development Area, June 1983 and 1984.

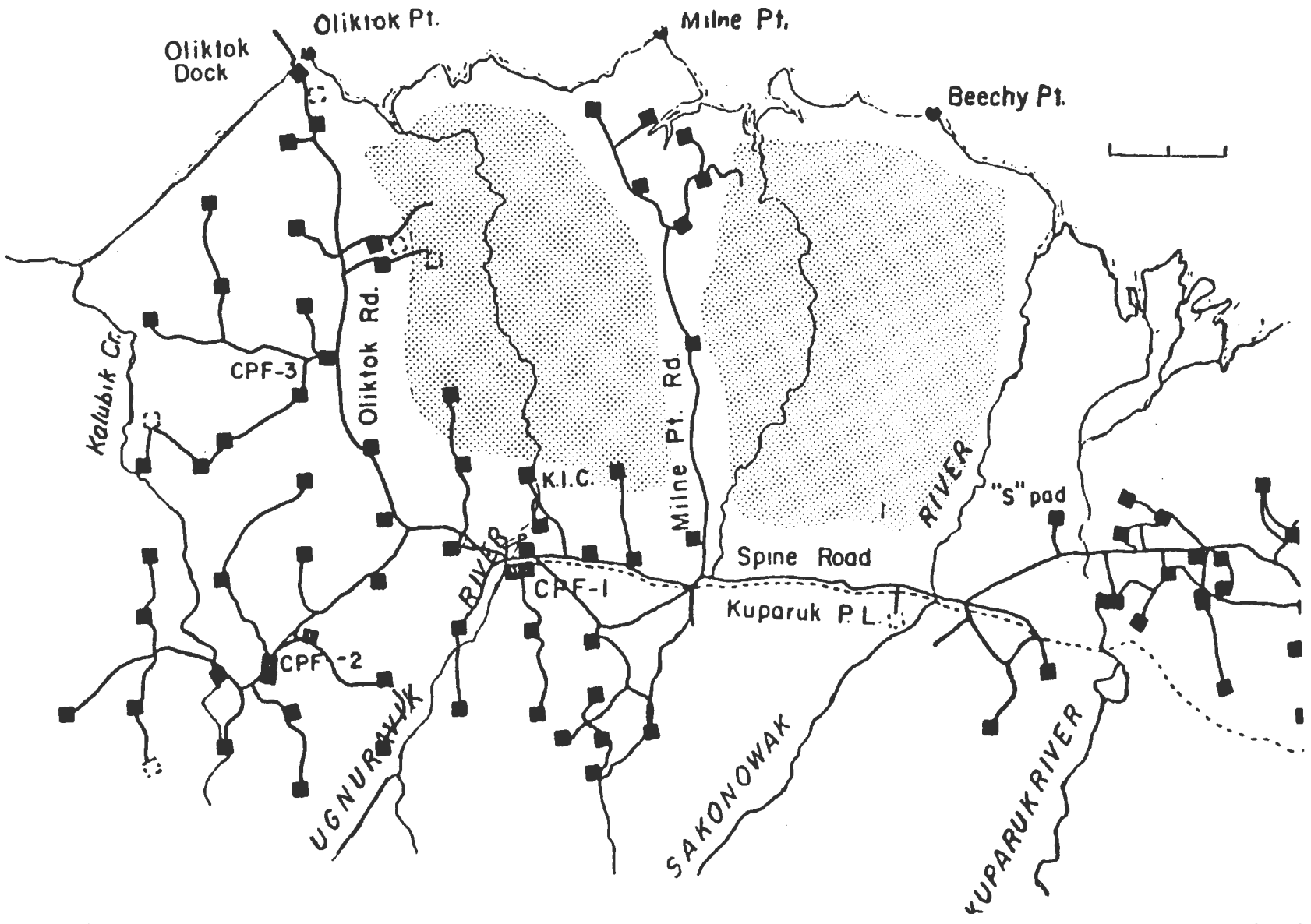


Fig. 2. Road system within the Kuparuk Development Area, summer 1984. The stippled area represents the approximate limits of the Milne Point calving concentration.

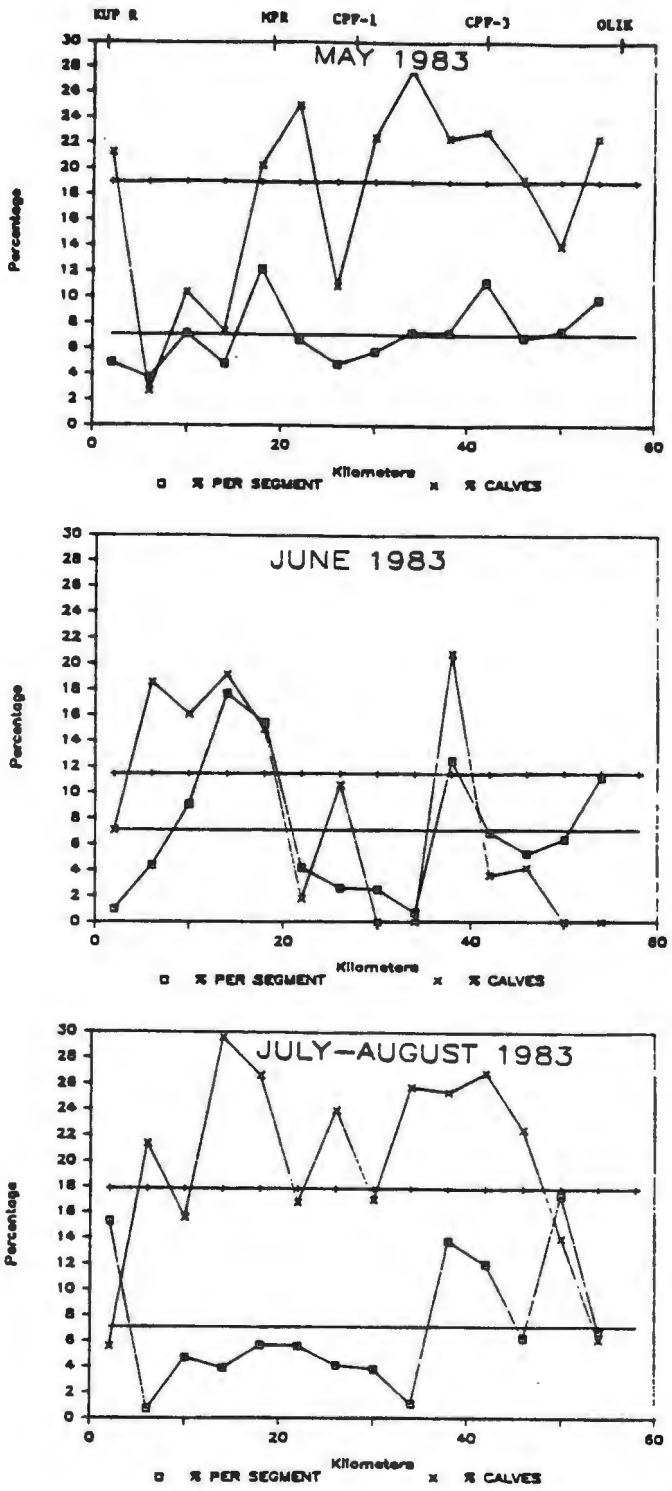


Fig. 3. Proportion of caribou and calf percentage within each 4 km segment of the Oliktok and Spine Roads, spring and summer 1983. Notes: Calves observed in May are short yearlings of the 1982 calf cohort. The solid horizontal line represents the percentage of the total number expected in each 4 km segment if the caribou were evenly distributed. The barred horizontal line is the overall calf percentage for the period. KUP R = Kuparuk River, MPR = Milne Point Road, OLIK = Oliktok Point.

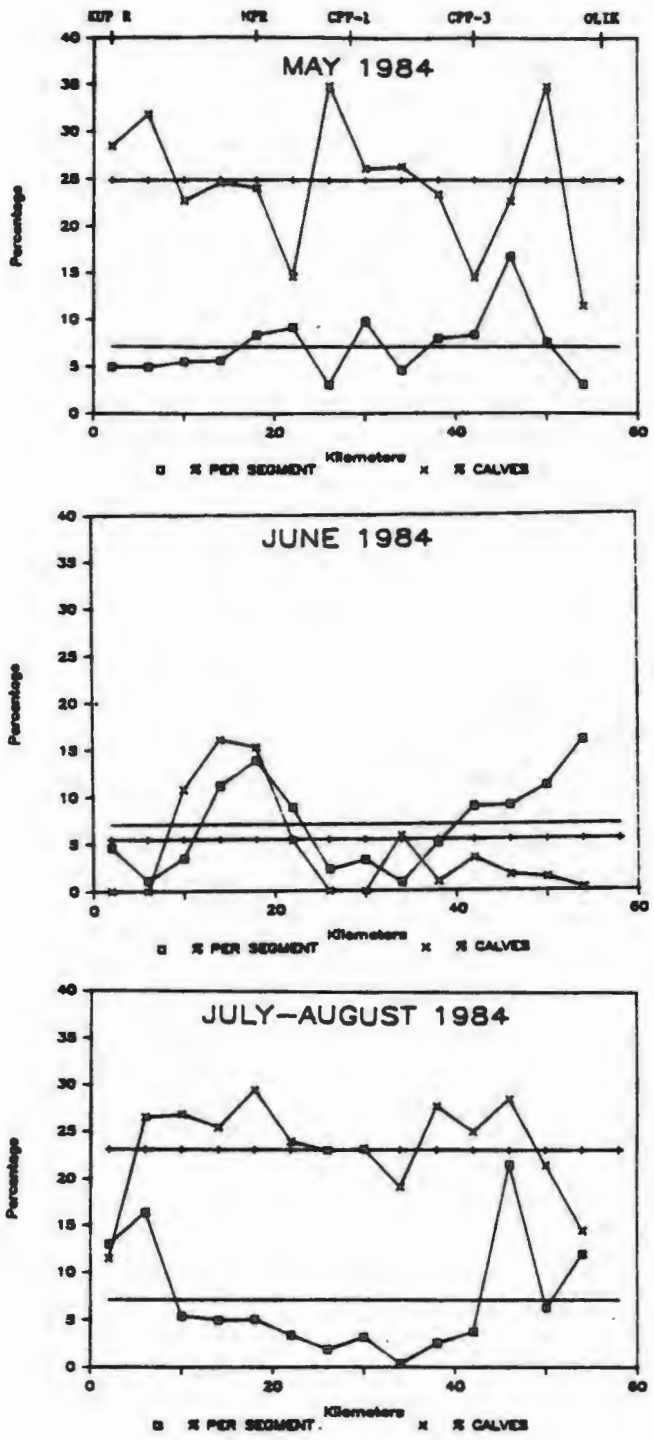


Fig. 4. Proportion of caribou and calf percentage within each 4 km segment of the Oliktok and West Sak Roads, spring and summer 1984. Notes: Calves observed in May are short yearlings of the 1983 calf cohort. The solid horizontal line represents the percentage of the total number of caribou expected in each 4 km segment if the caribou were evenly distributed. The barred horizontal line is the overall calf percentage for the period. KUP R = Kuparuk River, MPR = Milne Point Road, OKIK = Oliktok Point.

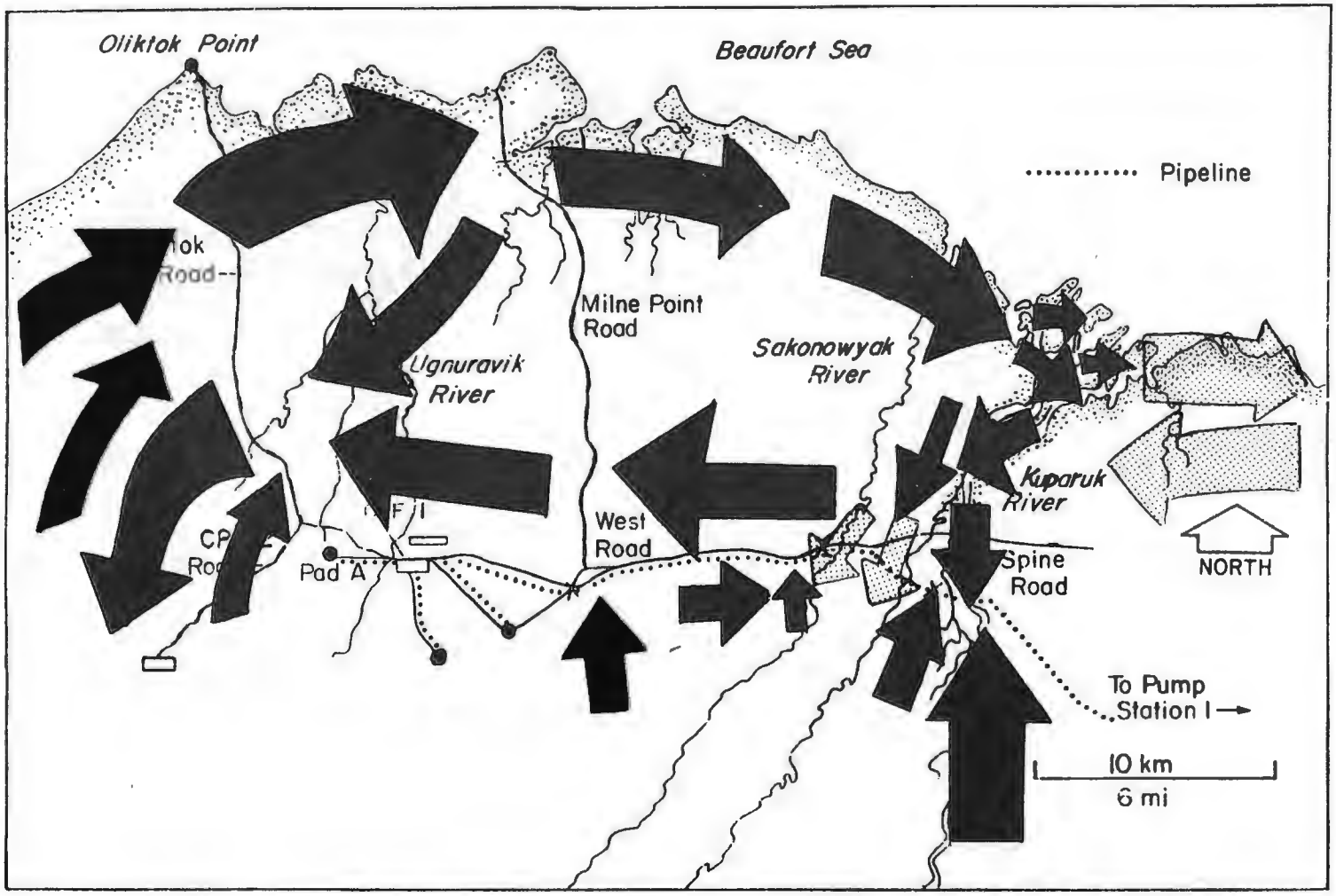


Fig. 5. Movements of caribou in response to insect harassment, Kuparuk Development Area. Dark arrows represent generalized movement patterns 1st observed in 1981. Stippled arrows are 1983 and 1984 movements noted in text.

