Alaska Department of Fish and Game
Division of Wildlife Conservation
Federal Aid in Wildlife Restoration
Research Progress Report

Distribution and Productivity of the Central Arctic Caribou Herd in Relation to Petroleum Development

by
Raymond D. Cameron
Walter T. Smith and
Steven G. Fancy

Projects W-23-2 & W-23-3
Study 3.35
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(with additional data through October 1989)

SUMMARY

In lieu of a standard Progress Report, we offer sections of an annual update of cooperative studies with the Alaska Fish and Wildlife Research Center (AFWRC), U.S. Fish and Wildlife Service. The following 2 appendices encompass the major objectives being addressed under Federal Aid support.

Appendix A:

Cameron, R. D., W. T. Smith, and S. G. Fancy. 1990. Reproductive performance of caribou in relation to habitat availability and quality. In T. R. McCabe, ed. Terrestrial research: 1002 area - Arctic National Wildlife Refuge. Ann. Prog. Rep., 1989. U.S. Fish and Wildl. Serv., Anchorage, Alaska. In press.

Appendix B:

Smith, W. T., and R. D. Cameron. 1990. Caribou responses to development infrastructures and mitigation measures implemented in the Central Arctic Region. In T. R. McCabe, ed. Terrestrial research: 1002 area - Arctic National Wildlife Refuge. Ann. Prog. Rep., 1989. U.S. Fish and Wildl. Serv., Anchorage, Alaska. In press.

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Appendix A.

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WORK UNIT II: Habitat requirements and potential impacts of oil development on caribou.

Work subunit IIa: Reproductive performance of caribou in relation to habitat availability and quality.

Raymond D. Cameron, Alaska Department of Fish and Game
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INTRODUCTION

A reduction in caribou (Rangifer tarandus granti) herd size or productivity resulting from habitat loss is the primary basis for concerns regarding oil development on the Arctic Slope of Alaska (Cameron 1983; Elison et al. 1986; Clough et al. 1987). Displacement of maternal females and their calves from preferred areas may adversely affect foraging success, and therefore, growth and fattening which in turn may reduce subsequent reproductive performance. Previous studies of domestic and wild reindeer (R. t. tarandus) in Norway, and of barren-ground (R. t. groenlandicus) and Peary caribou (R. t. pearyi) in Canada, indicate that condition of adult females at breeding and during winter influence conception/parturition rate, calving date, calf birth weight, and calf survival (Dauphiné 1976; Haukioja and Salovaara 1978; Skogland and Molmen 1980; Thomas 1982; Reimers 1983a,b,c; Reimers et al. 1983; Skogland 1983a,b, 1984, 1986; Lenvik 1988; Lenvik et al. 1988). Unfortunately, there is little evidence to support the notion that such predictive relationships apply universally to Rangifer subspecies (Davis et al. 1990).

This study was designed to clarify the process by which disturbance-induced alterations in habitat use and/or activity patterns of arctic barren-ground caribou might reduce the productivity of the population through a decline in female body condition. Specific objectives are to:

1. compare the body condition and reproductive performance of female caribou of the Central Arctic Herd (CAH) in contact with oil development (i.e., west of the Sagavanirktok River) with the status of those not contacting development (i.e., east of the Sagavanirktok River);

2. determine relationships between body condition and the reproductive performance of female caribou;

3. determine the influence of habitat availability/quality on the body condition of female caribou; and

4. develop and implement procedures to monitor changes in herd status through body condition trends of hunter-killed caribou and sequential sampling of marked individuals.

Preliminary data pertaining to Objectives 1 and 2 are presented here. Objective 3 will be addressed through a simulation model in 1991, and the results of studies dealing with Objective 4 are presented in the report for Research Work Order No. 30.

METHODS

In late September or October 1986-89 and in early July 1988-89, 38 radio-collared adult ($\geq$3 years old at calving) female caribou from the CAH and Porcupine Herd (PCH) were darted from a helicopter and weighed 1-5 times each. During late May and early June 1987-89, females were relocated on approximately alternate days using standard tracking methods by fixed-wing aircraft. Parturition status was determined by calf presence, antler retention, and/or udder distension, and the calving date for each pregnant female was estimated from successive observations. To ascertain the occurrence of perinatal calf mortality, radio-collared females were again tracked and observed 1-3 days after parturition. Females were then located at least once in July and again during the following late September or October; lactation status was determined on the basis of calf presence.

Body weight and rates of weight change were compared using Student's t-test. Data on body weight and calving date were evaluated by Spearman's rank correlation. Alpha levels <0.10 were considered statistically significant.

RESULTS

The combined data for the CAH and PCH demonstrate a direct relationship between fecundity and fall body weight. Radio-collared females that subsequently became pregnant (based on calf presence during the following May or June) were significantly ($\underline{P}$ < 0.05) heavier than those that did not produce a calf (Table 1). Furthermore, estimated pregnancy rate tended to increase with fall body weight (Fig. 1).

The influence of fall body weight on calving date is less clear. There appears to be no relationship for the CAH data (Fig. 2A), although a closer inspection reveals that the data points for the 2 years are clustered separately; in

1989, calving occurred later than in 1988, despite overlapping ranges in body weight. Even so, separate analyses of the 2 sets of points did not produce significant correlations ($\underline{P} > 0.1$). A similar discontinuity in the PCH data is apparent, except that there are only 2 obvious outliers (Fig. 2B); deleting these points results in a significant ($\underline{P} < 0.02$) relationship.

The incidence of perinatal mortality was apparently unrelated to body weight during either the previous fall or subsequent July. However, the rate of overwinter weight loss was significantly ($\underline{P} < 0.1$) higher among females whose calves died within a few days after birth (Table 2).

Differences in the rates of overwinter weight loss for pregnant and nonpregnant females were inconsistent between years. In 1987-88, those rates were nearly identical, whereas in 1988-89, pregnant females lost significantly ($\underline{P} < 0.05$) more weight than nonpregnant females; overall, however, mean weight loss did not differ (Table 3).

In contrast, rates of weight gain during summer and early fall were consistently dissimilar for lactating and nonlactating females. In both years the former gained significantly ($\underline{P} < 0.1$) less weight than the latter (Table 3).

The sample of radio-collared caribou is insufficient to adequately compare the body weights and fecundity of females in contact with oil development west of the Sagavanirktok River with the performance of those under disturbance-free conditions east of the Sagavanirktok River. Nevertheless, a preliminary comparison of weight changes across years can be made for pregnant and lactating females. While rates of overwinter weight loss were similar for females on the west and east sides of the river, rates of summer weight gain on the west were lower than on the east, but the difference was not significant ($\underline{P} > 0.1$) (Table 4).

Because the overall parturition rate of the CAH was unusually low in 1989 (see WSU IIb report), correspondingly fewer calving dates of radio-collared females were obtained. However, the available data indicate that calving activity was later in 1989 than in 1988. In 1989, all radio-collared females calved after 5 June, and two calved after 14 June; whereas in 1988, <30% of the females calved after 5 June, and none were known to have calved later than 14 June (Table 5).

DISCUSSION

Fall body weight of adult female CAH and PCH caribou appears to be a useful gross indicator of their reproductive potential. Heavier females have a higher probability of producing a calf (Fig. 1), demonstrating the importance of adequate food intake during summer and early fall. There is considerable overlap in the weights of subsequently parturient and nonparturient females, however, perhaps reflecting decreased fecundity among younger females within the 3+ year age category (Davis et al. 1990). In spite of this variability, mean body weights of females in the 2 reproductive classes differed significantly (Table 1).

Present data on fall body weight and calving date of CAH and PCH females indicate only that an inverse relationship <u>might</u> exist between the 2 variables. The apparent between-year differences (Fig. 2) indicate a certain plasticity in the reproductive process. In years of nutritional inadequacy, the onset of oestrus may be delayed (Skogland 1984; Lenvik 1988), and/or gestation may be extended (Skogland 1984); note that parturient females lost more weight between fall and summer 1988-89, when calving was relatively late, than during the same period in 1987-88 (Table 3). Thus, while there is some indication that nutrition influences the timing of reproductive events, additional study will be necessary to determine the probable cause, mechanism, and implications.

The occurrence of neonatal calf mortality appears to be linked to maternal body condition. Those females producing nonviable calves lost more weight during the previous winter than other pregnant females (Table 2), corroborating previous evidence that condition during gestation influences fetal growth and, hence, survivability of the newborn calf (Skogland 1984).

