RESEARCH ON THE POTENTIAL EFFECTS OF PETROLEUM DEVELOPMENT ON WILDLIFE AND THEIR HABITAT, ARCTIC NATIONAL WILDLIFE REFUGE

Interim Report - 1988-1990

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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.

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INTRODUCTION

A reduction in caribou (*Rangifer tarandus granti*) herd size or productivity resulting from habitat loss is a possible consequence of 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 influences conception/parturition rate, calving date, calf birth weight, and calf survival (Dauphinè 1976; Haukioja and Salovaara 1978; Thomas 1982; Reimers 1983a, b; Reimers et al. 1983; Skogland 1983a, 1984; Lenvik 1988; Lenvik et al. 1988). However, there is little evidence to support the notion that a specific relationship identified for one subspecies of *Rangifer* applies to all others (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. The following objectives and hypotheses were the basis for the research effort:

1. To determine relationships between body condition and the reproductive performance of female caribou.

    (a) H_o: Conception and parturition rates are independent of fall body condition.
    (b) H_o: Calf survival is unrelated to maternal condition prior to parturition.
    (c) H_o: Calving date is independent of fall body condition of cows.

2. To compare the body condition and reproductive performance of female caribou of the Central Arctic Herd (CAH) in frequent contact with oil development (i.e., west of the Sagavanirktok River) with the status of those seldom, if ever, contacting development (i.e., east of the Sagavanirktok River).

    (a) H_o: Female body condition and reproductive performance vary independent of exposure to oil development.

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

4. To develop and implement procedures for monitoring 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 simulation modelling when detailed habitat data become available. The results of studies dealing with Objective 4 are presented by Gerhart et al. 1992 and Allaye-Chan and White 1992.

METHODS

The study areas were within the ranges of the Central Arctic Herd (CAH) (Fig. 1) (Cameron and Whitten 1979) and the Porcupine Caribou Herd (PCH) (Fig. 1) (Fancy et al. 1992).

In late September and October 1986-90, 39 radio-collared adult ($\geq$3 years old at calving) female caribou from the CAH and PCH were darted (3 mg Carfentanil citrate, or 1.5 mg Carfentanil citrate with 20 mg xylazine; Adams et al. 1988) from a helicopter and weighed 1-5 times each. In early July 1988-90, an additional 34 females were darted and weighed (Table 1).

During late May and early June 1987-90, these same females were relocated daily or on alternate days by fixed-wing aircraft. Parturition status was determined by calf presence, antler retention, and/or udder distension (Whitten et.al. 1992), 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 relocated and observed at least once 2-3 days after parturition. Calves that were either confirmed dead or not observed were classified as perinatal mortalities. 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 weights, rates of weight change, parturition rates, and perinatal survival rates were compared using Student's *t*-tests. Relationships between fall body weight and calving date were evaluated with Spearman's rank correlation. Statistical significance was evaluated at the 90% confidence level.

RESULTS

Radio-collared females that produced a calf were significantly heavier than those that did not, as were those whose calves survived the perinatal period (Table 2). Furthermore, calving date varied inversely with fall body weight ($\underline{P} < 0.1$) (Fig. 2), and fall body weight was significantly higher among females that calved within 3 days of the estimated peak of calving (Table 2). Parturition rate, perinatal survival rate, and the occurrence of earlier calving all increased with fall body weight (Fig. 3).

Pregnant/lactating females lost significantly more weight during winter and spring than non-pregnant females, and lactating females gained significantly less weight during summer and autumn than non-lactating females (Table 3). These daily rates yield a mean annual net loss of 7 kg for pregnant/lactating females, compared with a net gain of 5 kg for nonpregnant/nonlactating females. Additionally, those bearing calves that suffered perinatal mortality had lost significantly more weight ($\bar{x}$ = -64 g/day) between the previous October and July ($\underline{P} < 0.05$) than did females whose calves survived ($\bar{x}$ = -36 g/d).

Mean July and October body weights and rates of summer weight gain of lactating females