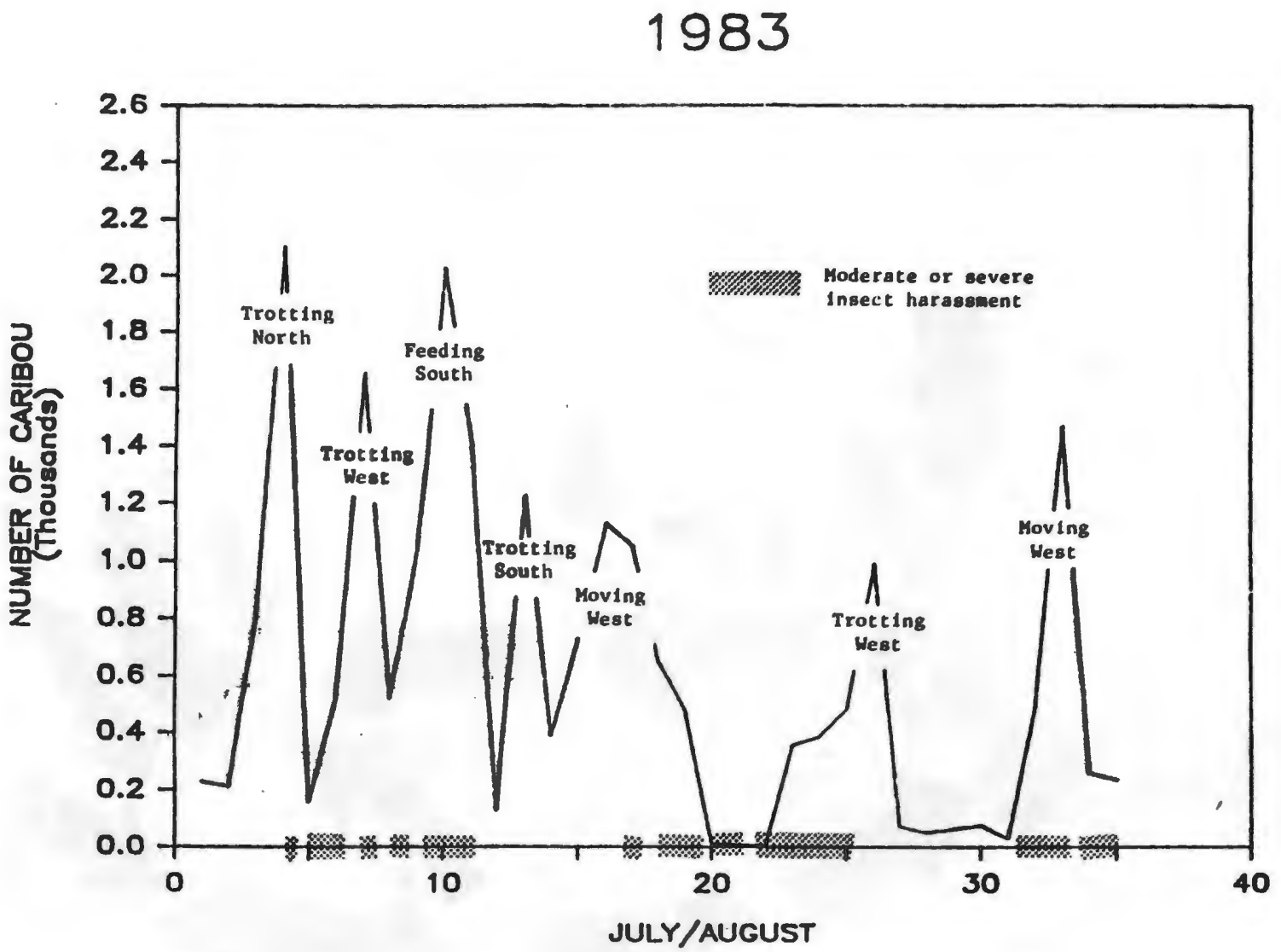


Fig. 6. Number and predominant movements, in relation to insect harassment, of caribou observed along the Spine and Oliktok Roads, summer 1983.

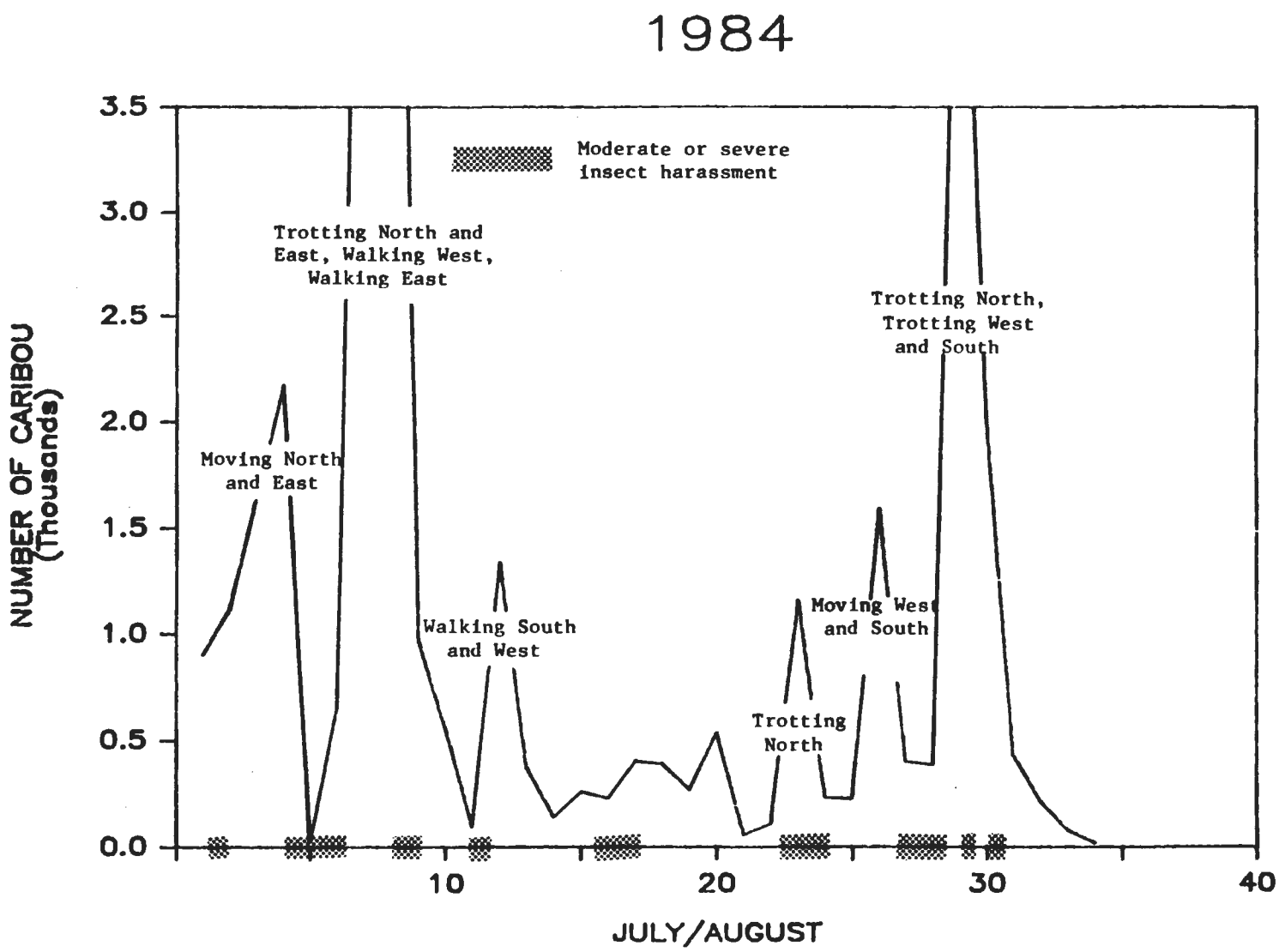


Fig. 7. Number and predominant movements in relation to insect harassment of caribou observed along the Spine and Oliktok Roads, summer 1984.

Table 1. Sex and age composition of calving caribou within the Kuparuk Development Area, Alaska, 1983-84.

| Date | Number of groups | Number of caribou | Number of bulls | Number of cows | Number of calves | Number of yrlgs | Percent calves | Percent yrlgs | Calves/ 100 cows | Bulls/ 100 cows | Yrlgs/ 100 cows |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/3/83 | 117 | 979 | 68 | 545 | 242 | 124 | 24.7 | 12.7 | 44 | 12 | 23 |
| 6/11-12/83 | 183 | 1859 | 72 | 810 | 737 | 240 | 39.6 | 12.9 | 91 | 9 | 30 |
| 6/18/83 | 124 | 1880 | 84 | 867 | 798 | 131 | 42.5 | 7.0 | 92 | 10 | 15 |
| 6/12-13/84 | 277 | 2692 | 68 | 1201 | 1071 | 303 | 39.8 | 11.3 | 89 | 6 | 25 |

Table 2. Population characteristics of caribou observed along the Spine and Oliktok Roads in 1983 and 1984.

| Date | Number of surveys | Number of groups | Number of caribou | Percent calves | Sighting rate (caribou/km) |
|---|---|---|---|---|---|
| | | | 1983 | | |
| 10-25 May | 14 | 287 | 1,156 | (19.0)[a] | 1.5 |
| 1-20 Jun | 19 | 294 | 1,343 | 11.5 | 1.3 |
| 1 Jul-4 Aug | 31 | 662 | 16,953 | 17.5 | 9.8 |
| Totals | 64 | 1,511 | 19,452 | 17.5 | |
| | | | 1984 | | |
| 10-25 May | 13 | 624 | 3,129 | (24.9)[b] | 4.3 |
| 1-20 Jun | 17 | 495 | 1,886 | 5.5 | 2.0 |
| 1 Jul-3 Aug | 57 | 1,327 | 38,492 | 23.2 | 13.5 |
| Totals | 87 | 2,446 | 43,507 | 22.5 | |

[a] 1982 calf cohort.

[b] 1983 calf cohort.

Table 3. Seasonal evaluation of crossing success of groups sighted along the Spine and Oliktok Roads, Alaska, 1983-84.

| | Road | | | Pipe | | | Road/pipe | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of groups | Number of caribou | Percent successful | Number of groups | Number of caribou | Percent successful | Number of groups | Number of caribou | Percent successful | Number of groups | Number of caribou | Percent successful |
| | | | | | | 1983 | | | | | | |
| May | 4 | 12 | 17 | -- | -- | -- | 1 | 2 | 50 | 5 | 14 | 21 |
| Jun | 2 | 13 | 100 | -- | -- | -- | 3 | 6 | 67 | 5 | 19 | 89 |
| Jul-Aug | 26 | 1404 | 46 | 6 | 126 | 29 | 45 | 1823 | 35 | 77 | 3353 | 40 |
| (groups >100) | (3) | (1066) | (30) | (1) | (119) | (25) | (6) | (1060) | (19) | (10) | (2245) | (25) |
| Total | 32 | 1429 | 47 | 6 | 126 | 29 | 49 | 1831 | 35 | 87 | 3386 | 40 |
| | | | | | | 1984 | | | | | | |
| May | 6 | 18 | 44 | -- | -- | -- | 2 | 13 | 31 | 8 | 31 | 42 |
| Jun | 3 | 6 | 83 | -- | -- | -- | 2 | 8 | 100 | 5 | 14 | 93 |
| Jul-Aug | 60 | 5039 | 98 | 19 | 901 | 99 | 46 | 1790 | 58 | 125 | 7730 | 89 |
| (groups >100 | (9) | (3738) | (98) | (2) | (765) | (100) | (7) | (855) | (61) | (18) | (5884) | (90) |
| Total | 69 | 5063 | 98 | 19 | 901 | 99 | 50 | 1811 | 58 | 138 | 7775 | 89 |

APPENDIX A

# RESPONSES OF BARREN-GROUND CARIBOU TO PETROLEUM DEVELOPMENT NEAR MILNE POINT, ALASKA

J. R. Dau and R. D. Cameron

Interim Report to CONOCO, Inc.

May 1984

## SUMMARY

1. The Milne Point region was surveyed by helicopter during the caribou calving period in 1980-83, and ground surveys were conducted from the Milne Point road system in May, June, July, and August 1982-83.

2. A between-year comparison of survey results obtained during calving suggests that a minor redistribution of caribou has occurred with surface development in the Milne Point area. Prior to road construction, caribou were loosely distributed in the approximate center of the study area; after road construction, 2 areas of relatively high use were discernible, one on either side of the road system.

3. During the June calving period, maternal caribou are apparently more sensitive to disturbance associated with the road system than in May, July, or August.

4. Caribou frequently crossed the northernmost 4 km of the road system and road segments near intersections; areas adjacent to these crossing points were occupied regularly.

5. We recommend that:

a. traffic and human activity near Milne Point be minimized between May and August, particularly during the periods 15 May-20 June and 1 July-1 August.

b. during summer, the area between C/D Pads and the coast be maintained entirely free of obstructions and human activity.

c. crossing ramps in the Milne Pipeline be located approximately 1-4, 9-10, and 13-15 km north of the West Sak Road.

i. local topographic features should be considered in the final selection of ramp locations.

ii. ramps should be low in profile and as wide as technically and economically feasible.

iii. ideally, transitions to pipeline sections of standard height should be gradual.

## INTRODUCTION

The Central Arctic Herd (CAH) is a distinct subpopulation of approximately 9,000 caribou (Rangifer tarandus granti) (Whitten and Cameron 1983) that range the Arctic Slope between the Canning and Colville Rivers (Cameron and Whitten 1979). Seasonal movements are principally north-south between calving grounds/summer range on the Arctic Coastal Plain and wintering areas in the Brooks Range. During late spring and summer,

the coastal region between Oliktok Point and the Kuparuk River receives high use by CAH caribou. The Milne Point Development Complex (MDC) is roughly centered on this area, raising 2 principal concerns regarding caribou: (1) potential displacement of maternal females from an established calving area, and (2) possible disruption of insect-induced movements during summer.

Maternal females appear to be extremely sensitive to disturbance (Lent 1966). Fewer cow/calf groups occur near areas of oil-related development (Cameron et al. 1979, Cameron and Whitten 1980). In fact, CAH calving activity has declined near Prudhoe Bay, apparently in response to the expanding oilfield network (Cameron et al. 1983, Smith and Cameron 1983). The habitat requirements of calving caribou are not well understood; consequently, it is difficult to predict the long-term effects of such displacement on the CAH and to ascertain the availability and suitability of alternative calving areas. However, based on principles of natural selection, it seems reasonable to assume that use of the present calving grounds has survival value to caribou. Therefore, disturbance to CAH caribou during this critical period should be minimized.

Caribou presumably optimize their energy balance in summer by minimizing exposure to insects and maximizing foraging efficiency. On warm, still days when insects are active, groups of CAH caribou coalesce and move toward coastal areas which are typically cooler and windier than inland regions. During subsequent cool and/or windy periods, groups fragment and move to inland feeding sites. These coastal-inland oscillations occur frequently during the summer (White et al. 1975). In addition, during long periods of particularly severe insect harassment, large groups of caribou may parallel the coast into prevailing northeasterly winds. Thus, midsummer movements are not strictly north-south, but may be modified by the duration/intensity of insect harassment, wind patterns, and surface features.