Inconsistent differences in the rates of overwinter weight loss between pregnant and nonpregnant females (Table 3) may reflect changes in the ability to compensate for the metabolic costs of gestation and early lactation. Presumably, the degree of compensation varies with regional snow conditions and the particular wintering area selected. On the other hand, lactating females regained consistently less weight than nonlactating females between summer and fall (Table 3), although the difference was somewhat less than the estimated equivalent cost of milk production during the period (Cameron and Allaye-Chan, unpubl. data), suggesting some degree of compensatory feeding by lactating females as well. Perhaps pregnant and lactating caribou <u>must</u> offset, in part, the added costs of reproduction in order to attain some minimum standard of condition each fall, thereby maximizing the chance of conception.

Given the importance of female body condition to the reproductive process, it follows that any stresses that decrease nutrient retention, be they naturally occurring or human-induced, are potentially detrimental to the population. Multiple stresses, if additive or synergistic, would be especially serious. Considered collectively, our data tend to support these concerns. Reduced access to preferred calving and summer habitats within an oilfield, if superimposed on a late spring and/or a particularly severe insect season, could result in substandard body condition of lactating females by fall (Table 4) and, hence, a lower conception rate (Table 1, Fig. 1). A subsequent winter of relatively deep snow would exacerbate the situation through reduced feed intake and greater weight loss of pregnant females (Table 3), thereby delaying parturition (Table 5, Fig. 2) and increasing perinatal mortality (Table 2).

This scenario may apply to the 1988-89 performance of CAH females exposed to oil development. Persistent snow cover during the 1988 calving period was followed by relatively unfavorable insect and winter snow conditions. The 1989 estimates of initial calf production west and east of the Sagavanirktok River in June 1989 were 29 and 63 calves/100 cows, respectively (see WSU IIb report).

It should be emphasized that body weight may be neither the best index of body condition nor the most suitable predictor of reproductive performance. Body composition is purported to be superior to body weight as a basis for assessing nutritional status, as changes or differences in body weight do not necesarily reflect proportionately equal changes or differences in the amounts of the principal body components (i.e., water, fat, and protein). The availability of <u>in vivo</u> techniques for estimating body composition of free-ranging caribou (see report for Research Work Order No. 30) should assist greatly in clarifying the role of condition in the reproductive process.

RESEARCH PROSPECTUS

Many of the results presented above may be biologically meaningful, despite a lack of statistical significance. Accordingly, future research will be directed toward augmenting sample sizes to increase the power of the various tests. The reproductive success of females presently radio-collared will be monitored in late May and June 1990, and additional adult females (perhaps 12-15) will be captured, collared, and weighed in early July 1990. These, together with females from our current sample, will be recaptured and reweighed during the following September or October and, as above, tracked and observed repeatedly during the subsequent spring to determine calf production and early survival. If CAH calving success is again low in 1990, we will collar additional females in July and monitor their future performance in an effort to identify the cause.

Field trials and collections related to body composition studies will continue to be done in conjunction with capture activities planned for spring, summer, and fall.

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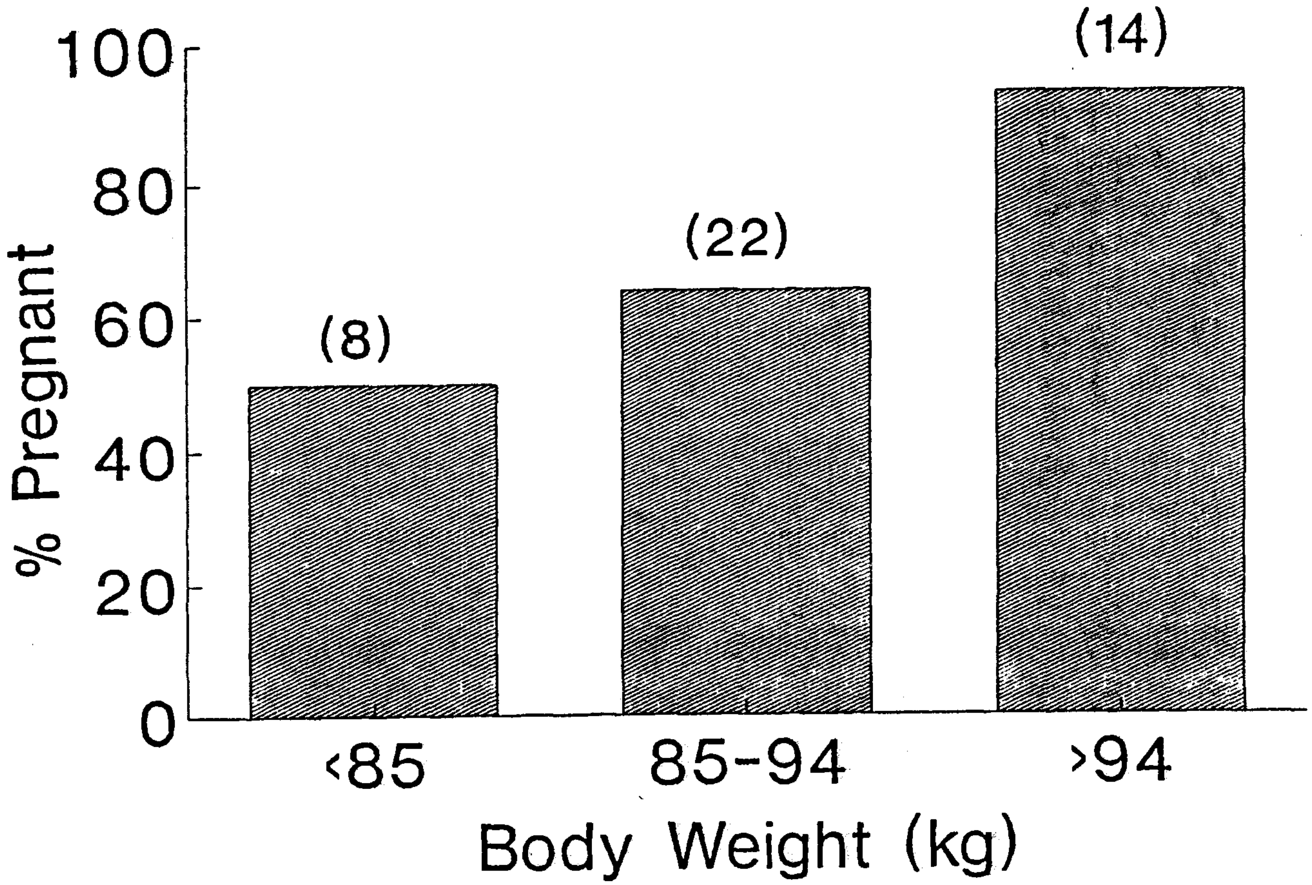

Fig. 1. Estimated pregnancy rate (based on observations at calving) among radio-collared adult (≥3-year-old) female caribou in relation to fall body weight, Central Arctic Herd and Porcupine Herd, 1986-88.