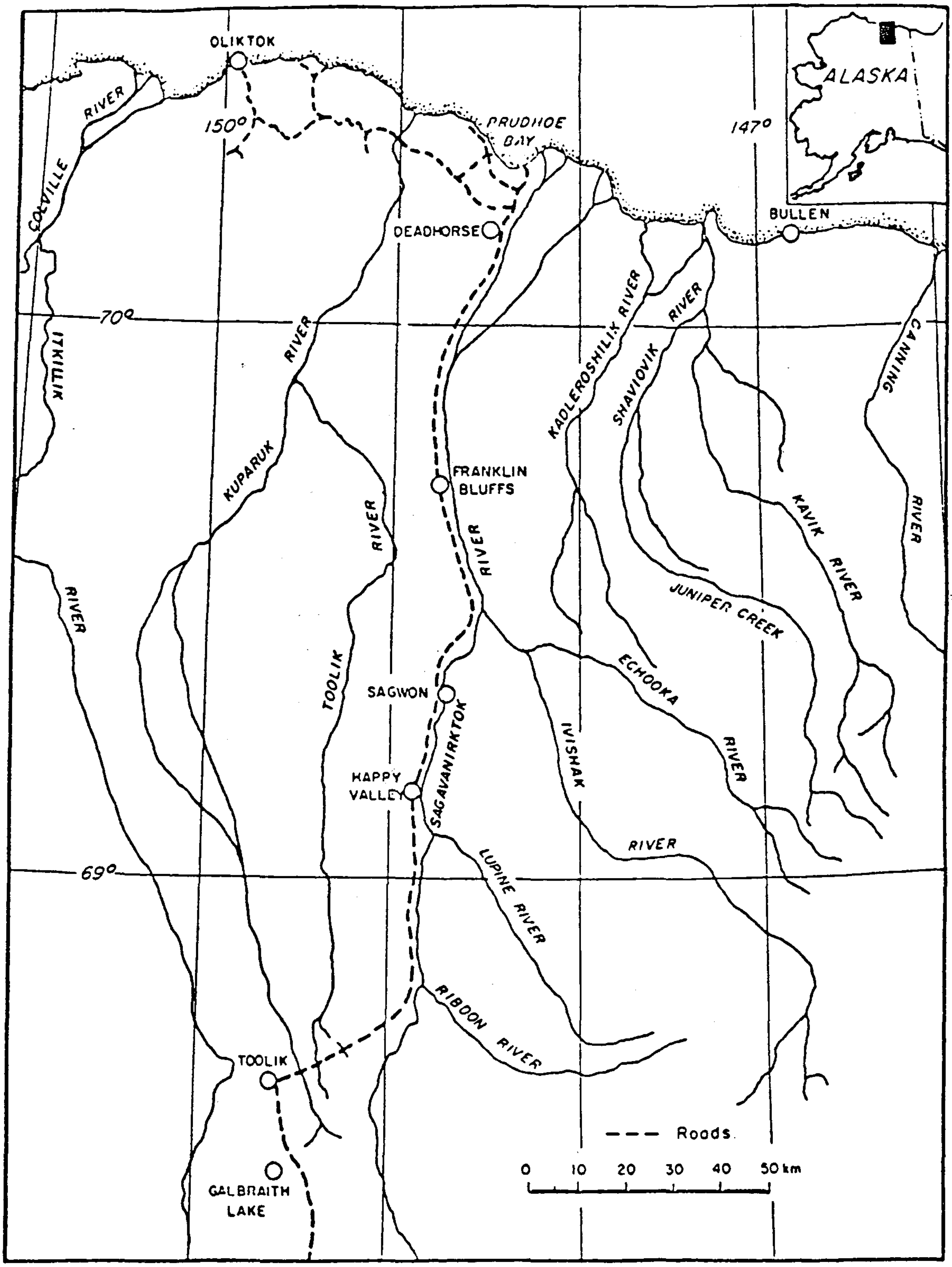

Figure 1. The greater range of the Central Arctic Herd, arctic coastal plain, Alaska.