Several investigators have shown that CAH caribou often have difficulty crossing elevated pipelines and/or roads with traffic (Child 1973, Smith and Cameron 1983, Curatolo and Murphy 1983, Fancy 1983). A few gravel ramps have been constructed across pipelines in attempts to enhance movements of caribou. The success of ramp crossings has been highly variable. It appears that the use of ramps is influenced by a number of factors, including ramp width, proximity to other structures (e.g., roads or buildings), and the intensity of nearby traffic.

The goal of this study is to minimize the potentially deleterious effects of petroleum development on CAH caribou near the MDC. This involves 3 phases: (1) identifying areas of high caribou use near Milne Point, (2) developing recommendations to minimize the effects of surface development on caribou, and (3) evaluating the effectiveness of mitigation. This report addresses phases 1 and 2; phase 3 studies will be initiated following construction of the Milne Pipeline.

## METHODS

The study area lies north of the West Sak Road between the Oliktok Road and Kuparuk River (Fig. 1).

Regional distribution of caribou during calving was described using the results of aerial surveys conducted annually between 1980 and 1983. The study area was surveyed intensively each year on 11-14 June, soon after the peak of calving. Additional surveys were conducted on 5 and 17 June 1982, and on 3 and 18 June 1983.

All surveys were flown by Bell 206 helicopter along transects spaced at 3.2 km (2 mi). The pilot and 3 observers searched ahead and to within 1.6 km (1 mi) of each side of the aircraft. Thus, nearly total coverage of the study area was achieved. Location, group size, and sex/age composition were recorded for all groups of caribou observed.

In 1982 and 1983, surveys were conducted twice-daily along the entire road system (Fig. 2) during 4 periods: 9-27 May (precalving), 1-20 June (calving), 1 July-5 August (postcalving), and 19-25 August (August dispersal). Usually, 1 observer conducted the surveys in a light truck at speeds less than 48 km/hr (30 mi/hr). For each sighting, the vehicle was stopped at the point approximately perpendicular to the group and the caribou were observed using binoculars or a spotting scope. The following information was recorded for each group observed within approximately 1,000 m of the road system:

1. date and time
2. location along the Milne Road system
3. group size and sex/age composition
4. estimated distance from the observer
5. location of any road crossings
6. number of caribou in the crossing group

## RESULTS AND DISCUSSION

### Regional Distribution of Caribou During Calving

We observed 245 and 991 caribou during the 1980 and 1981 aerial surveys, respectively (no development present). On 3 surveys each in 1982 and 1983 (road system in place), we observed 2,101 and 3,883 caribou, respectively.

The study area was partitioned into 40 blocks of 1,036 ha (4 sq mi) each. Numbers of total caribou and calves observed within each block were tallied separately. Blocks defined as preferred by caribou were those in which the percentage of total caribou observed exceeded 2.5%, the percentage of total area represented by each block. Of the 7 blocks encompassing the present road system, 3 were preferred by caribou in both 1980 and 1981, but only 1 block was occupied preferentially in 1982 and 1983 (Fig. 3). Pre- and postconstruction differences are summarized in

Fig. 4. Overall, 18% of the caribou observed (17% of the calves) were within the 7 central blocks during the 2 years prior to road construction, whereas only 6% of the caribou (5% of the calves) were present in the same area during the 2 years following road placement.

This apparent shift in distribution of caribou during calving was examined further by stratifying the area within 6,000 m of the road system into 1,000 m intervals. Percentage of total caribou and percentage of calves within each distance stratum (excluding those groups closer to the West Sak Road) were plotted for 1980-81 and 1982-83 (Fig. 5). In 1980-81, highest use occurred 2,000-3,000 m from the existing roads. Following road construction, peak occupancy shifted to the 3,000-4,000 m stratum, and relatively fewer caribou occurred within 1,000 m of the road system (7% vs. 16%). Also, the percentage of calves observed within 3,000 m was lower after road construction (38% vs. 68%).

From these data it appears that a local redistribution of calving caribou has occurred. In 1980-81, caribou were loosely distributed in the approximate center of the study area; but the 1982-83 survey results suggest a tendency toward formation of 2 separate areas of relatively high use, one on either side of the road system (Fig. 4). These differences are rather subtle, however, and there is no evidence that the total number of caribou utilizing the area has declined as a result, nor have there been any major changes in calving success.

Distribution and Movements of Caribou Observed from the Milne Road System

More caribou were observed in 1983 than in 1982 (Table 1), in part because northward movements in 1982 were hindered by the late spring thaw. Also, alternating periods of high and low insect activity were longer in 1983 and large transient aggregations of caribou were observed more frequently than during the previous year. Mean distance to groups within 1,000 m of roads was similar within and between years (Table 2).

The locations of caribou sightings and road crossings recorded in 1982 and 1983 were combined (Fig. 6). Relatively high use and frequent road crossings by caribou were observed along the northernmost 4 km of the road system. We believe that this reflects preferential use of coastal regions by caribou under insect harassment. High use also occurred near the Pit Road-East Road intersection and the West Road-West Sak Road intersection, suggesting that approaching caribou tend to parallel roads after initial contact and are subsequently funneled into these areas.

Our analyses focused on that section of the Milne road system between the "Y" and West Sak Road (Fig. 2) because: (1) maintaining caribou movements through the future production complex north of the "Y" would require multiple crossings of flow lines; (2) high levels of human activity associated with production wells and the proposed processing facility could reduce or preclude the use of special crossings by caribou; (3) a natural movement corridor between C/D Pads and the coast already exists. We believe that caribou movements through the area will

be least affected if the corridor north of C/D Pads is maintained and crossing ramps are installed in areas of high use at 1-4, 9-10, and 13-15 km north of the West Sak Road (Figs. 7 and 8).

Temporal differences in the sensitivity of caribou to roads were evaluated by comparing the distribution of total caribou and calves among 100 m increments from the road during the 4 sampling periods (Fig. 9). Relatively fewer total caribou and calves were observed within 500 m of roads during June than during May (calves of the previous year), July, or August. These data further support the contention that maternal caribou tend to avoid man-made structures and vehicular activity during the calving period. Insect harassment during July and August apparently diminishes the sensitivity to disturbing stimuli.

## RECOMMENDATIONS

We recommend that traffic and human activity near Milne Point be minimized from May through August, particularly during 15 May-20 June and 1 July-1 August. The Milne Point area is occupied regularly during calving, a period when caribou are especially sensitive to disturbance. Minimal traffic and human activity between 15 May and 20 June should allow access of caribou to the Milne calving grounds and reduce disturbance to maternal groups using the area. Similar restrictions during 1 July-1 August will minimize interference with insect-induced movements of caribou within the coastal zone. The area between the coast and C/D Pads is important insect relief terrain and a natural movement corridor for caribou; it should be kept free of obstructions and human activity during summer.

Caribou crossing ramps in the Milne Pipeline should be located approximately 1-4, 9-10, and 13-15 km north of the West Sak Road. Local topographic features (e.g., ridges and lake margins) that may influence caribou movements should be considered in the final placement of ramps. Ramps should be low in profile, as wide as technically and economically feasible, and include gradual transitions in elevation between exposed and buried sections of pipe. This should maximize the visual "window" effect and increase use of the ramp crossings.

## ACKNOWLEDGMENTS

Primary funding for this study was provided by the Milne Point Unit owners through Conoco, Inc. Additional support was obtained from the Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Project W-21-2. Aerial surveys conducted in 1980 and 1981 were funded in part by a grant from ARCO Alaska, Inc. We thank W. T. Smith and J. Smith for helpful advice and technical assistance.

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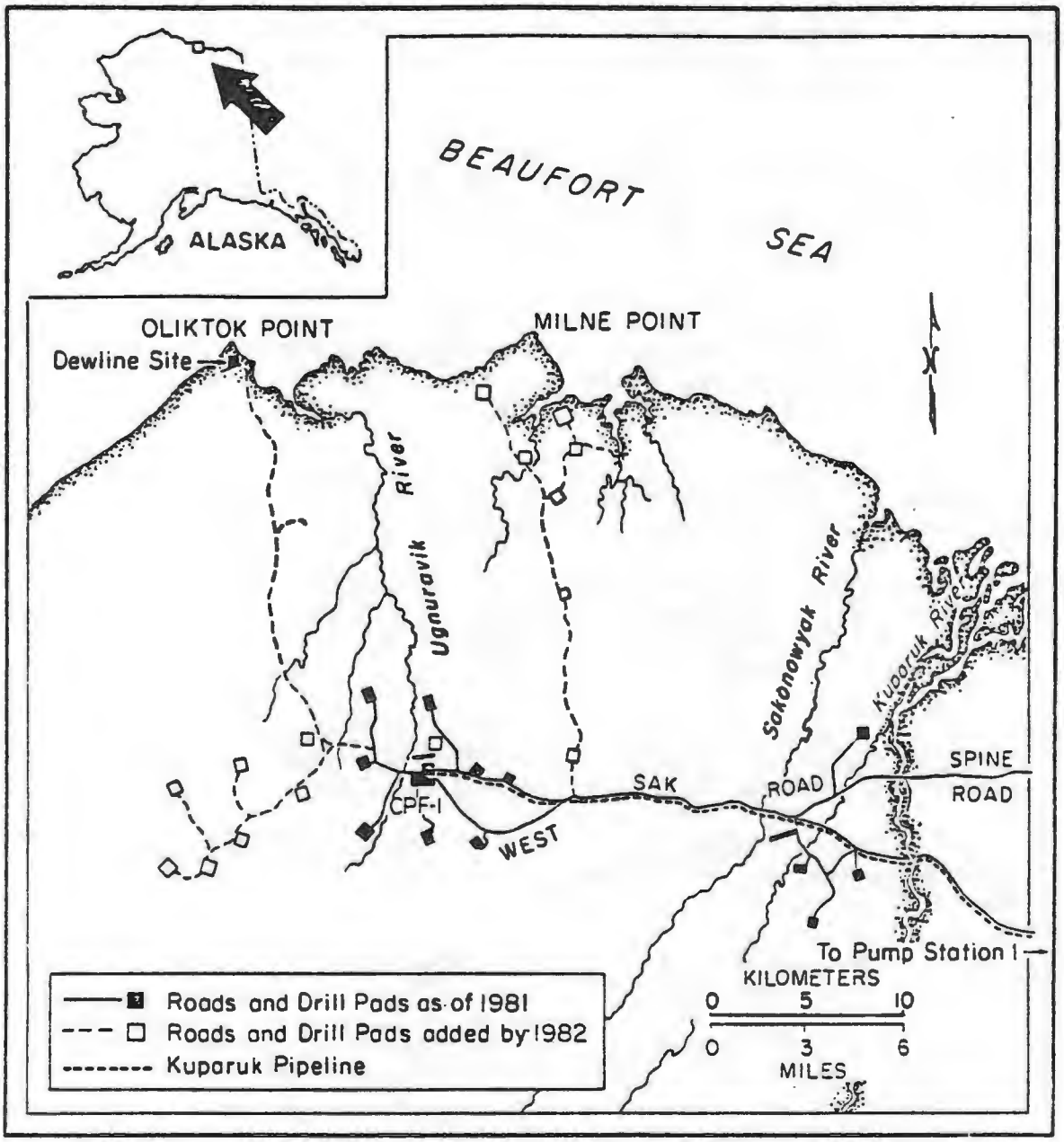


Fig. 1. The Milne Point study area.

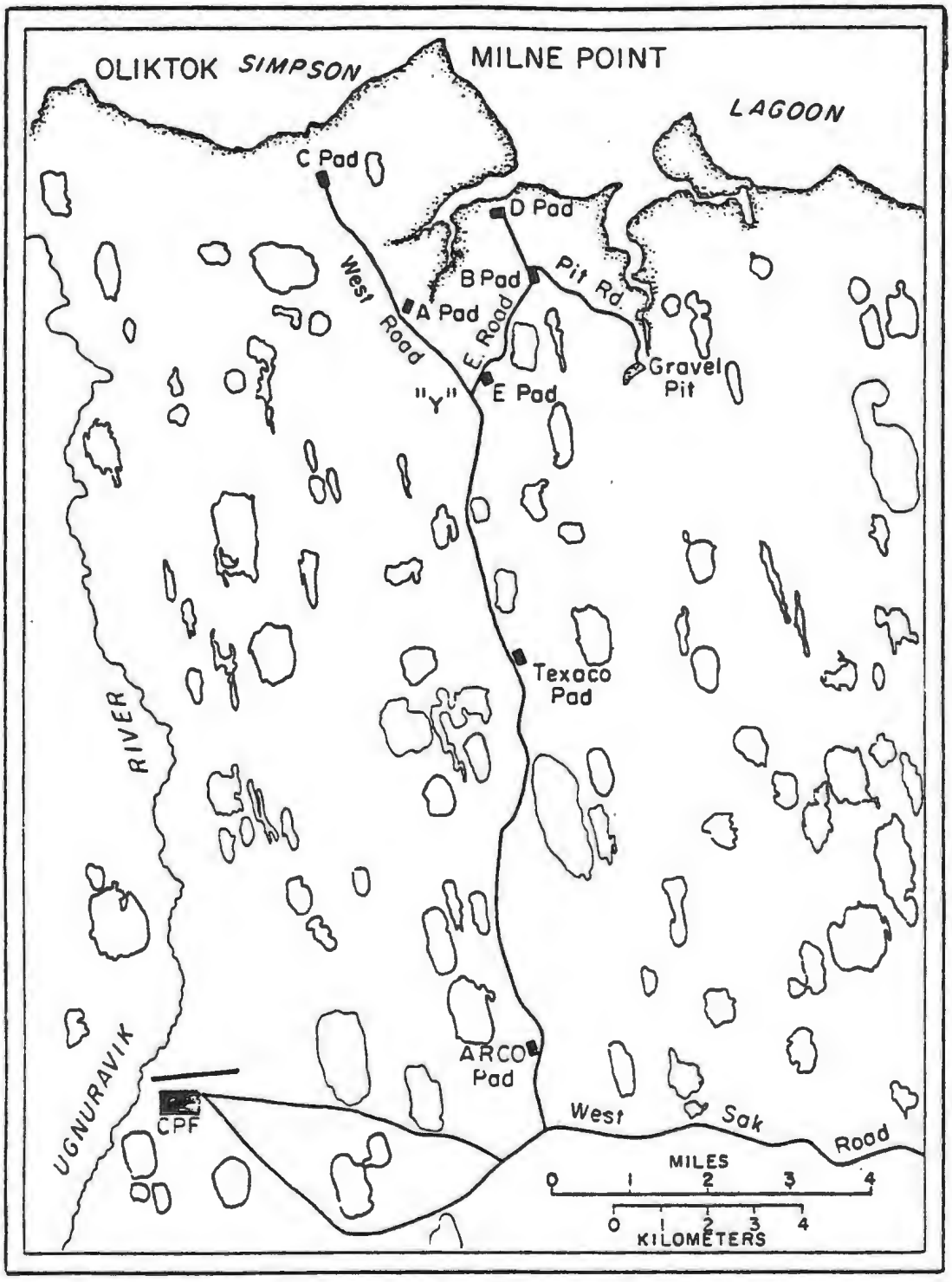


Fig. 2. The Milne Point Development Complex.