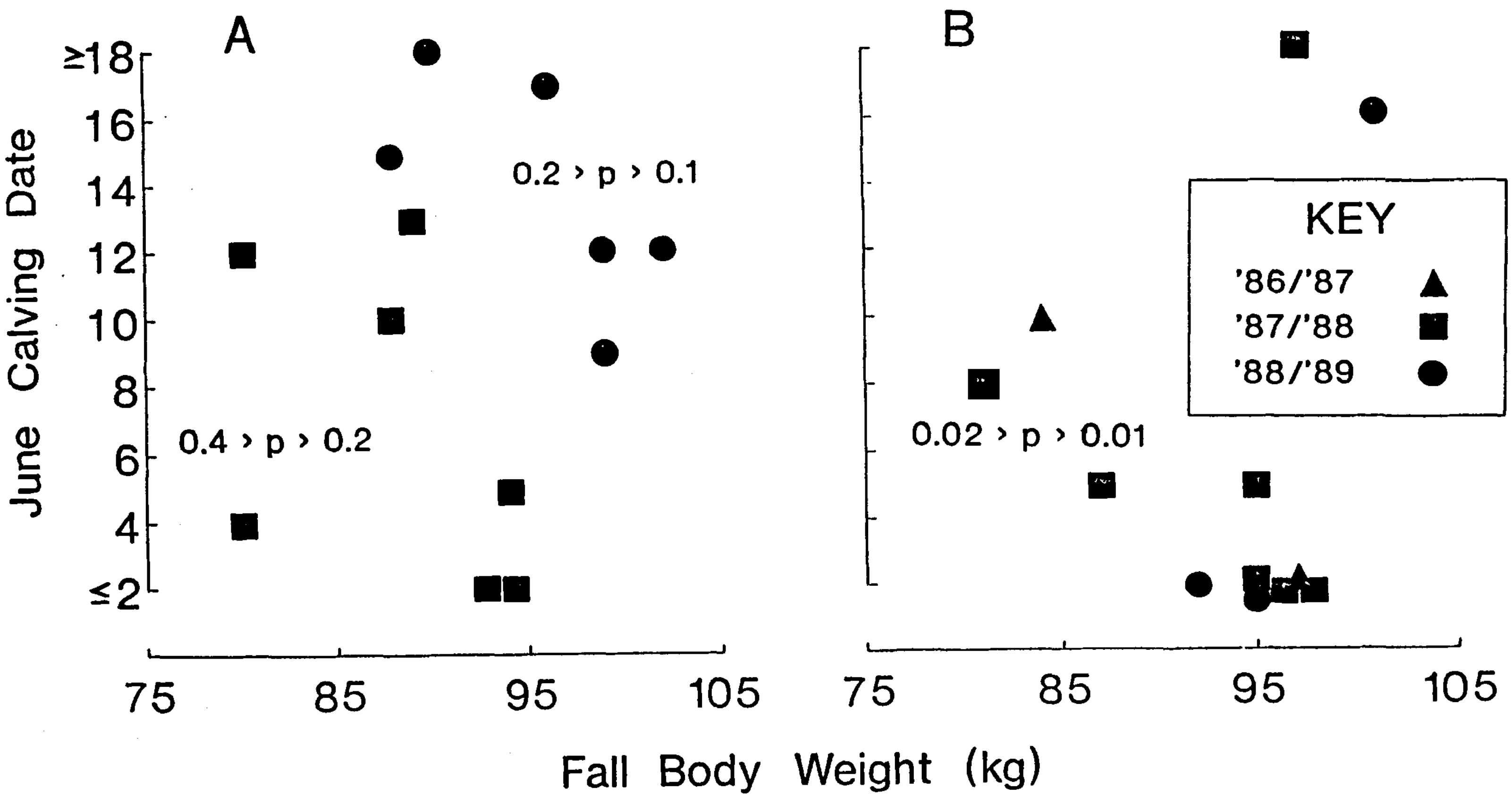

Fig. 2. Plots of 1987-89 calving dates against corresponding (preceding) fall 1986-88 body weights of radio-collared female caribou, Central Arctic Herd (A) and Porcupine Herd (B).

Table 1. Comparative mean ±SE ($\underline{n}$) fall body weights (kg) of radio-collared adult (≥3-year-old) parturient and nonparturient female caribou, Central Arctic Herd (CAH) and Porcupine Herd (PCH), late September and October 1986-88.

Herd	Parturient[a]	[t-test]	Nonparturient[a]
CAH	91.5 ± 1.5 (17)	[0.2 > P > 0.1]	85.8 ± 3.0 (10)
PCH	92.6 ± 1.5 (14)	[0.2 > P > 0.1]	88.3 ± 2.7 (3)
Both	92.0 ± 1.0 (31)	[0.05 > P > 0.02]	86.4 ± 2.4 (13)

[a] Based on observations during the subsequent calving period.

Table 2. Comparative mean $\pm$SE ($\underline{n}$) body weights and weight changes of radio-collared adult ($\geq$3-year-old) female caribou whose calves died or survived, Central Arctic Herd and Porcupine Herd, October 1987-July 1989.

Variable	Calf died[a]	[t-test]	Calf survived[b]
Oct body weight (kg)	91.2 $\pm$ 2.4 (10)	[0.9 > P > 0.5]	92.7 $\pm$ 1.2 (18)
Jul body weight (kg)	73.4 $\pm$ 4.7 (5)	[0.2 > P > 0.1]	81.8 $\pm$ 2.5 (6)
Oct-Jul weight loss (g/day)	-67.6 $\pm$ 10.7 (5)	[0.1 > P > 0.05]	-41.5 $\pm$ 8.9 (6)

[a] Calf observed dead or not observed with dam within 2-3 days after birth.

[b] Calf observed with dam at least once 3 or more days post-partum.

Table 3. Effects of pregnancy and lactation on mean ±SE (n) weight changes (g/day) of radio-collared adult (≥3-year-old) female caribou, Central Arctic Herd, October 1987-October 1989.

Status	October-July			
	1987-88	[t-test]	1988-89	Combined
Pregnant/ lactating	-40-5 ± 9.0 (6)	[0.1 > P > 0.05]	-68.8 ± 9.8 (5)	-53.4 ± 7.7 (11)
[t-test]	[P > 0.9]		[0.05 > P > 0.02]	[0.2 > P > 0.1]
Nonpregnant	-40.0 ± 5.6 (6)	[P > 0.9]	-40.3 ± 5.5 (3)	-40.1 ± 3.9 (9)

Status	July-October			
	1988	[t-test]	1989	Combined
Lactating	+128.4 ± 14.1 (8)	[0.4 > P > 0.2]	+101.0 ± 24.2 (3)	+120.9 ± 12.2 (11)
[t-test]	[0.1 > P > 0.05]		[0.01 > P > 0.001]	[P < 0.001]
Nonlactating	+172.9 ± 19.6 (7)	[0.1 > P > 0.05]	+223.0 ± 18.7 (8)	+199.6 ± 14.7 (15)

Table 4. Comparative mean ±SE ($\underline{n}$) rates of weight change (g/day) among radio-collared adult (≥3-year-old) female caribou west and east of the Sagavanirktok River, Central Arctic Herd, October 1987-October 1989.

Status	Interval	West	[t-test]	East
Pregnant/ lactating	Oct-Jul	-56.6±5.0 (5)	[0.9 > P > 0.5]	-50.7±14.1(6)
Lactating	Jul-Oct	+101.0±13.3(5)	[0.2 > P > 0.1]	+137.5±17.5(6)

Table 5. Calving dates of radio-collared adult (≥3-year-old) female caribou west and east of the Sagavanirktok River, Central Arctic Herd, June 1988-89.

Year	Calving location		No. of females calving					
		Dates:	≤6/2	6/3-5	6/6-8	6/9-11	6/12-14	≥6/15
1988								
West of Sagavanirktok River			2	1	2	2	1	0
East of Sagavanirktok River			6	6	0	0	1	0
	Total		8	7	2	2	2	0
1989								
West of Sagavanirktok River			0	0	2	2	3	0
East of Sagavanirktok River			0	0	2	0	1	2
	Total		0	0	4	2	4	2

Appendix B.

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WORK UNIT II: Habitat requirements and potential impacts of oil development on caribou.

Work subunit IIb: Caribou responses to development infrastructures and mitigation measures implemented in the Central Arctic Region.

Walter T. Smith, Alaska Department of Fish and Game
Raymond D. Cameron, Alaska Department of Fish and Game

INTRODUCTION

The Central Arctic Caribou (Rangifer tarandus granti) Herd (CAH) has been exposed to petroleum development in the Prudhoe Bay region for more than a decade. Findings to date indicate that oilfield complexes directly influence the distribution and movements of CAH caribou (for review, see Shideler 1986). Parturient and post-partum females are particularly sensitive to disturbance and tend to avoid areas of human activity, resulting in losses of CAH calving habitat (Whitten and Cameron 1985; Dau and Cameron 1986). In addition, access to portions of summer range has been impaired, either through avoidance of disturbed areas (Smith and Cameron 1983; Whitten and Cameron 1983; Johnson and Lawhead 1988) or because of the impediments to movement posed by roads and pipelines (Smith and Cameron 1985a,b; Curatolo and Murphy 1986). Thus far, habitat losses have been limited to areas occupied by industrial complexes near Prudhoe Bay and within the Kuparuk Development Area (KDA), and it appears that sufficient habitat remains available to parturient and maternal females. However, continued expansion and intensification of oil development within the central Arctic region could result in large-scale displacement of caribou with the potential for major impacts on herd productivity.

Studies of CAH calving distribution and summer movements in relation to petroleum development were initiated in 1978 and have continued on an annual basis. Specific objectives are to:

1. compare the distribution and movements of caribou in the KDA with those of caribou in undeveloped areas;

2. determine the frequency with which CAH caribou in the KDA encounter development infrastructures; and

3. evaluate the effectiveness of caribou mitigation measures implemented to date within the Prudhoe Bay, Kuparuk, Lisburne, and Endicott production units.

Results herein pertain to Objectives 1 and 2. Objective 3 will be addressed through a cooperative industry/agency team beginning in 1990.

METHODS

On 11-15 June 1989, low-level surveys were conducted by helicopter (Cameron et al. 1985; Whitten and Cameron 1985) between the Colville and Canning Rivers. Caribou were counted and classified within 25 north-south strip transects, each 3.2 km wide and extending 35-73 km inland from the coast (Smith and Cameron 1988).