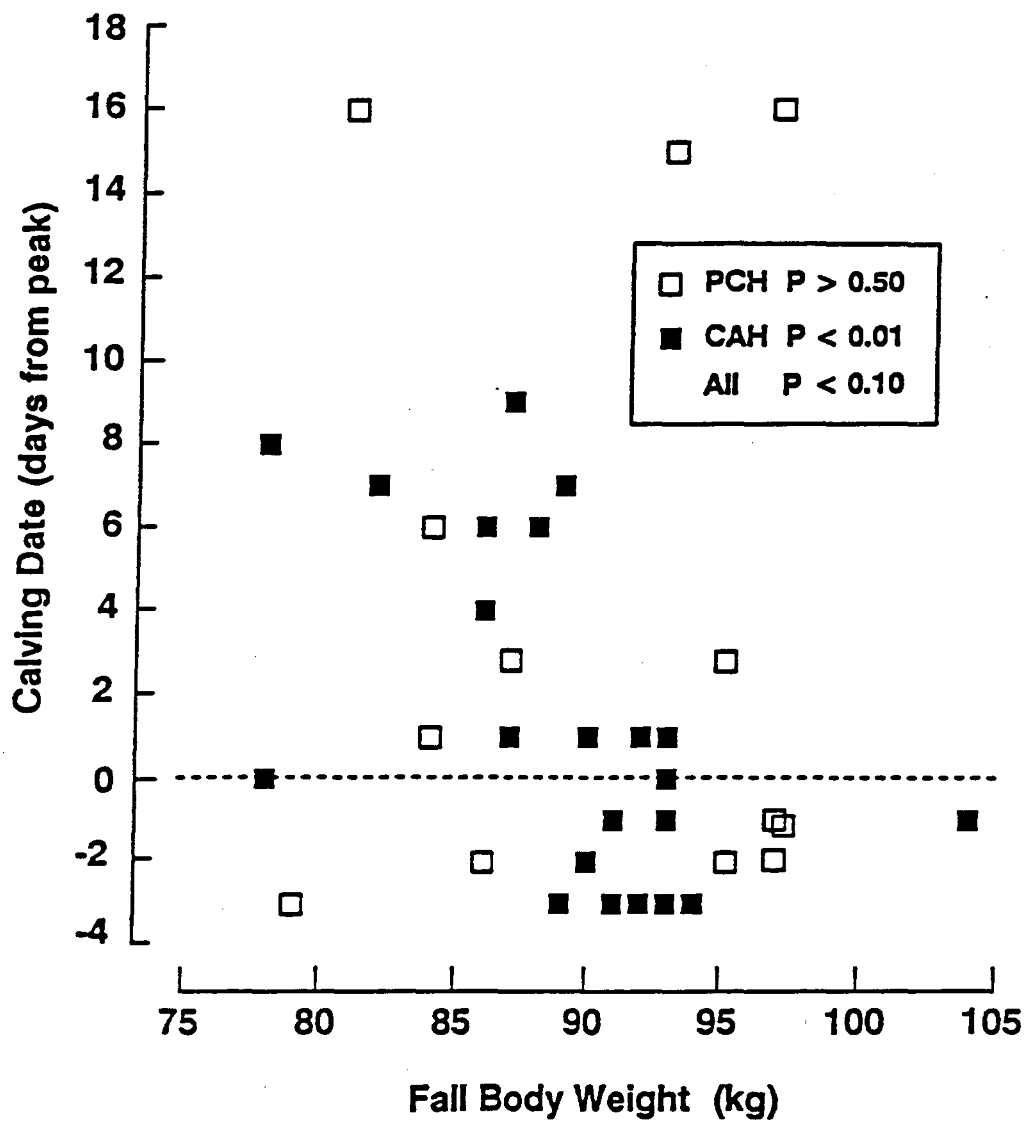

Figure 2. Relationship between 1987-90 calving dates (days from estimated peak of calving) and preceding fall (1986-89) body weights of radio-collared CAH and PCH female caribou.

Table 1. Numbers of captures (or recaptures) of 73 adult female caribou of the Central Arctic Herd (CAH) and Porcupine Herd (PCH), 1986-90.[a]

Year	CAH Jul	CAH Sep/Oct	PCH Oct
1986	–	3	4
1987	–	15	8
1988	20	18	5
1989	22	17	–
1990	15	21	–

[a] Excludes those females for which reproductive status was unknown or uncertain.

Table 2. Mean $\pm$ SE (n) body weights of fecund[a] female caribou in October relative to subsequent parturition, perinatal calf survival/mortality, and calving time, Central Arctic Herd and Porcupine Herd, 1986-90.

Status[b]	Body weight (kg)	*t*-test
Parturient	90 $\pm$ 1 (42)	$P < 0.001$
Nonparturient	82 $\pm$ 2 (12)	
Perinatal survival[c]	91 $\pm$ 1 (28)	$P < 0.01$
Perinatal mortality[d]	87 $\pm$ 1 (14)	
Calving at peak, $\pm$3 d[e]	91 $\pm$ 1 (24)	$P < 0.05$
Calving >3 d after peak[e]	86 $\pm$ 2 (11)	

[a] Calf at heel when collared, or reproductive activity observed previously.
[b] Based on observations during the June calving period.
[c] Calf alive $\geq$ 48 post-partum.
[d] Calf confirmed dead or not observed with its dam < 48 hours post-partum.
[e] See Fig. 2.