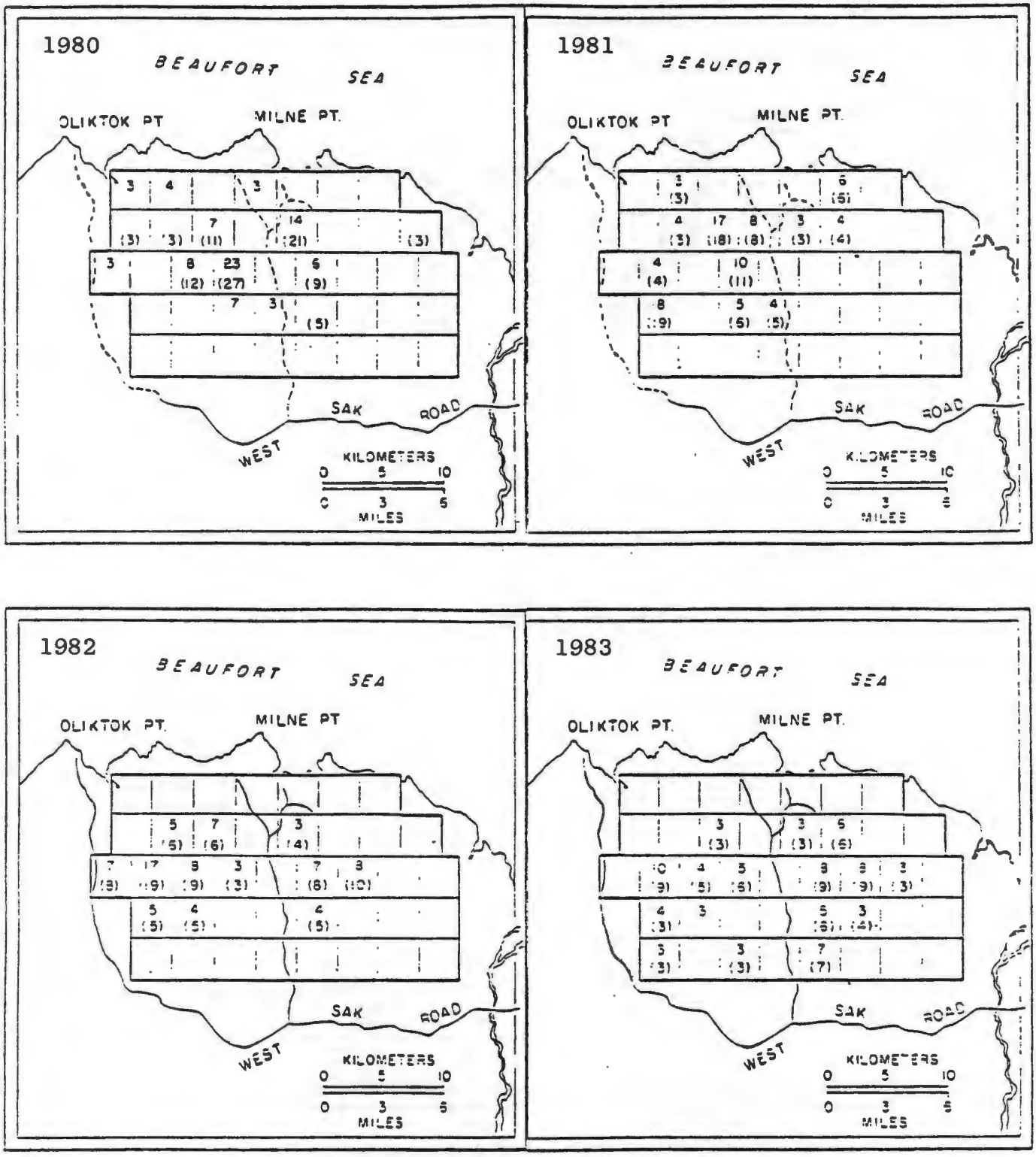


Fig. 3. Distribution of areas preferred by caribou during calving, June 1980, 1981, 1982, 1983. The occurrence of caribou (calves, in parentheses) within 1036-ha blocks is expressed as a percentage of the total observed in all 40 blocks (41440 ha); only those percentages exceeding 2.5% (the percentage of the total area represented by each block) are shown.

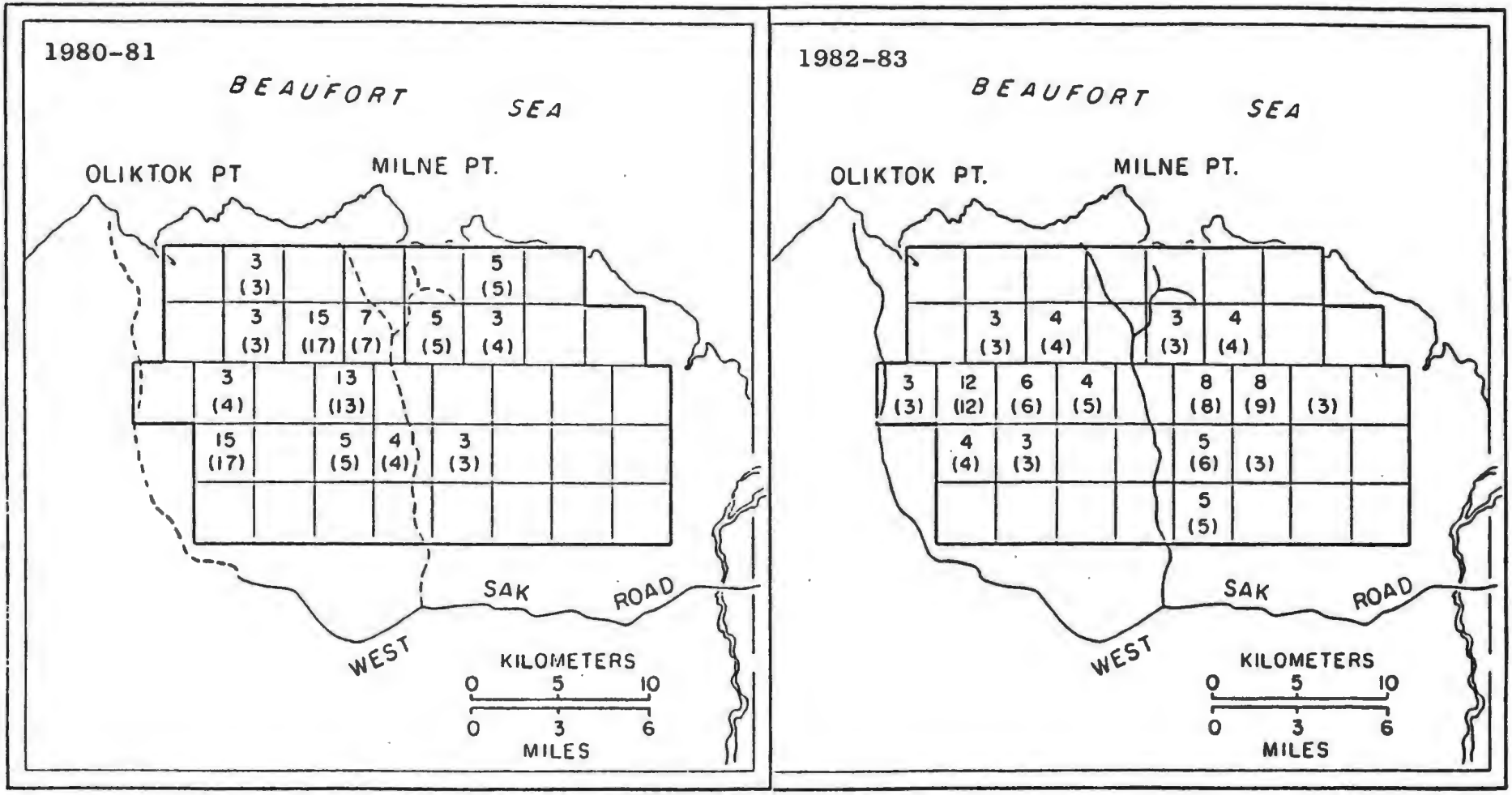


Fig. 4. Distribution of areas preferred by caribou during calving, June 1980-81 and June 1982-83. The occurrence of caribou (calves, in parentheses) within 1036-ha blocks is expressed as a percentage of the total observed in all 40 blocks (41440ha); only those percentages exceeding 2.5% (the percentage of the total area represented by each block) are shown.

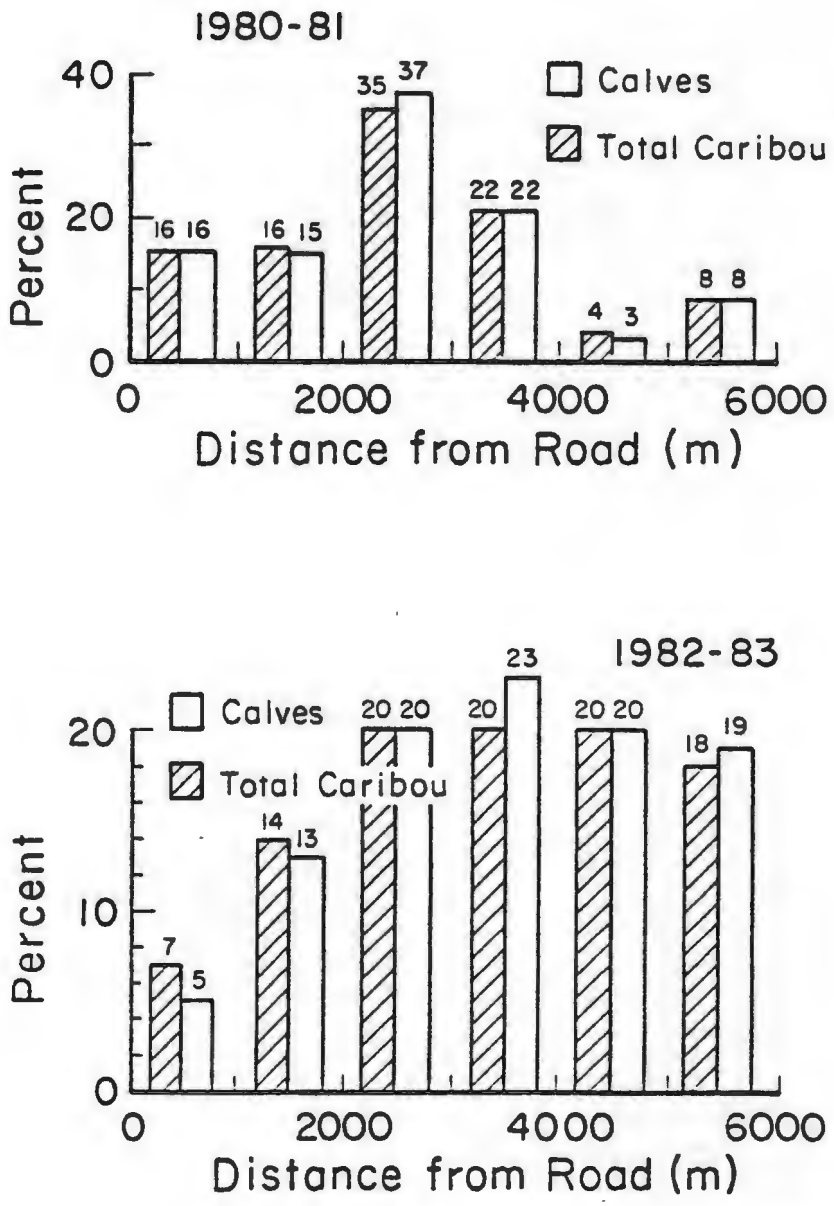


Fig. 5. Percentages of total caribou and calves observed within each of 6 distance intervals from the Milne road system, June 1980-81 and June 1982-83.

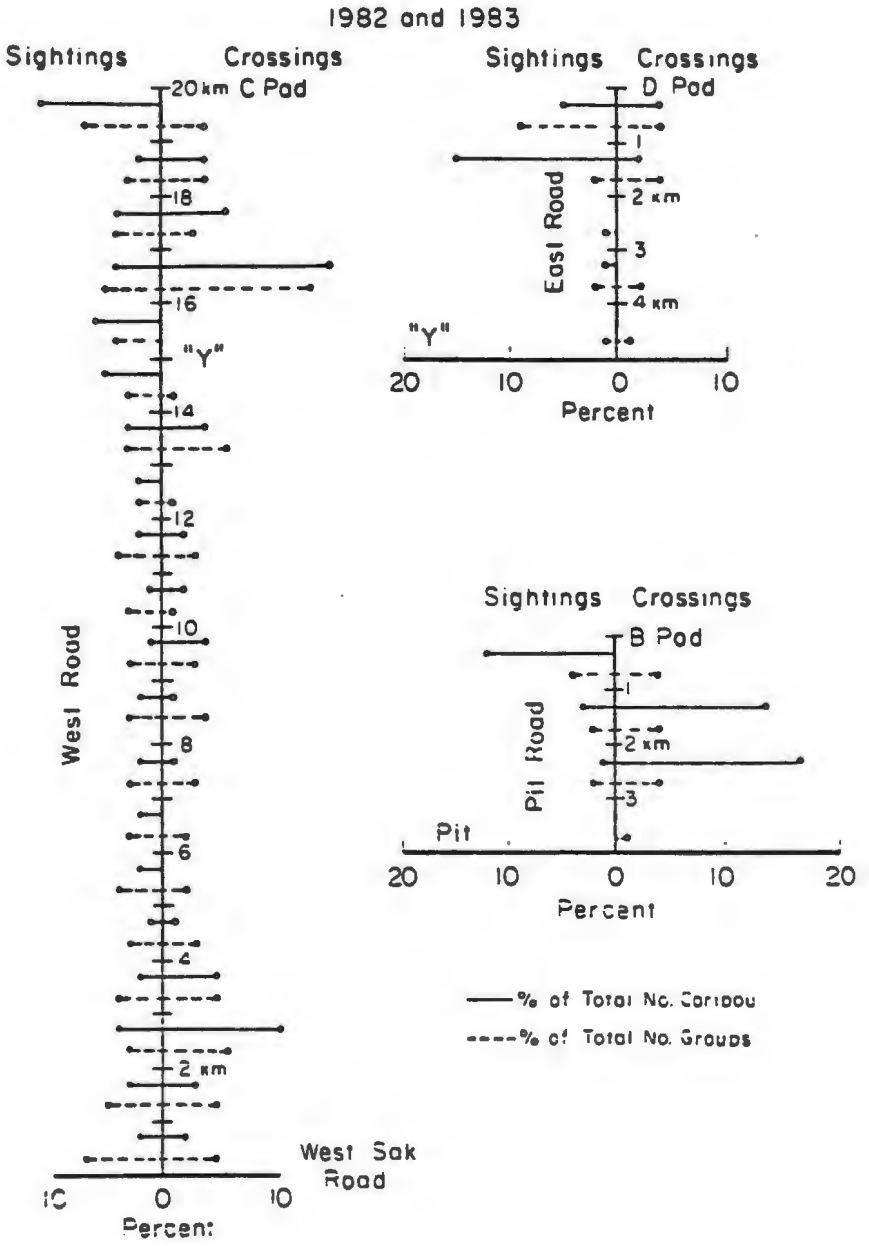


Fig. 6. Distribution of caribou sightings and road crossings along the Milne road system, May-August 1982-83.