On 2-17 June and again on 2-31 July, systematic surveys (Smith and Cameron 1985a) were conducted once daily along the Kuparuk Spine Road (SR) and Oliktok Road (OR) (Fig. 1). Each SR/OR survey began on the east bank of the Kuparuk floodplain (km 0.0), continued through CPF-1 (km 29.3) near the SR/OR junction, and terminated at Oliktok Point (km 56.0).

From 1987 through 1989, 12 CAH adult female caribou were fitted with satellite transmitters and located at least once daily (Fancy et al. 1988) for 1 to 3 summers (May-August) Each collar contains a mercury tip switch to measure caribou activity patterns. A microprocessor sums the number of 1-sec intervals during which the switch is activated by neck movements and then sums all 1-min counts for each 24-hr period. This total is relayed to the satellite as part of the transmitter signal.

RESULTS

Aerial Surveys

During strip transect surveys in June 1989, we classified 2,520 caribou, approximately one-half the totals for 1987 and 1988 (Lawhead and Cameron 1988; Smith and Cameron 1988). The overall distribution of caribou was similar to the 2 previous years, with concentrations south of Bullen Point, east of Franklin Bluffs, and in the vicinity of Milne Point (Fig. 2). Essentially no caribou were seen in the central portion of the study area, an apparent avoidance of the Dalton Highway and the road system within the Prudhoe Bay industrial complex (Whitten and Cameron 1985). Unlike 1987 and 1988, however, few caribou were seen in the Mileveach and Ugnavarik uplands south of the Kuparuk Oilfield.

The overall calf:cow ratio was 51:100, considerably lower than ratios obtained in 1987 and 1988 (Table 1). Furthermore, the calf:cow ratio west of the Sagavanirktok River was lower than the ratio east of the Sagavanirktok River (29:100 vs. 63:100). The parturition rate among radio-collared cows also was lower on the west side (50% vs. 63%), but the difference was not significant (Chi-square, $\underline{n} = 25$, $\underline{P} > 0.3$).

Intensive strip transect surveys encompassing the KDA (Fig. 2) yielded a ratio of 40 calves:100 cows, significantly lower than the mean of 78 for the previous 11 years (t-test, $\underline{P} < 0.05$) (Cameron et al. 1988, unpubl. data). Calves were most abundant between the Oliktok and Milne Point Roads (Fig. 3). Few calves were within transect segments near roads, an observation consistent with avoidance responses reported previously (Dau and Cameron 1986).

<u>Road Surveys</u>

On 14 road surveys conducted during the calving period (2-17 June), we observed 901 caribou (Table 2), less than one-half the number seen in 1988. Caribou sighting rates along the SR and OR were similar, unlike previous years when caribou were more numerous along the OR. Only 3 caribou were observed crossing roads and/or pipelines, compared with a previous range of 4-142. Most caribou were seen in the middle segments of the SR and OR, apparently avoiding the Kuparuk floodplain, CPF-1 area, and Oliktok Point (Fig. 4). Only 5 calves were observed from the road.

During the summer insect period (2-31 July) we observed 24,533 caribou along the SR and OR (Table 2). Unlike all previous years, few caribou were seen near the Kuparuk River; most were observed in insect-harassed groups at Oliktok Point and immediately east of CPF-1 (Fig. 5). A total of 10,223 caribou in 151 groups attempted to cross roads and/or pipelines, again mostly at Oliktok Point and east of CPF-1 (Fig. 6).

<u>Satellite Telemetry</u>

Data from satellite-collared cows were collected for 16 caribou-summers; of these, 12 are for the vicinity of the KDA and 4 apply to an undisturbed portion of range east of Prudhoe Bay. In 1987, mean daily distance traveled and daily activity counts were closely related for satellite-collared cows both east and west of Prudhoe Bay (Fig. 7). The mean distance traveled was similar for cows in the 2 areas, but activity comparisons were inconclusive because of large variances in activity counts. Unfortunately, transmitter failures, movements from the CAH range for all or part of the summer, and some mortality of cows east of Prudhoe Bay precluded similar comparisons in 1988 and 1989.

In 1987 and 1988, as in most years, parturient cows were in or near calving areas on the coastal plain by early May, and daily movements for the month were localized (Fig. 8). In 1989, however, most collared cows were still 150 km south of the calving grounds as late as mid-May; consequently, they moved farther during the 2-3 weeks before calving. Movement activity was low in June but increased approximately 3-fold during the July insect season as caribou alternately occupied coastal insect relief habitat and inland feeding areas; mean distances traveled within eastern and western areas were similar. Movements in August were localized and nondirectional, a typical response to oestrid flies.

DISCUSSION

When road survey data from the 1989 calving period (Table 2) are compared with data from 1981-85 and 1988 (Smith and Cameron 1986, 1988), we noted the following: (1) the overall sighting rate of 1.2 caribou/km was within the previous range of 0.8-2.8; (2) sighting rates of 0.7 and 0.8 caribou/km within 1,000 m and 2,000 m, respectively, of the road also were within the previous ranges of 0.2-2.4 and 0.4-2.7; (3) mean group size was 2.9, within the range of 2.6-5.6; and (4) the overall calf percentage was the lowest ever recorded, 0.7 vs. the previous range of 1.2-7.4. The road survey results, like the strip transect data, indicate that few calves were in the vicinity of oilfield structures during the calving period.

We noted the following trends when comparing results of July 1989 road surveys (Table 2) with those obtained in 1981-85 and 1988 (Smith and Cameron 1986, 1988): (1) the overall sighting rate was higher--17.5 caribou/km vs. the previous range of 4.6-16.4; (2) sighting rates of 12.3 and 14.9 caribou/km within 1,000 and 2,000 m, respectively, of the road are near the upper end of the previous ranges of 1.9-12.3 and 3.4-15.8; (3) the mean group size of 29.5 fell within the previous range of 16.9-42.5; (4) the overall calf percentage was the lowest ever recorded, 11.5 vs. the previous range of 16.2-23.2; and (5) as in previous years, more caribou were sighted along the OR portion of the survey.

For the first time since we began road surveys in 1978, few caribou were seen in the Kuparuk floodplain in July (Fig. 5). Rather, inland movements were primarily to areas west of the OR and south of the SR (Table 3). More than 60% of the caribou were seen on 3 days: on 6 and 15 July when large groups were observed at Oliktok Point under moderate mosquito harassment, and on 24 July, when caribou moved north into the CPF-1 area in response to moderate mosquito and oestrid fly harassment.

In July 1989, more than 150 groups were observed crossing the road and/or pipelines (Table 2), of which 80% were seen on moderate-to-severe insect harassment days. As most caribou were seen during crossing episodes, the distribution of crossings and sightings are similar (Figs. 5, 6). Eighty-six percent of the groups crossed successfully (i.e., ≥50% crossed), and 64% of the individuals within those groups were successful. Crossing success by large groups (>100 individuals) continued to be markedly higher along the OR and SR than observed in the early 1980's (Smith and Cameron 1985a,b; Smith and Cameron 1986); 12 of 14 large groups observed and 60% of the individuals crossed roads and/or pipelines. The 2 largest groups, totaling 6,746 caribou, were delayed in crossing, during which time insect activity decreased because of higher winds and lower temperatures. With impetus to move gone, the caribou began feeding and lying. The individuals that did not cross constituted 80% of all caribou in the unsuccessful category for July. Thus, many of these unsuccessful crossings can be attributed to changes in weather rather than to the presence of roads and pipelines.

RESEARCH PROSPECTUS

Plans for the 1990 field season are to continue the same basic program of aerial and road surveys. However, additional emphasis will be placed on determining the responses of caribou to oilfield infrastructures using satellite telemetry.