Fig. 7. Distribution of caribou sightings and road crossings along the West Road, between the "Y" and the West Sak Road, May-August 1982 and May-August 1983.

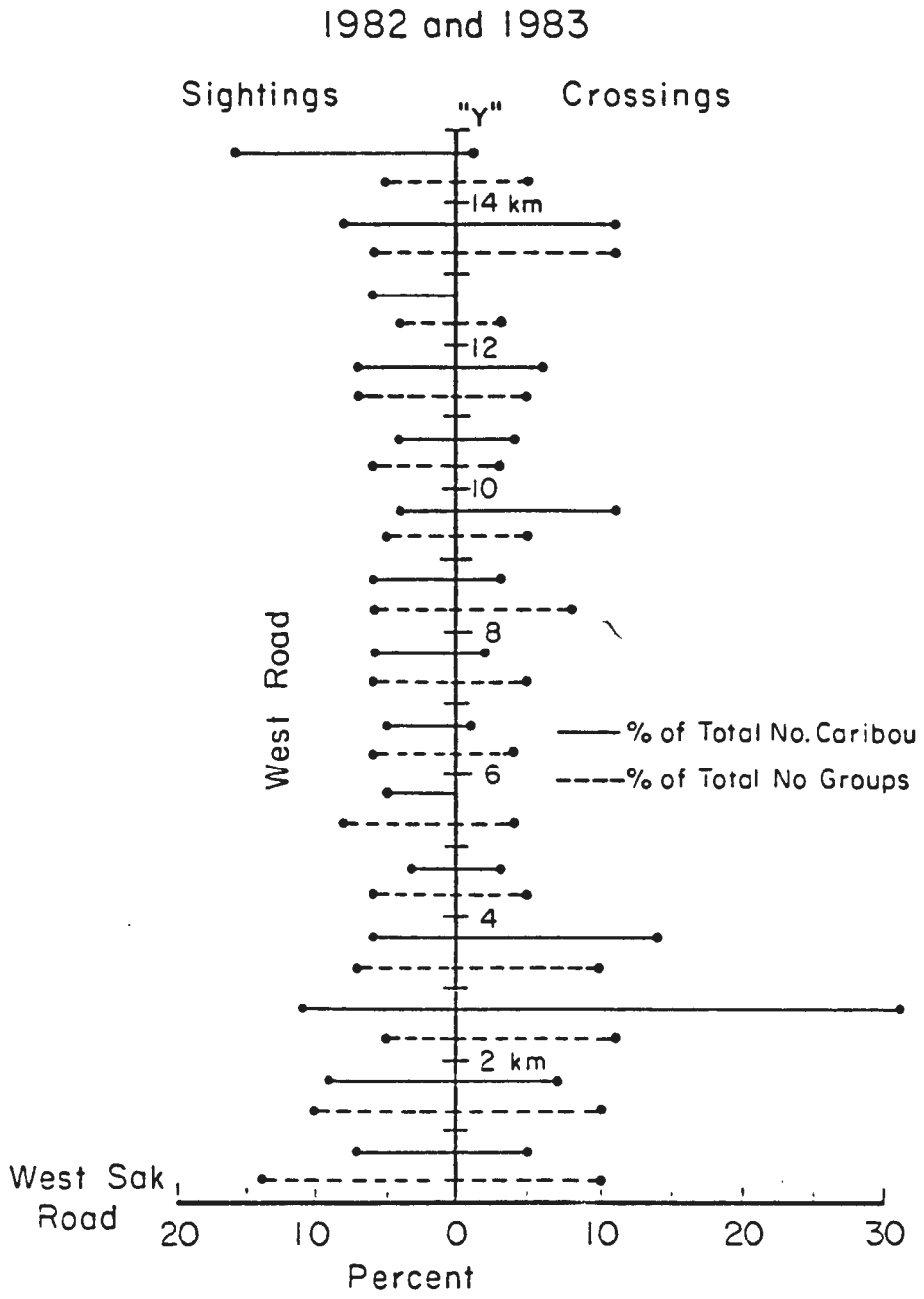


Fig. 8. Distribution of caribou sightings and road crossings along the West Road, between the "Y" and the West Sak Road, May-August 1982-83.

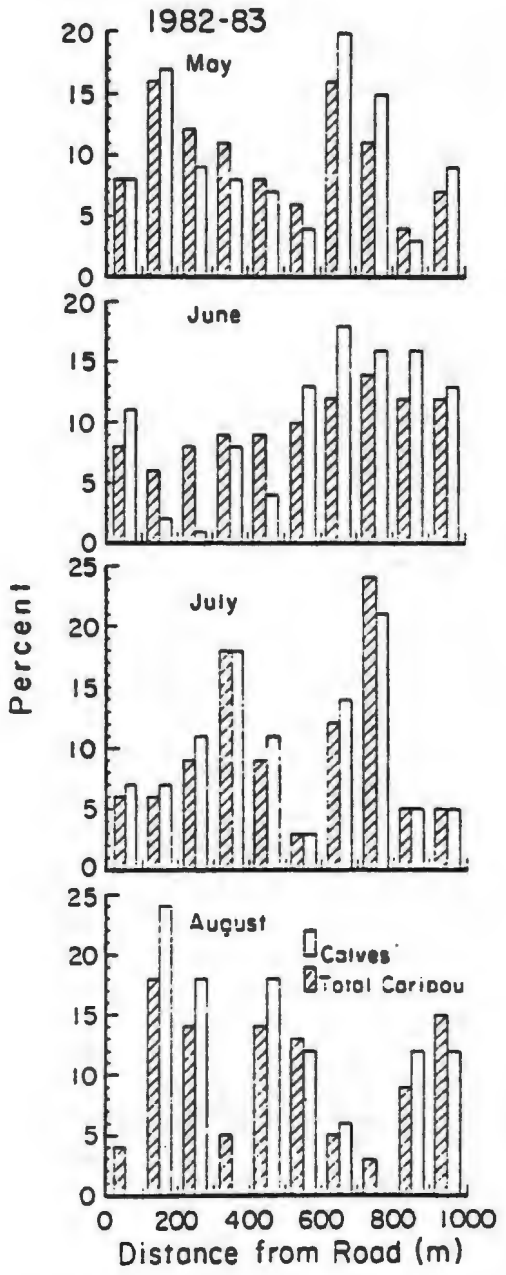


Fig. 9. Percentages of total caribou and calves observed within each of 10 distance intervals from the Milne road system, May-August 1982-83.

Table 1. Numbers and sex/age composition[a] of caribou observed within 1,000 m of roads during road surveys, May-August 1982 and 1983.

| Month | Total caribou | Bulls | Cows | Calves | Yearlings | Adults | No. of groups |
|---|---|---|---|---|---|---|---|
| 1982 | | | | | | | |
| May | 227 | 24 (11) | 133 (59) | 62 (27) | 0 (0) | 8 (4) | 81 |
| Jun | 351 | 32 (9) | 164 (47) | 6 (2) | 88 (25) | 61 (17) | 104 |
| Jul | 1493 | 188 (13) | 475 (32) | 255 (17) | 66 (4) | 509 (34) | 106 |
| Aug | 51 | 5 (10) | 21 (41) | 13 (25) | 8 (16) | 4 (8) | 19 |
| Totals | 2122 | 249 (12) | 793 (37) | 336 (16) | 162 (8) | 582 (27) | 310 |
| 1983 | | | | | | | |
| May | 544 | 11 (2) | 169 (31) | 143 (26) | 63 (12) | 158 (29) | 121 |
| Jun | 1067 | 41 (4) | 372 (35) | 218 (20) | 231 (22) | 205 (19) | 246 |
| Jul | 6017 | 631 (10) | 1373 (23) | 1153 (19) | 920 (15) | 1940 (32) | 159 |
| Aug | 27 | 1 (4) | 22 (81) | 4 (15) | 0 (0) | 0 (0) | 12 |
| Totals | 7655 | 684 (9) | 1936 (25) | 1518 (20) | 1214 (16) | 2303 (30) | 538 |

[a] ( ) = % of total.

Table 2. Mean group size and observation distance of caribou observed within 1,000 m of roads during road surveys, May-August 1982 and 1983.

| | Group size | | | Observation distance | | |
|---|---|---|---|---|---|---|
| Month | Mean | S.D. | S.E. | Mean | S.D. | S.E. |
| 1982 | | | | | | |
| May | 2.8 | 1.7 | 0.2 | 455 | 243 | 27 |
| Jun | 3.4 | 3.1 | 0.3 | 548 | 263 | 26 |
| Jul | 14.0 | 28.1 | 2.7 | 483 | 261 | 29 |
| Aug | 2.7 | 1.9 | 0.5 | 589 | 305 | 70 |
| 1983 | | | | | | |
| May | 4.5 | 3.3 | 0.3 | 540 | 306 | 28 |
| Jun | 4.3 | 5.9 | 0.4 | 534 | 295 | 19 |
| Jul | 38.0 | 102.3 | 8.1 | 477 | 317 | 25 |
| Aug | 2.3 | 2.1 | 0.6 | 421 | 360 | 104 |

APPENDIX B

# RESPONSES OF BARREN-GROUND CARIBOU TO PETROLEUM DEVELOPMENT NEAR MILNE POINT, ALASKA

J. R. Dau and R. D. Cameron

Interim Report to Continental Pipeline Company

February 1985

## SUMMARY

The primary results of caribou surveys conducted in the Milne Point region in 1984 are outlined below. References to comparable data obtained in 1982 and/or 1983 (Dau and Cameron 1984*) are given in brackets [].

1. The Milne Point region was surveyed by helicopter on 12-13 June, and ground surveys were conducted from the Milne Point road system between 10 May and 5 August. Study objectives and surveillance procedures were identical to those described previously.

2. During the calving period in 1984, 2 areas of relatively high use were discernible, 1 on either side of the Milne Point road system (Fig. 1); a similar pattern was noted in both 1982 and 1983 [Fig 3.]. Cumulative data for 1982-84 (Fig. 2) indicate that only 6% and 5% of total caribou and calves, respectively, were observed within the 7 central 1,036-ha blocks encompassing the road system; whereas in 1980-81, prior to road construction [Fig. 4], the respective values were 18% and 17%.

3. The combined 1982-84 data on relative distribution of total caribou and calves among 1,000-m distance intervals from the road system clearly indicate that occupancy increased directly with distance within the first 4,000 m (Fig. 3), similar to the pattern observed in 1982-83, but appreciably different from that in 1980-81 [Fig. 5].

4. More caribou were observed from the road system in 1984 (Table 1) than in either previous year [Table 1], despite a reduction in sampling intensity during May, June, and August, and the deletion of coverage along the Pit Road [see Fig. 2]. Mean group size and observation distance of caribou within 1,000 m of roads were similar during all 3 survey years (Table 2) [Table 2].

5. The combined 1982-84 distribution of caribou sightings indicates continued high use of the northernmost 4 km of the Milne Point road system (Fig. 4) [Fig. 6].

6. Road survey data on caribou distribution obtained in 1982 and 1983 suggested 3 nodes of relatively high use and crossing activity at 1-4, 9-10, and 13-15 km north of the West Sak Road [Figs. 7 and 8]. In 1984, however, only 2 such nodes were apparent, at approximately 1-6 and 11-15 km (Fig. 5); the combined 1982-84 data show a similar pattern of distribution (Fig. 6). It should be noted that high use at 11-12 km is attributable to 2 large groups (ca. 1,200 and 4,000 caribou) observed on 7 July.

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* Dau, J. R. and R. D. Cameron. 1984. Responses of barren-ground caribou to petroleum development near Milne Point, Alaska. Interim Rep. to CONOCO, Inc. 24pp.

7. During all sampling periods in 1984, the highest percentages of both total caribou and calves observed within 1,000 m of the road system were at distances greater than 900 m (Table 3). Trends in observation distance were less distinct in 1982-83 [Fig. 9].

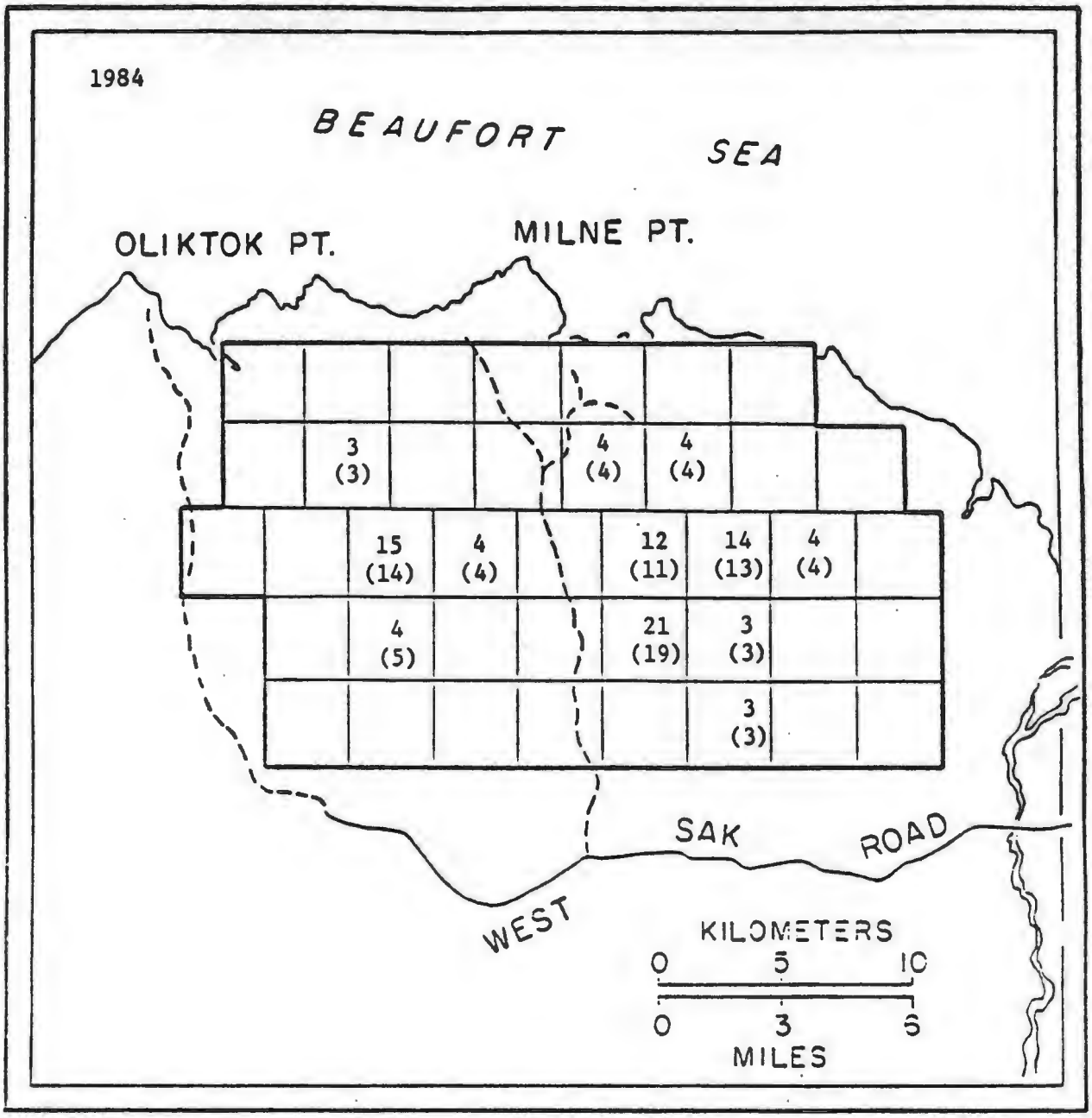


Fig. 1. Distribution of areas preferred by caribou during calving, June 1984. The occurrence of caribou (calves, in parentheses) within 1,036-ha blocks is expressed as a percentage of the total observed in all 40 blocks (41,440 ha); only those percentages exceeding 2.5% (the percentage of the total area represented by each block) are shown.

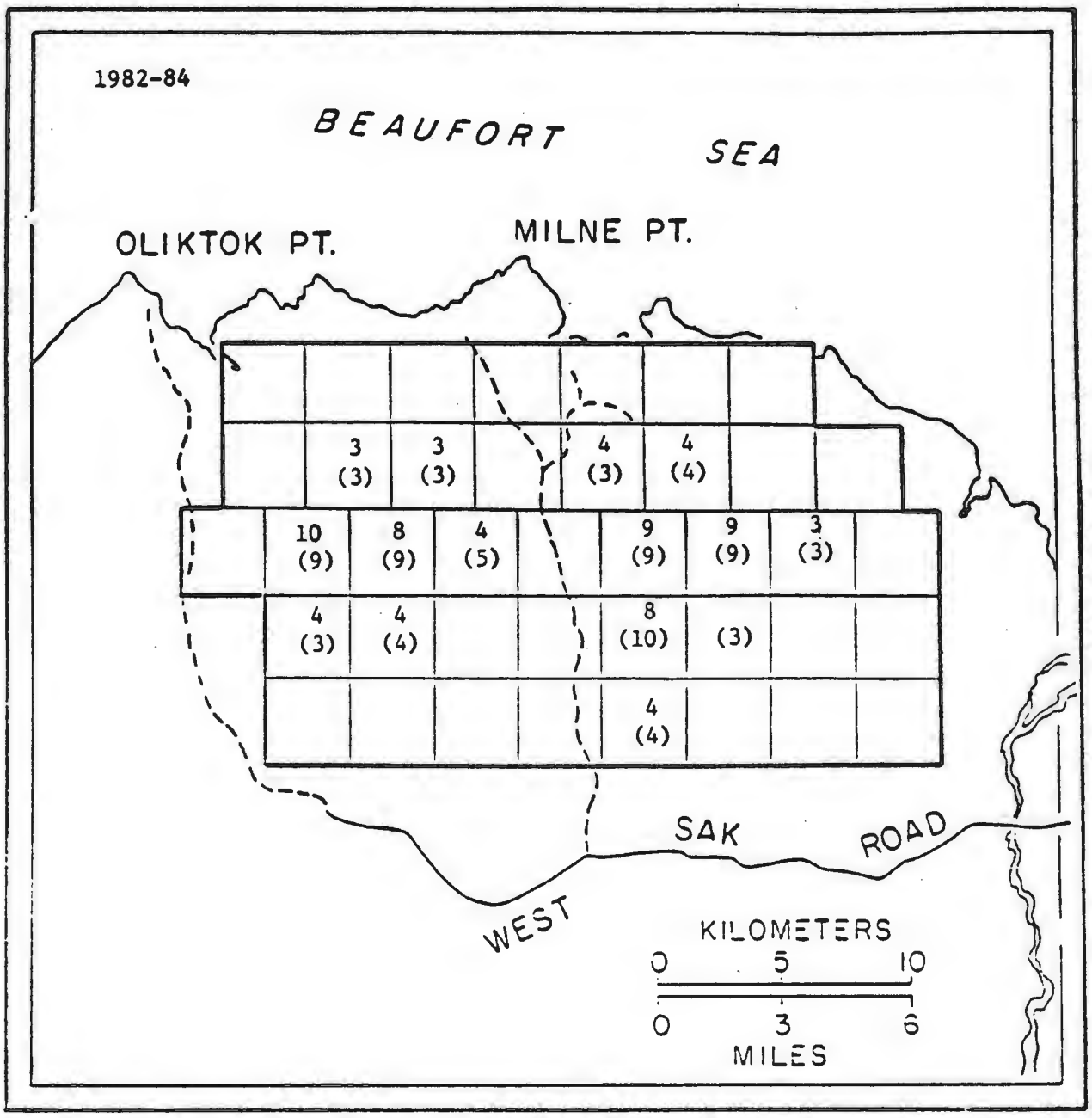


Fig. 2. Distribution of areas preferred by caribou during calving, June 1982-84. The occurrence of caribou (calves, in parentheses) within 1,036-ha blocks is expressed as a percentage of the total observed in all 40 blocks (41,440 ha); only those percentages exceeding 2.5% (the percentage of the total area represented by each block) are shown.

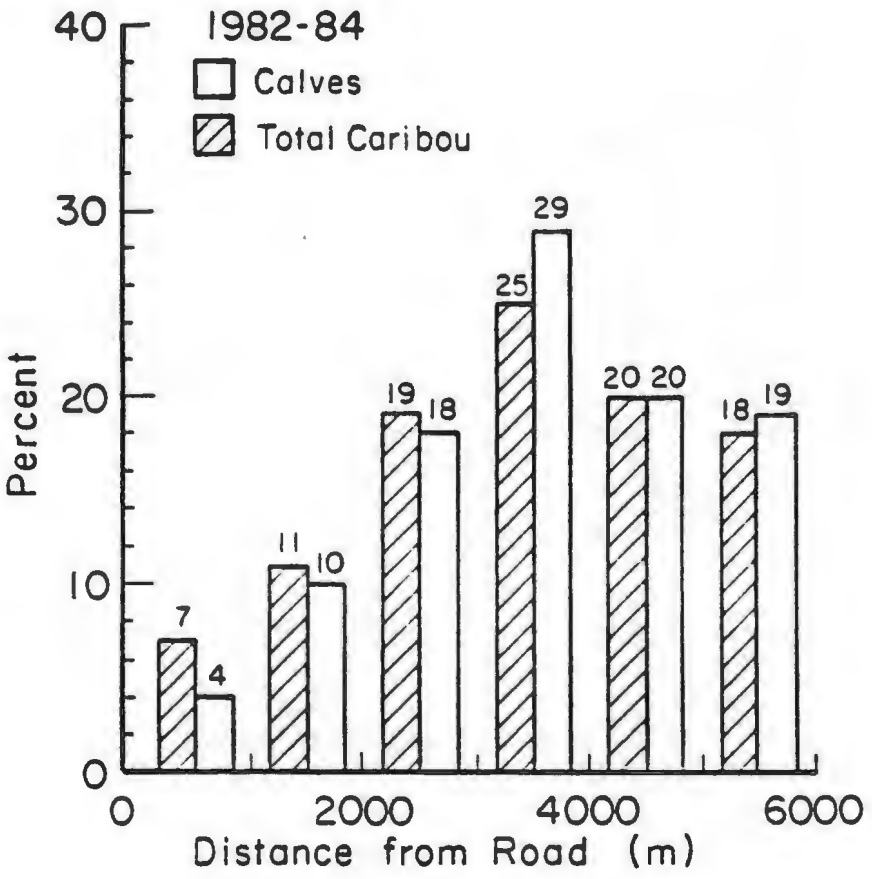


Fig. 3. Percentages of total caribou and calves observed within each of 6 distance intervals from the Milne road system, June 1982-84.

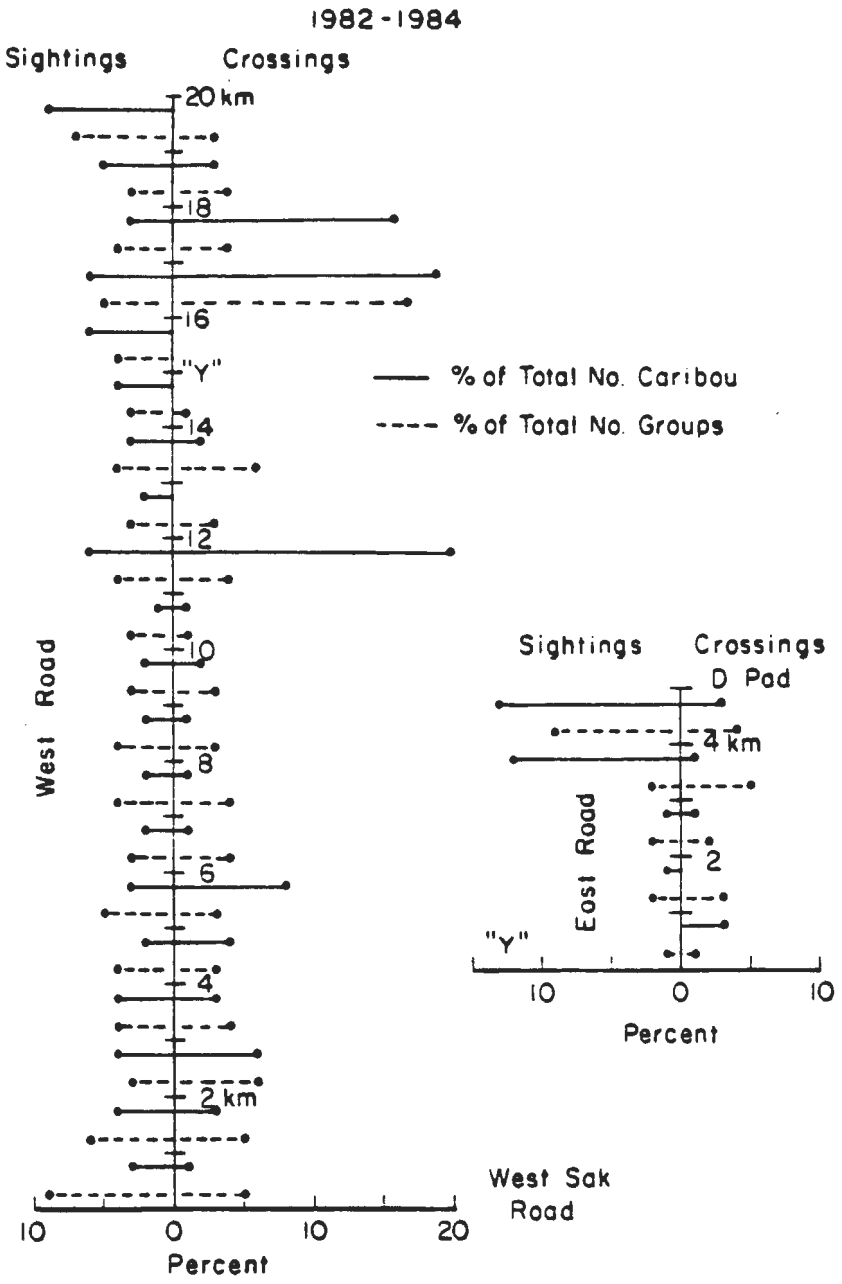


Fig. 4. Distribution of caribou sightings and road crossings along the Milne road system, May-August 1982-84.

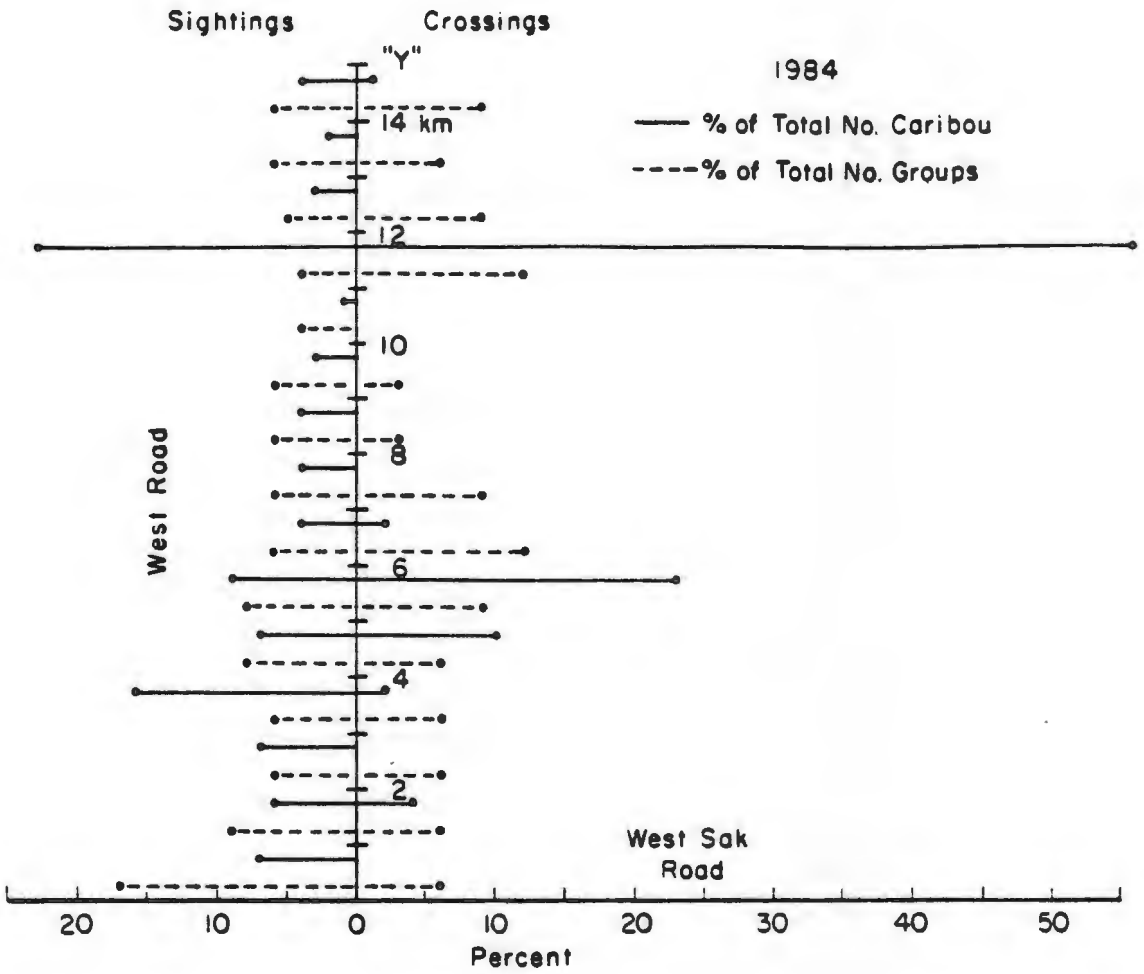


Fig. 5. Distribution of caribou sightings and road crossings along the West Road, between the "Y" and the West Sak Road, May–August 1984.