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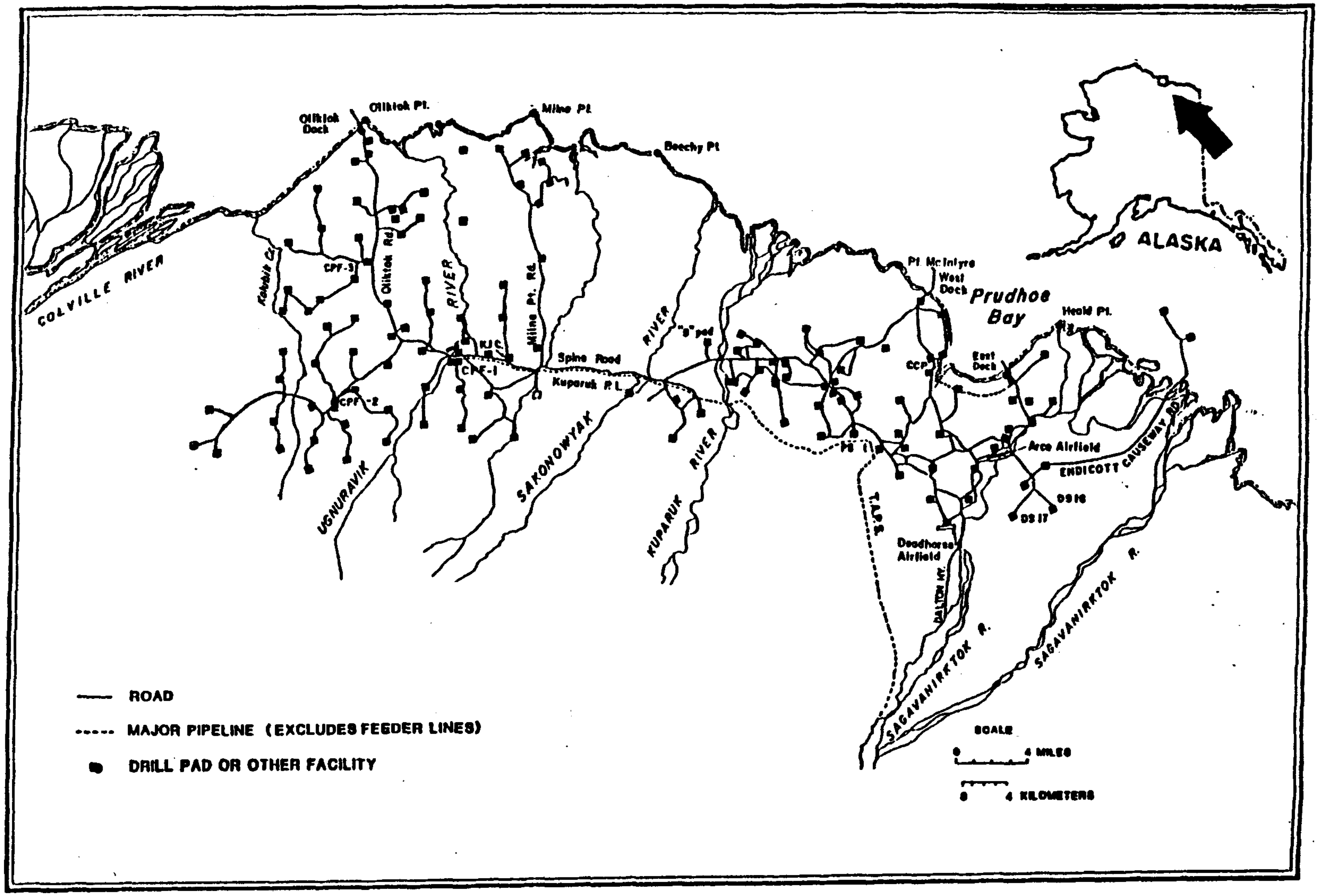

Fig. 1. Oilfield development in the Prudhoe Bay area, 1989. (Revised from Shideler 1986.)

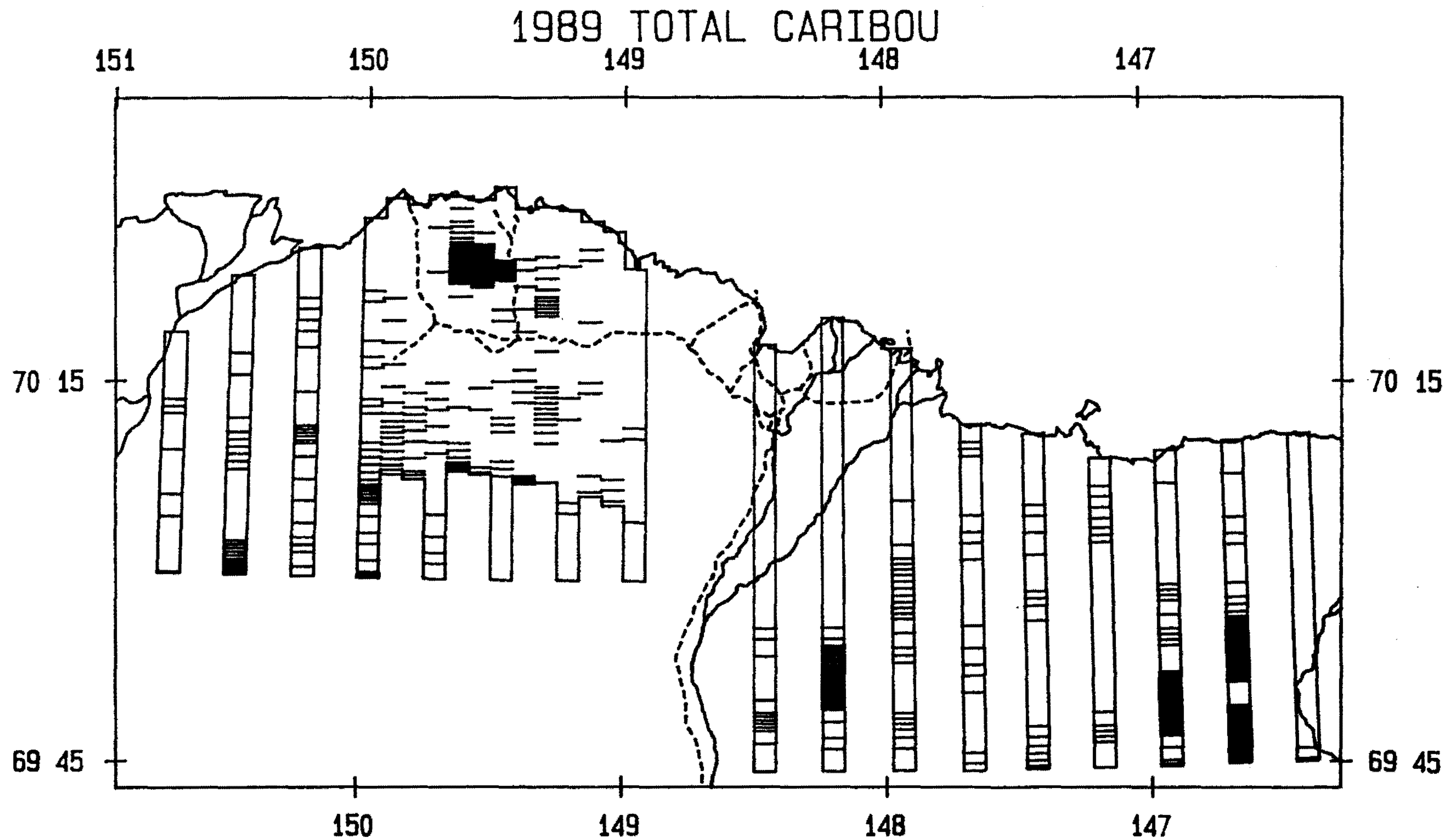

Fig. 2. Distribution and relative density of all caribou observed on helicopter surveys of the Central Arctic Herd calving grounds, 11-15 June 1989. Gradations in shading depict average densities in 10.4-km^2 transect segments from $\leq 0.4/km^2$ (open) to $\geq 7.7 km^2$ (solid).