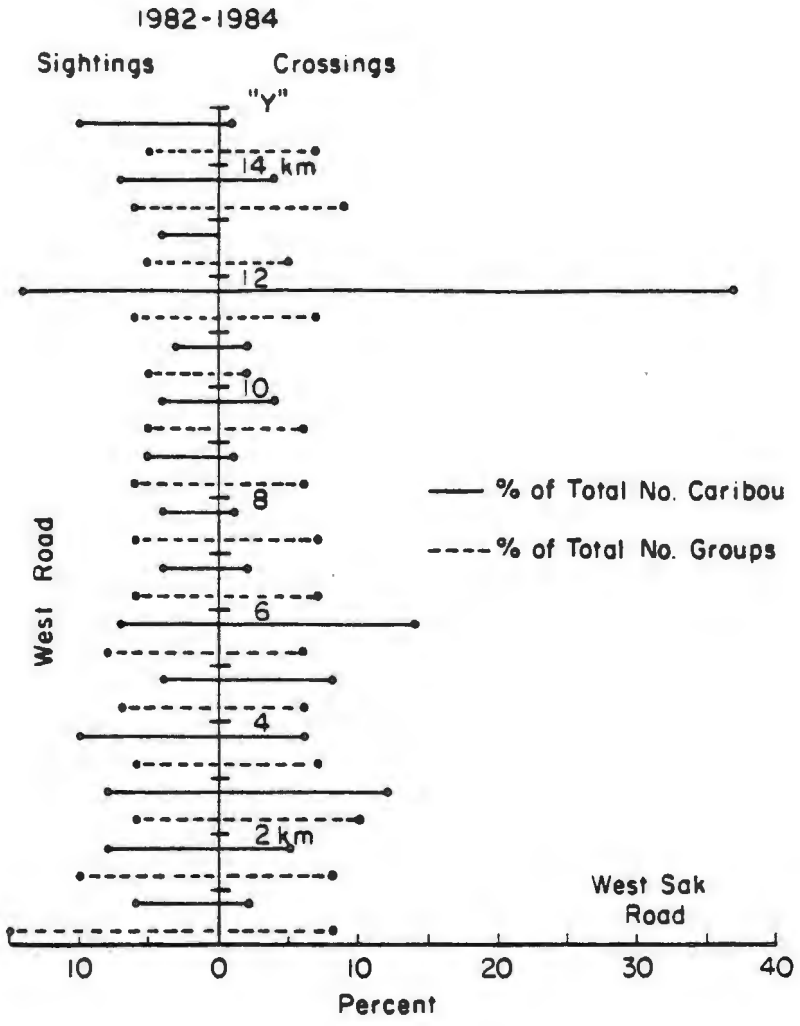


Fig. 6. Distribution of caribou sightings and road crossings along the West Road, between the "Y" and the West Sak Road, May-August 1982-84.

Table 1. Numbers and sex/age composition[a] of caribou observed within 1,000 m of roads during road surveys, May-August 1984.

| Month | Total caribou | Bulls | Cows | Calves | Yearlings | Adults | No. of groups |
|---|---|---|---|---|---|---|---|
| May | 318 | 15 (5) | 83 (26) | 85 (27) | 5 (2) | 130 (41) | 94 |
| June | 1,299 | 37 (3) | 159 (12) | 243 (19) | 190 (15) | 670 (52) | 229 |
| Jul/Aug | 13,876 | 1,745 (13) | 671 (5) | 2,989 (22) | 113 (1) | 8,358 (60) | 538 |
| Totals | 15,493 | 1,797 (12) | 913 (6) | 3,317 (21) | 308 (2) | 9,158 (59) | 861 |

[a] ( ) = % of total.

Table 2. Mean group size and observation distance of caribou observed within 1,000 m of roads during road surveys, May-August 1984.

| | Group Size | | | Observation distance (m) | | |
|---|---|---|---|---|---|---|
| Month | Mean | S.D. | S.E. | Mean | S.D. | S.E. |
| May | 3.4 | 2.3 | 0.2 | 616 | 303 | 29 |
| Jun | 5.7 | 9.8 | 0.7 | 539 | 307 | 20 |
| Jul/Aug | 30.6 | 118.5 | 5.1 | 440 | 294 | 13 |

Table 3. Percentages of total caribou and calves observed within each of 10 distance intervals from the Milne road system, May-August 1982-84.

| Distance from road (m) | May | | June | | July/August | |
|---|---|---|---|---|---|---|
| | Total | Calves | Total | Calves | Total | Calves |
| 0-100 | 5 | 8 | 3 | 2 | 9 | 16 |
| 101-200 | 8 | 10 | 3 | 2 | 2 | 4 |
| 201-300 | 7 | 7 | 3 | 1 | 8 | 12 |
| 301-400 | 7 | 9 | 3 | 2 | 6 | 9 |
| 401-500 | 6 | 6 | 4 | 3 | 19 | 12 |
| 501-600 | 6 | 5 | 3 | 3 | 5 | 6 |
| 601-700 | 9 | 11 | 4 | 5 | 4 | 5 |
| 701-800 | 7 | 9 | 5 | 5 | 6 | 9 |
| 801-900 | 4 | 4 | 5 | 4 | 2 | 4 |
| 901-1000 | 40 | 31 | 68 | 73 | 37 | 24 |

APPENDIX C

# SAMPLING ERRORS ASSOCIATED WITH AERIAL TRANSECT SURVEYS OF CARIBOU

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Abstract. Five low-level caribou surveys were conducted by helicopter within a 1550-km$^2$ area of the Arctic Coastal Plain of Alaska on 11-14 June 1980-84. Caribou were counted using 12 contiguous north-south strip transects, each 3.2 km wide and extending 41 km inland; numbers of adults and calves seen within each strip were recorded, essentially providing direct total counts. Total numbers were also estimated by extrapolating from the results obtained with various combinations of systematic transect coverage equivalent to 50%, 33%, 25%, and 17% of the study area. Mean (± SD) differences between the extrapolated results and the direct total counts for the 5-year study period were 12% (8%), 17% (11%), 33% (30%), and 27% (24%); those for calf percentage were 3% (3%), 8% (6%), 11% (12%), and 10% (9%). Cumulatively, two-thirds or more of the possible transect combinations at and above 33% coverage yielded estimates of total caribou and calf percentage that were within 20% and 10%, respectively, of the observed value, whereas half or less of the combinations at 25% and 17% provided estimates within these limits.

Key words: barren-ground caribou, aerial survey, sampling errors, transects, Alaska.

## INTRODUCTION

Systematic transect surveys are commonly used for estimating the size and/or composition of North American caribou herds (Watson and Scott 1956, Bergerud 1963, Tener 1963, Thomas 1969, Parker 1972, Miller et al. 1977, Calef and Heard 1980, Carruthers and Jakimchuk 1983, Jakimchuk and Carruthers 1983). Evenly spaced parallel transects are flown over a predetermined area at a constant altitude, and caribou within a specified strip width are counted and classified. The area may be stratified on the basis of caribou density, in which case total numbers are estimated as the sum of the extrapolated totals for each stratum, and overall sex/age composition is calculated by weighting the observed values for each stratum in proportion to the size of the sample. Where stratifying is difficult or inappropriate, estimates generated by line-transect data assume that caribou are sampled in proportion to their occurrence.

Potential errors resulting from inability to accurately observe, classify, and record all caribou present on transects will not be considered here. Rather, this paper examines the more fundamental supposition that the level of coverage selected is sufficient to provide reasonably accurate data on population characteristics. Unfortunately, opportunities to determine actual errors incurred at different sampling intensities are rare, as concurrent total counts are seldom made. In this paper, we evaluate the extent of those errors, and hence the validity of the inherent assumptions, by comparing the projected results at 4 levels of partial coverage with total counts in a specific study area.

## METHODS

A 1550-$km^2$ portion of the central Arctic Coastal Plain, approximately 35 km west of Prudhoe Bay, was surveyed intensively between 11 and 14 June each year from 1980 to 1984. Caribou were counted within 12 contiguous north-south transect strips, each 3.2 km (2 mi) wide and extending 41 km inland from the coast of the Beaufort Sea (Fig. 1). Survey conditions varied greatly from year to year, but within any one year, snow cover, weather, and sightability were essentially uniform over the study area.

All surveys were flown by Bell 206-B helicopter; USGS 1:63,360 topographic maps were used for position reference. The pilot and 3 observers (1 front-seat, 2 rear-seat) searched each strip thoroughly. We used the transect centerlines for orientation, but in practice usually flew zig-zag patterns between transect strip boundaries. We varied altitude and airspeed to maximize sightability, and often scanned with binoculars in attempting to find all caribou in the transects. We made a low pass or hovered briefly near each group of caribou to positively count and classify all animals. Each observation was assigned a number which was marked directly on the map. Numerous lakes, rivers, roads, and construction pads facilitated course plotting and mapping. On rare occasions when ground reference was uncertain, we climbed to altitude to determine our exact position. Caribou did not run far from the helicopter, and movement between transects was minimal. Occasionally while flying one transect, we diverted to isolated areas (i.e., by lakes or streams) of adjacent transects and mapped groups there. For data analysis, however, groups were always included in their proper transect.

It was assumed that each survey resulted in 100% coverage of the study area, with data recorded for 12 transect strips. Simulated results at lower levels of coverage were obtained by combining observations from alternate transects, every 3rd transect, every 4th transect, and every 6th transect; designated 50, 33, 25, and 17% coverage, respectively (Fig. 2). For each of the 15 simulated partial surveys within a year (i.e., 2 at 50%, 3 at 33%, 4 at 25%, and 6 at 17%), the total number of caribou within the study area was estimated by multiplying by the appropriate conversion factor (i.e., 2 for 50%, 3 for 33%, etc.). Calf

percentage was computed directly from each sample and was assumed to be representative of caribou in the entire area. Errors were expressed as percentage deviations from the corresponding values obtained through complete coverage.

## RESULTS AND DISCUSSION

In many ways, our survey technique differed from most transect surveys in which constant altitude, airspeed, and direction are maintained. Our transect strip width was also much wider, 0.5-1.0 km being more common. Our goal was to map, as accurately as possible, the distribution of caribou within the study area. We make no claim that we observed every caribou, and it is possible that some caribou were recorded more than once. Our technique was designed to minimize such errors, but an objective discussion of how well this was accomplished is beyond the scope of this paper. For purposes of further discussion, we assume that all caribou on each transect were observed.

Total numbers of caribou observed within the study area ranged from 499 in 1980 to 2,601 in 1984 (Table 1). Calf percentage varied between 30.1 in 1980 and 46.8 in 1981. Variation in total numbers was in part due to annual snowmelt conditions (drier conditions correlated with more caribou), and calf percentage was highly dependent on the number of yearlings accompanying cows to the calving grounds (Whitten and Cameron 1985). Generally increasing numbers also resulted from a population increase rate of about 13% per year during the study period (Whitten and Cameron 1983; unpublished).

Five-year mean (± SD) errors associated with estimating total numbers of caribou from partial coverage indicate a generally decreasing trend with increasing survey intensity (Fig. 3a). Most striking, however, is that the maximum errors incurred at 17 and 25% coverage were substantially higher than those at 33 and 50% coverage (115 and 120% vs. 41 and 26%, respectively). The pattern of error for estimating calf percentage was similar but somewhat less variable, and maximum errors were all <50% (Fig. 3b). Overall, these data suggest that in order to minimize the possibility of errors exceeding 20%, total population estimates should be based on approximately 50% coverage, whereas for estimates of calf percentage it appears that 33% coverage would suffice.

Another approach is to calculate the proportion of possible sample estimates within each coverage level that are associated with errors within specified limits. For total caribou numbers, less than one-half of all possible estimates were in error by <10%. Approximately half of the estimates at 17 and 25% coverage, and two-thirds or more of those at 33 and 50% coverage, were within 20% of the actual value (Fig. 4a). The corresponding estimates of calf percentage were somewhat more accurate. All samples at 50% coverage, and the majority of those at lower levels of coverage yielded estimates with less than a 20% error. However, little

more than half of the estimates at 17, 25, and 33% were in error by <10% (Fig. 4b).

Assuming that the 5 years' data from these surveys are reasonably representative of population variability, the data in Fig. 4 can be used to generate probability statements. For example, given survey coverage of 33%, there is a one-third probability that errors will exceed 20% for total numbers and 10% for calf percentage.

These error predictions can be useful elsewhere if one can be reasonably assured that caribou distribution falls within a similar range of density and variability. In this study, coefficients of variation for total numbers of caribou and percentage calves ranged from 43 to 106% and from 6 to 26%, respectively. Unfortunately, extensive coverage would be necessary to accurately quantify the characteristics of a particular study population on-site, effectively defeating the purpose. An alternative approach might be modest presurveillance of an area of interest to obtain a subjective indication of whether or not the population qualifies.

The area surveyed in this study is but a small portion of the calving grounds of the Central Arctic Herd (Whitten and Cameron 1985). Had we undertaken an area-wide census, the present study area might well have been considered a single, high-density stratum, since caribou in the immediate surrounding areas typically occur at much lower densities during the first half of June. The point is that even when caribou distribution is relatively uniform, it appears that coverage of at least one-third is required to minimize the chances of serious error.

Bergerud (1963) suggested that at least one-third coverage would be necessary to assure accuracy within 10% for estimating caribou numbers where density exceeds 2.3 caribou/km$^2$ (6 caribou/mi$^2$). Caribou density in the present study was considerably lower (0.3-1.6 caribou/km$^2$), which some workers have suggested correlates with a more random distribution (Thomas 1969). Yet our analysis indicates that distribution was not random and at least 50% coverage would have been necessary to achieve accuracy within 10%; even then, the chances of error >10% were considerable (Figs. 3a, 4a).

We realize that time constraints, financial limitations, and logistics problems often preclude the high levels of coverage that are apparently necessary to obtain reasonably accurate population counts. For similar reasons, corrections for sightability are often ignored or inadequately addressed. It should be recognized, however, that even when numbers of caribou on transects are counted exactly, estimates based on less than one-third area coverage, and particularly those based on <10% coverage, may be little more than quantitative wild guesses.

ACKNOWLEDGMENTS

Primary funding for this study was provided by the Alaska Department of Fish and Game through Federal Aid in Wildlife Restoration Projects W-21-1, W-21-2, W-22-1, and W-22-2. Additional support was provided by ARCO Alaska, Inc. and by Habitat Division, Alaska Department of Fish and Game. We are indebted to J. R. Dau for valuable technical assistance.

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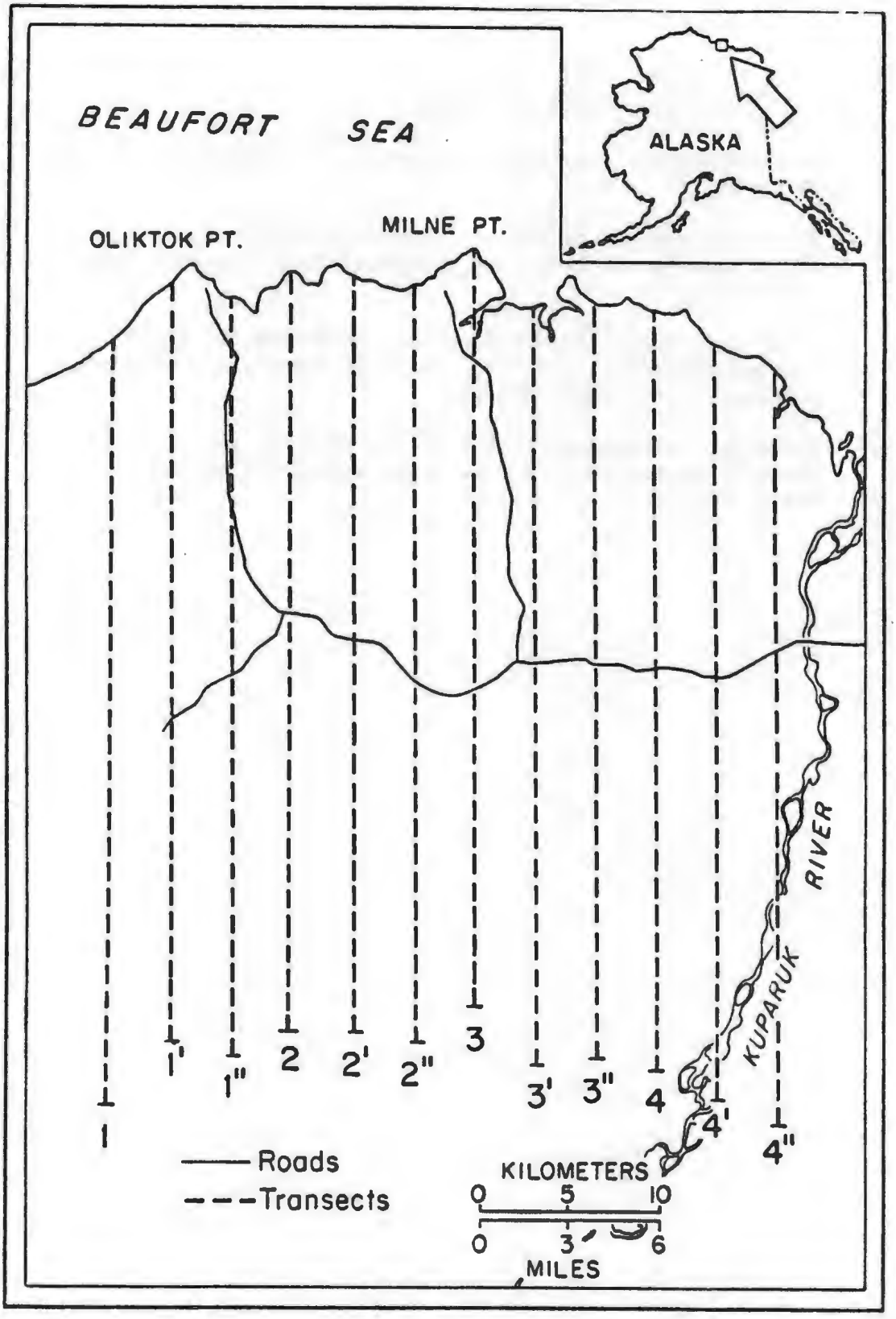
FIGURE LEGENDS

Fig. 1. Center lines of transects surveyed by helicopter, 11-14 June 1980-84.

Fig. 2. Schematic representation of transect combinations used to achieve different levels of coverage within the study area (see Fig. 1).

Fig. 3. Mean (±SD) and maximum errors for estimating (a) total numbers of caribou and (b) percentage calves at 4 levels of coverage, 11-14 June 1980-84.

Fig. 4. Proportion of cumulative estimates, 1980-84, of (a) total caribou numbers and (b) percentage calves within 10% and 20% error.

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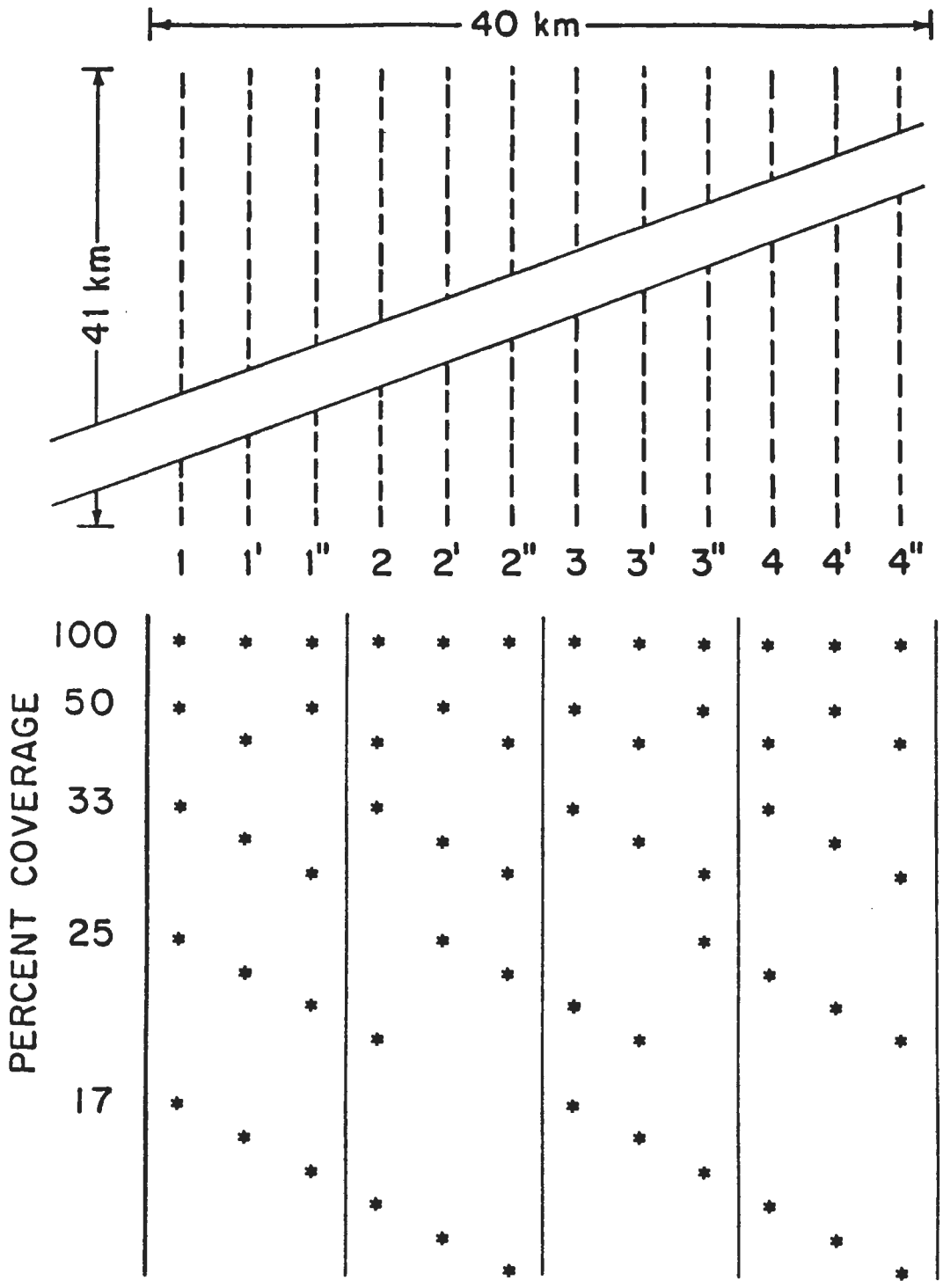


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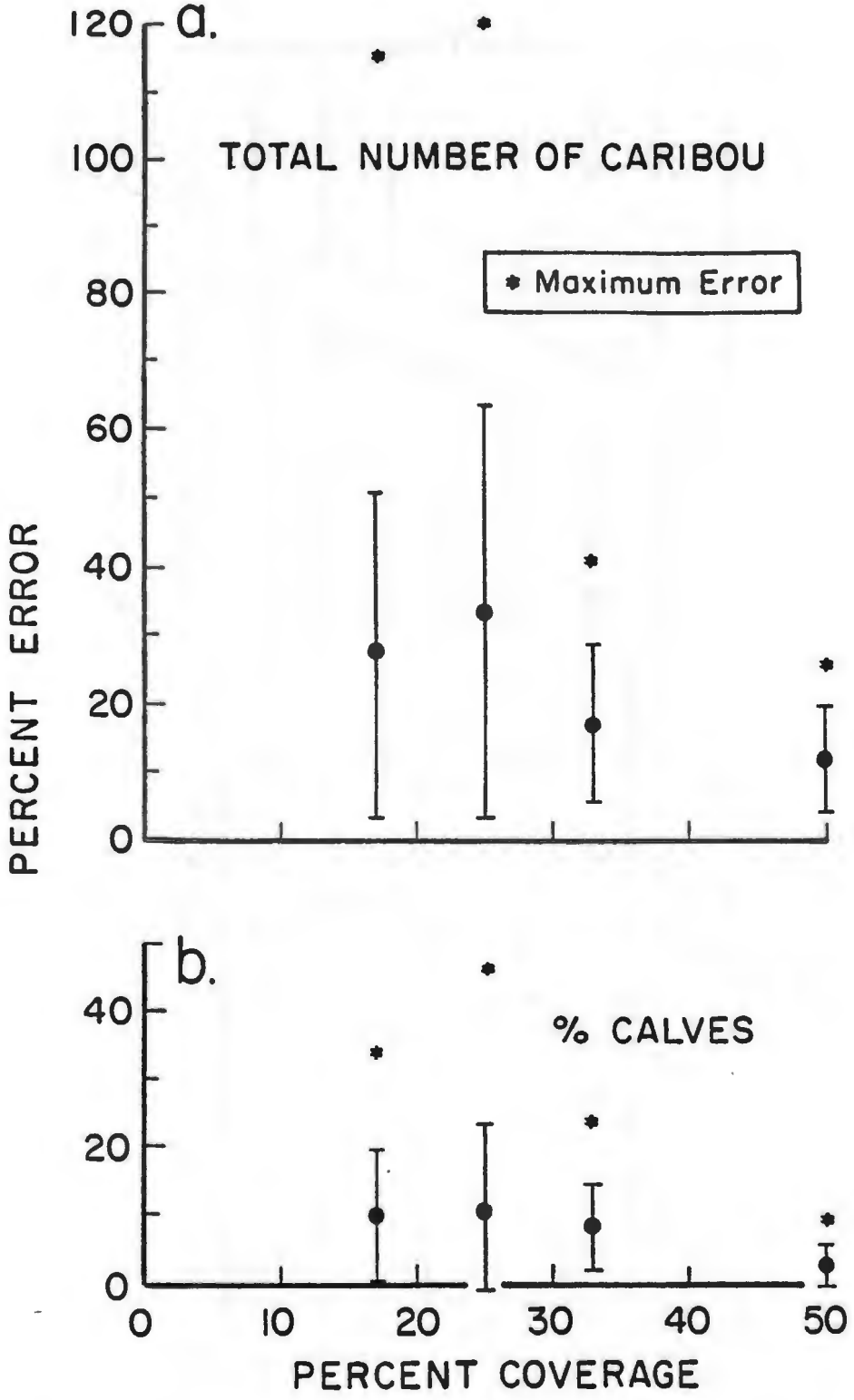


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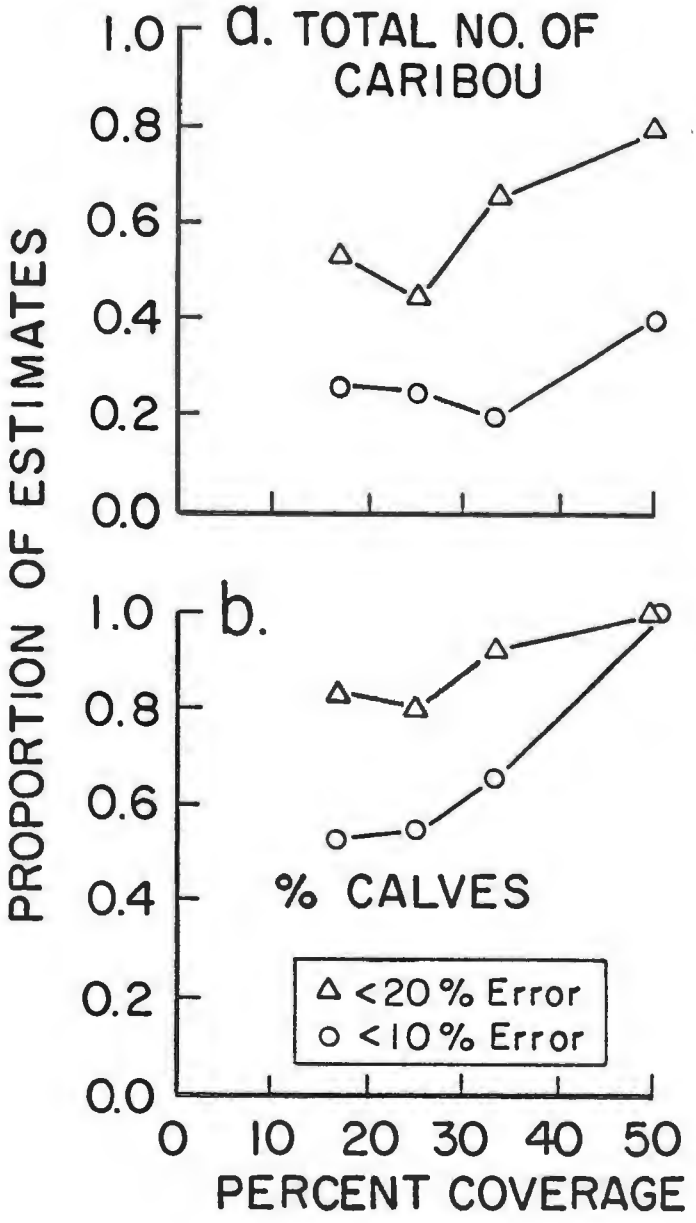


Fig. 4. Proportion of cumulative estimates, 1980-84, of (a) total caribou numbers and (b) percentage calves within 10% and 20% error.

Table 1. Numbers of caribou (numbers of calves) observed on each of 12 aerial survey transects, Central Arctic Coastal Plain, June 1980-84.

| | Year | | | | |
|---|---|---|---|---|---|
| Transect | 1980 | 1981 | 1982 | 1983 | 1984 |
| 1 | 70(24) | 25(13) | 74(24) | 130(39) | 165(61) |
| 1' | 18(6) | 119(49) | 67(25) | 45(10) | 66(15) |
| 1" | 48(11) | 63(30) | 110(39) | 13(0) | 92(32) |
| 2 | 27(5) | 74(36) | 141(44) | 37(6) | 68(15) |
| 2' | 38(13) | 273(131) | 134(52) | 408(184) | 422(172) |
| 2" | 69(16) | 274(131) | 111(43) | 209(88) | 239(102) |
| 3 | 66(16) | 166(80) | 63(17) | 48(8) | 92(8) |
| 3' | 74(27) | 115(53) | 55(14) | 248(97) | 208(71) |
| 3" | 41(13) | 129(60) | 127(52) | 262(116) | 842(400) |
| 4 | 26(9) | 18(9) | 53(15) | 258(119) | 324(138) |
| 4' | 16(8) | 14(3) | 61(25) | 78(28) | 30(6) |
| 4" | 6(2) | 5(2) | 30(4) | 31(5) | 53(15) |
| Total | 499(150) | 1275(597) | 1026(354) | 1767(700) | 2601(1035) |