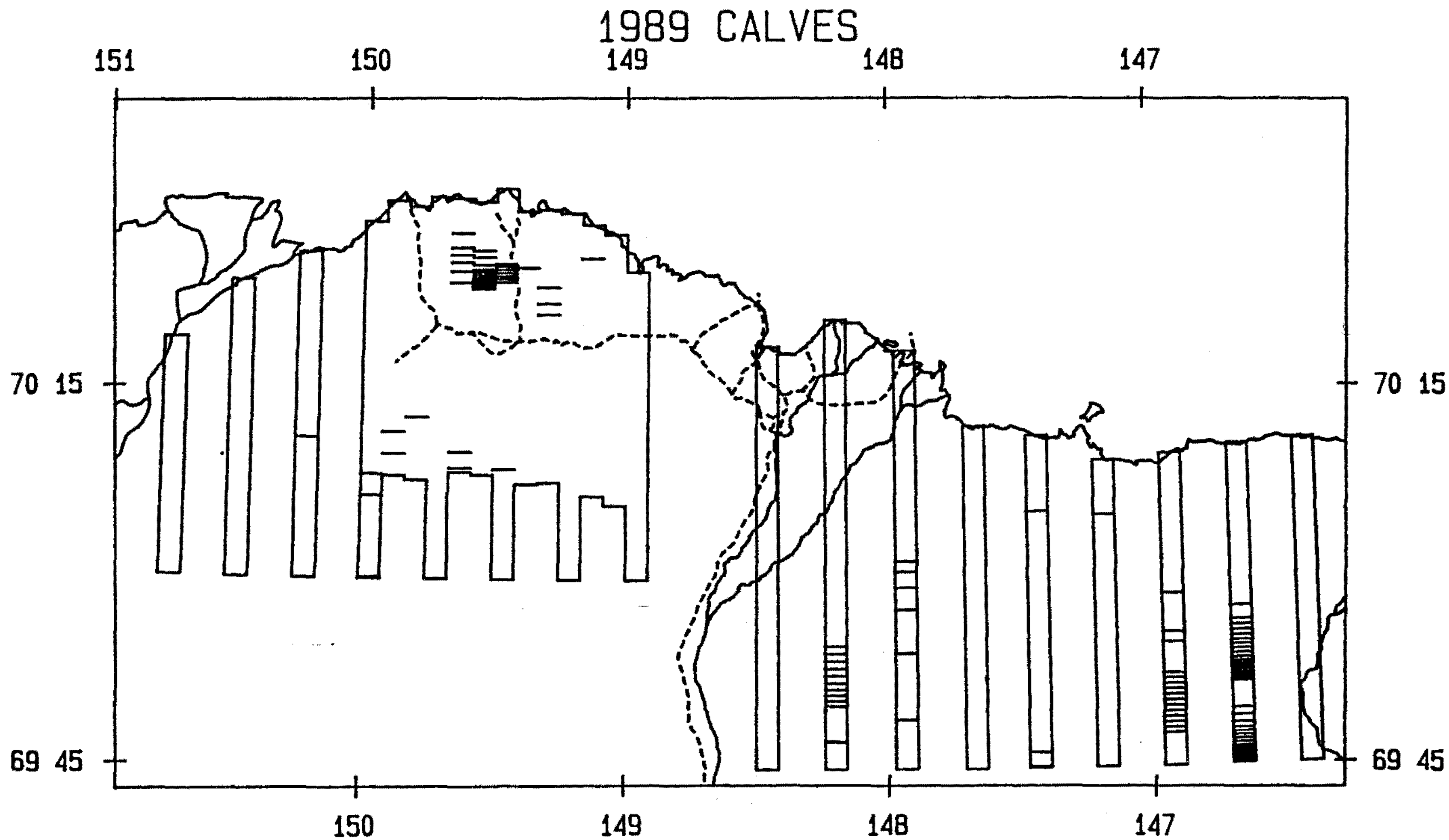

Fig. 3. Distribution and relative density of caribou calves observed on helicopter surveys of the Central Arctic Herd calving grounds, 11-15 June 1989. Gradations in shading depict average densities in 10.4-km^2 transect segments from $\leq$0.4/km^2 (open) to $\geq$7.7/km^2 (solid).

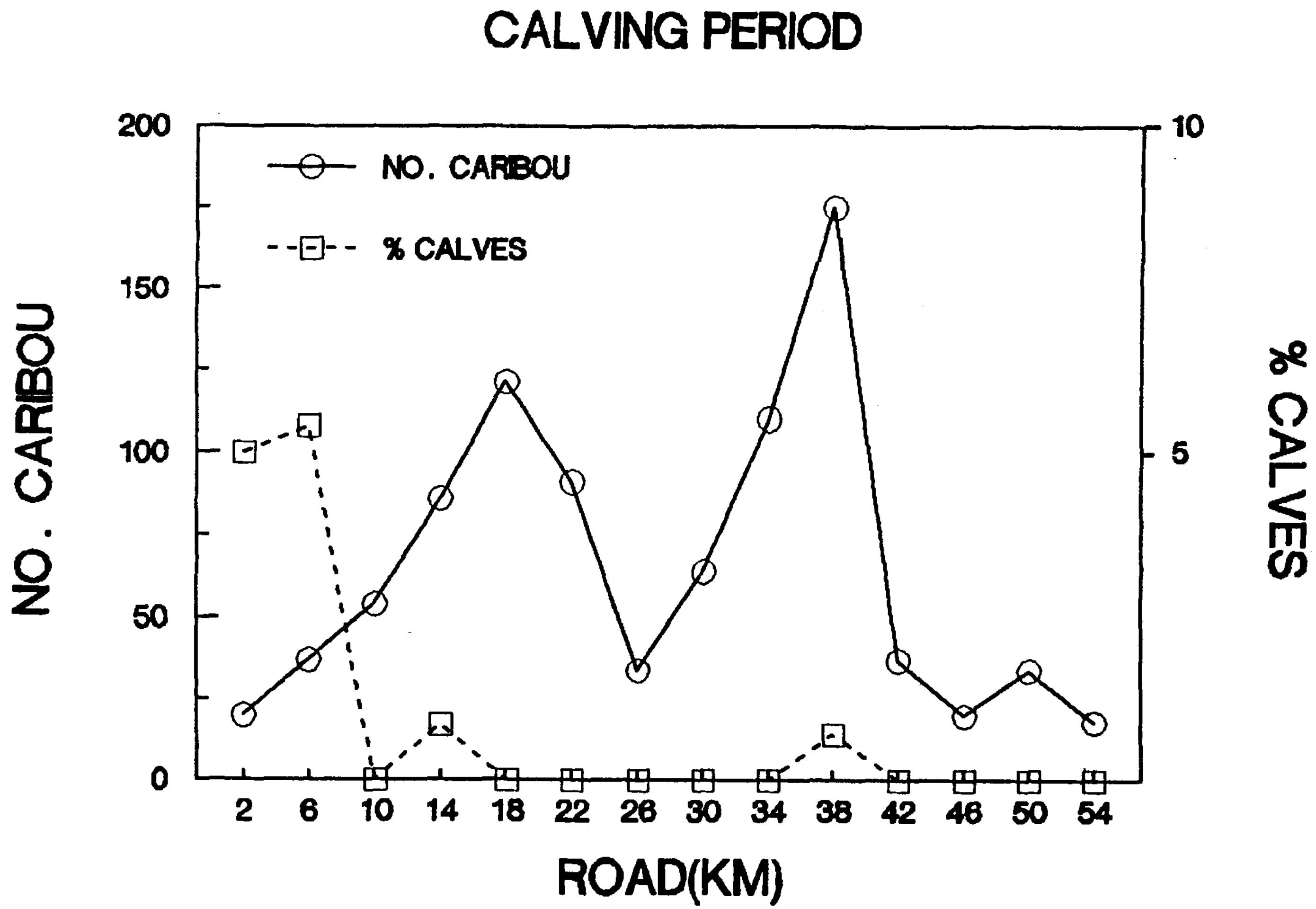

Fig. 4. Number of caribou and calf percentages observed within 4-km segments of the Spine and Oliktok Roads, Kuparuk Development Area, 2-17 June 1989.

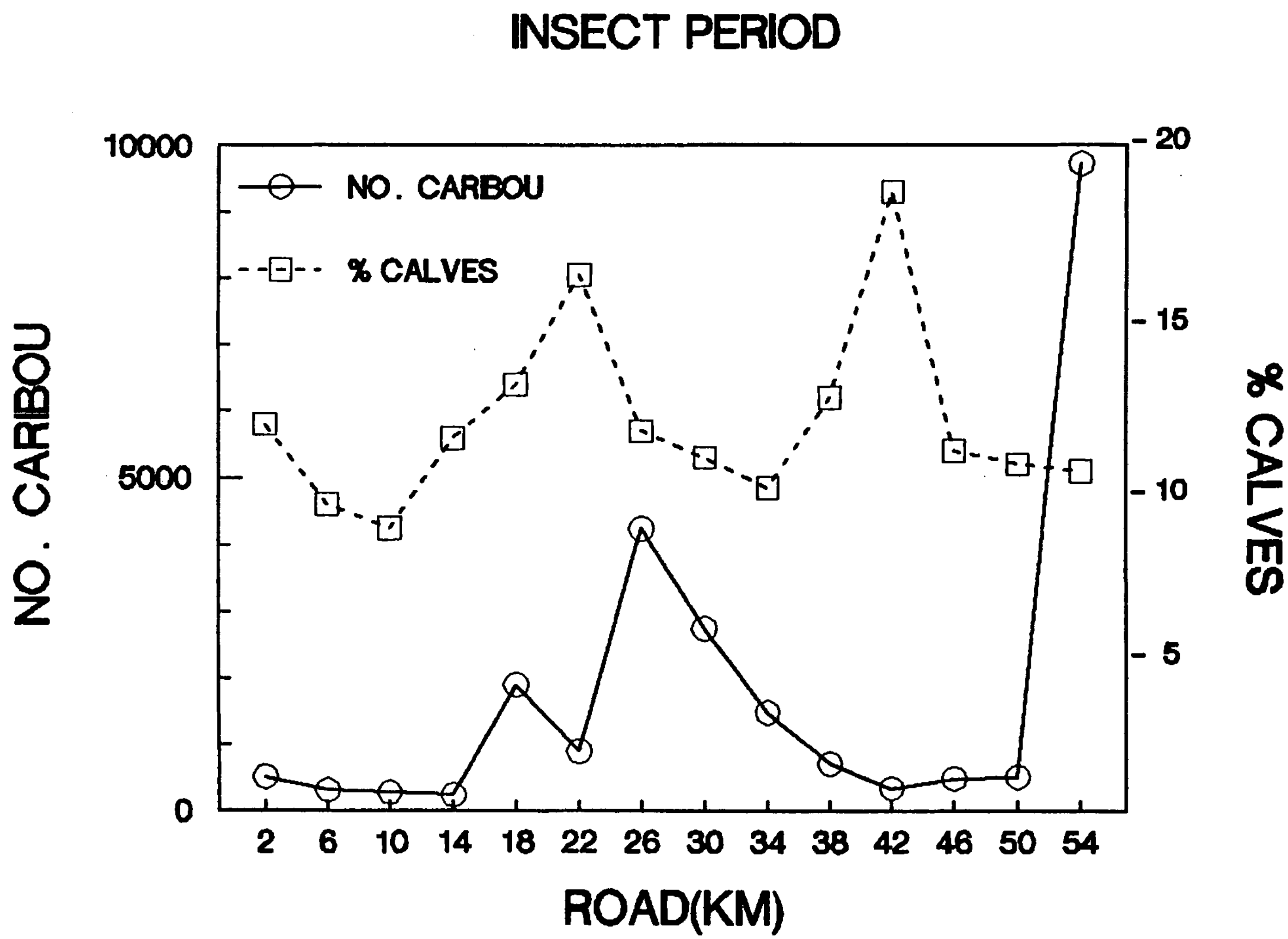

Fig. 5. Number of caribou and calf percentages observed within 4-km segments of the Spine and Oliktok Roads, Kuparuk Development Area, 2-31 July 1989.

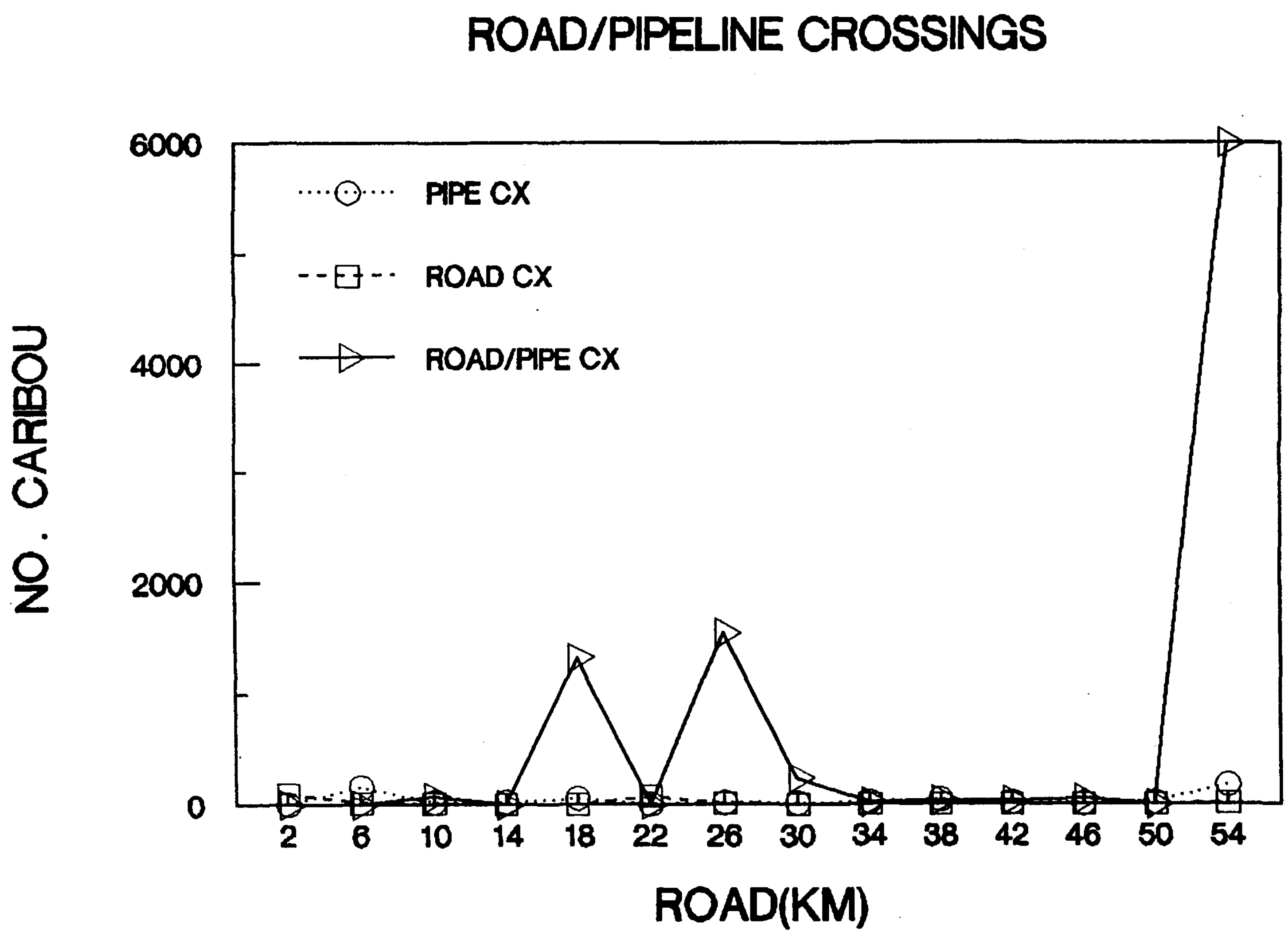

Fig. 6. Number of caribou attempting to cross pipelines, roads, and road/pipeline complexes within 4-km segments of the Spine and Oliktok Roads, Kuparuk Development Area, 2-31 July 1989.

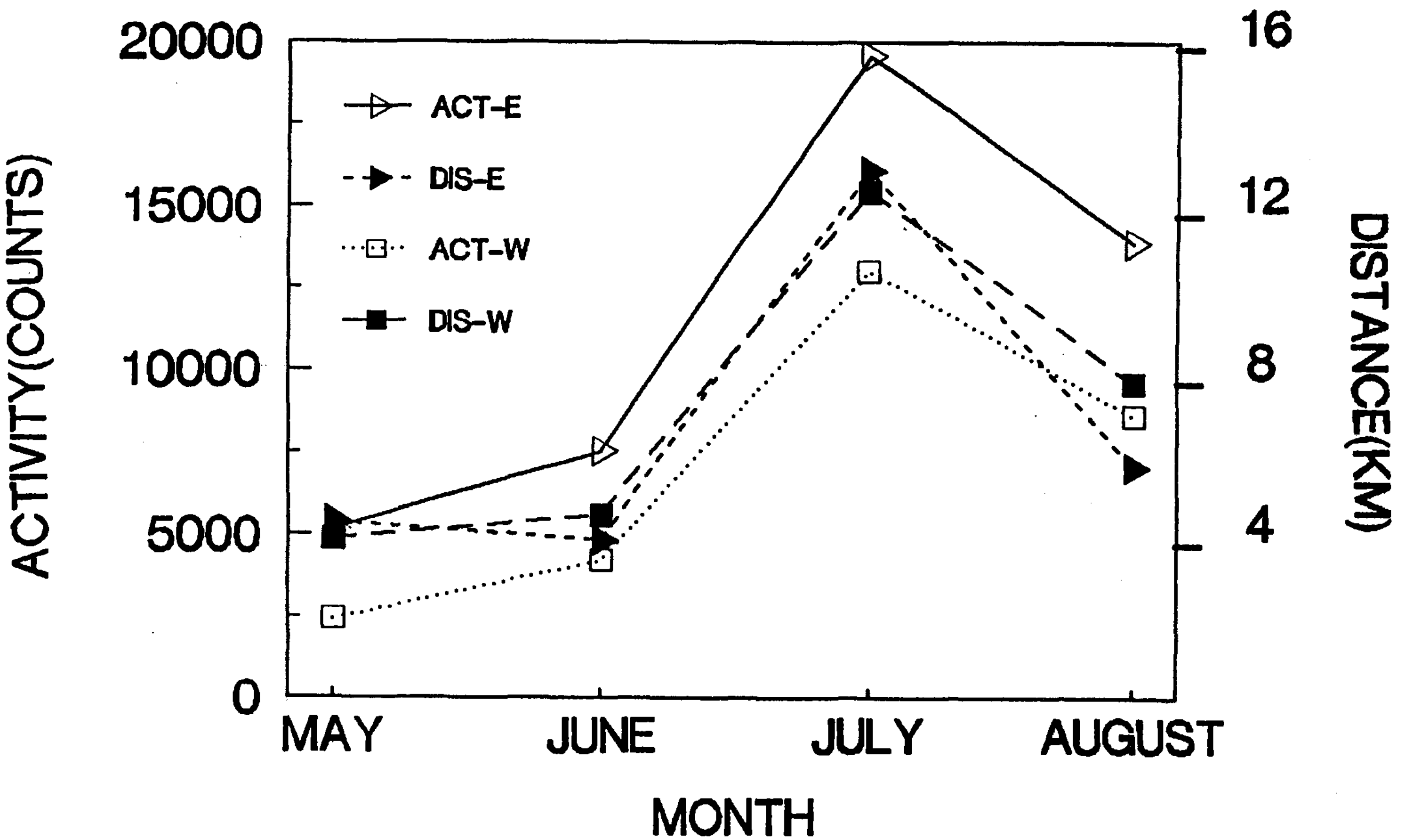

Fig. 7. Mean daily activity counts (ACT) and mean daily distance traveled (DIS) by satellite-collared female caribou east (E) and west (W) of oilfield development, Prudhoe Bay Region, summer 1987.

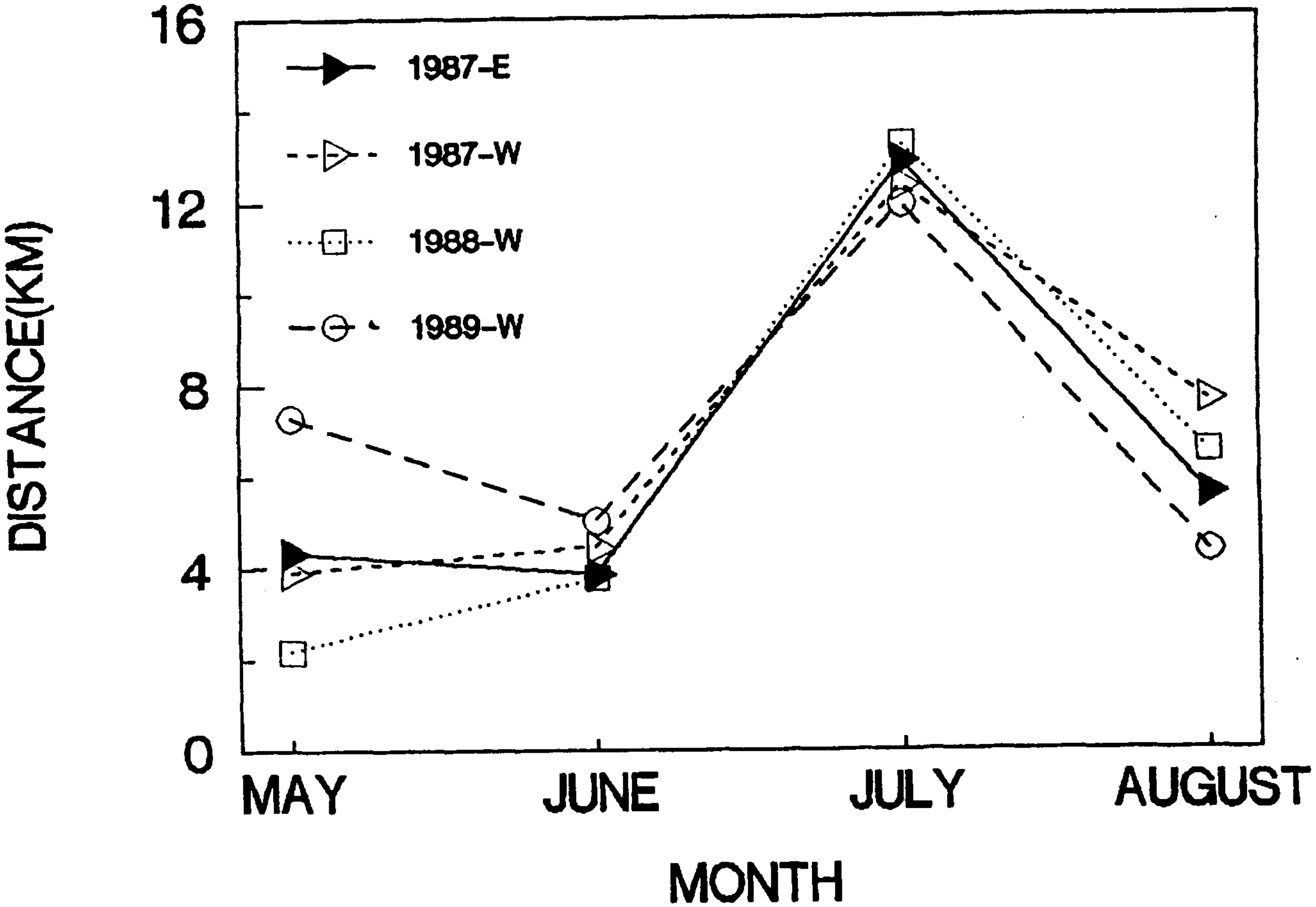

Fig. 8. Mean daily distance traveled by satellite-collared female caribou east (E) and west (W) of oilfield development, Prudhoe Bay region, summer 1987-89.

Table 1. Sex/age composition and sighting rates of caribou within strip transects[a] during helicopter surveys of the Central Arctic Herd calving grounds, June 1987-89.

	West of Sagavanirktok River (transects 3-10)				East of Sagavanirktok River (transects 11-20)				Total (transects 3-20)			
Year	Calves :100 cows	Yrlgs :100 cows	Bulls :100 cows	Sighting rate caribou/km	Calves :100 cows	Yrlgs :100 cows	Bulls :100 cows	Sighting rate caribou/km	Calves :100 cows	Yrlgs :100 cows	Bulls :100 cows	Sighting rate caribou/km
1987	77	16	3	4.0	71	23	4	4.0	74	21	4	4.0
1988	68	33	6	3.8	66	34	7	4.1	67	34	7	4.0
1989	29	29	12	1.6	63	12	3	2.6	51	18	4	2.1

[a] Only transects at 9.6-km intervals (see Smith and Cameron 1988).

Table 2. Population characteristics of caribou observed along the Spine and Oliktok Roads, Kuparuk Development Area, 2 June-31 July 1989.

Category	Calving (2 -17 June)					Summer (2 -31 July)				
	No. groups	No. caribou	Mean group size	Sighting rate (caribou/km)	% calves	No. groups	No. caribou	Mean group size	Sighting rate (caribou/km)	% calves
Kuparuk Spine Road (0.0-32.0km)	174	507	2.9	1.1	1.0	498	11,151	22.4	13.9	11.9
Oliktok Road (32.1-56.0km)	140	394	2.8	1.2	0.3	335	13,382	39.9	22.3	11.0
Total (Road) (0.0-56.0km)	314	901	2.9	1.2	0.7	833	24,533	29.5	17.5	11.5
0-1,000 m	196	527	2.7	0.7	0.8	720	17,213	23.9	12.3	11.5
0-2,000 m	245	674	2.8	0.8	0.6	813	20,873	25.7	14.9	11.6
Pipe crossings	--	--	--	--	--	67	562	8.4	0.4	8.5
Road crossings	--	--	--	--	--	30	332	11.1	0.2	10.8
Road/Pipe crossings	2	3	1.5	<0.1	0.0	54	9,329	172.7	6.7	11.4
Total (crossings)	2	3	1.5	<0.1	0.0	151	10,223	67.7	7.3	11.2
On insect days	--	--	--	--	--	206	15,938	77.4	31.6	10.3

Table 3. Summary of July movements of the Central Arctic Herd within the Kuparuk Development Area, July 1989.

Date	Location and movements	Wind direction	Avg. high temp. °C[a]	Insect harassment	No. caribou seen from road
1-4	Moved to coast, north of Spine road	N, NE	13.0	Moderate	1,079
5-7	Moved west along coast, crossing road at Oliktok Point	W	17.5	Light-moderate	3,284
8-13	Local movements west of Oliktok Point and in Colville Delta	W	18.0	Light-moderate	374
14-15	Moved east along coast, crossing road at Oliktok Point	N, W	20.5	Moderate-severe	6,002
16-18	Moved south and crossed Spine Road east of CPF-1	VAR	13.5	Light-moderate	4,713
19-22	Local movements south of Spine Road	NE	9.5	Light	680
23-24	Moved north to Spine Road east of CPF-1	VAR	17.5	Moderate	4,107
25-31	East and south of Spine Road; some movement to Prudhoe Bay Oilfield	NE	13.5	Light-	4,294

[a] Summarized from hourly weather observations, Deadhorse Airport, Alaska.

WILDLIFE RESTORATION

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