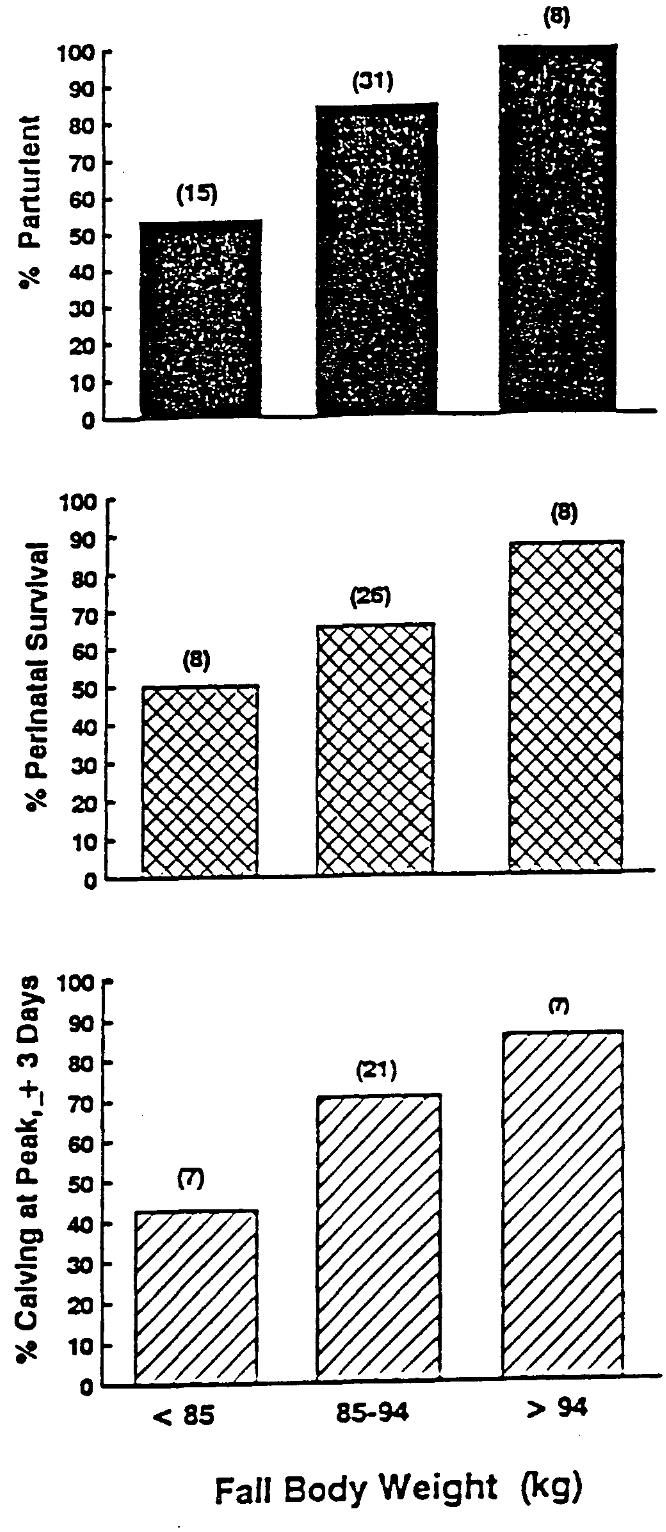

Figure 3. Parturition rate, perinatal calf survival rate, and calving time of fecund female caribou of the CAH and PCH, 1986-90, in relation to fall body weight.

Table 3. Seasonal mean ± SE (n) rates of weight change of pregnant/lactating and nonpregnant/nonlactating female caribou, Central Arctic Herd, 1987-90.

Interval	Mean weight change (g/d)		
	Pregnant/ lactating	[t-test]	Nonpregnant/ nonlactating
Jul-Oct (16)	+62 ± 14 (14)	[P < 0.001]	+138 ± 14
Oct-Jul (10)	-47 ± 6 (16)	[P < 0.02]	-27 ± 4

to the west of the Sagavanirktok River all tended to be lower than those to the east, but the differences were not statistically significant (Table 4, Figure 4). The occurrence of successive 2-year parturition events and the rate of perinatal calf survival tended to be lower for western females (67% and 73% respectively) than for eastern females (87% and 84%, respectively), but again, the differences were not statistically significant (P > 0.2 and P > 0.4, respectively).

Table 4. Seasonal mean ± SE (n) body weights and rates of weight change of pregnant/lactating female caribou west and east of the Sagavanirktok River, Central Arctic Herd, 1987-90.

Variable	Month(s)	West	[t-test]	East
Body weight (kg)	Jul	75 ± 2 (21)	[P > 0.5]	76 ± 2 (21)
	Oct	82 ± 2 (22)	[P > 0.2]	84 ± 1 (19)
Weight change (g/d)	Jul-Oct	+44 ± 18 (6)	[P > 0.2]	+75 ± 19 (8)
	Oct-Jul	-49 ± 6 (8)	[P > 0.9]	-48 ± 12 (7)

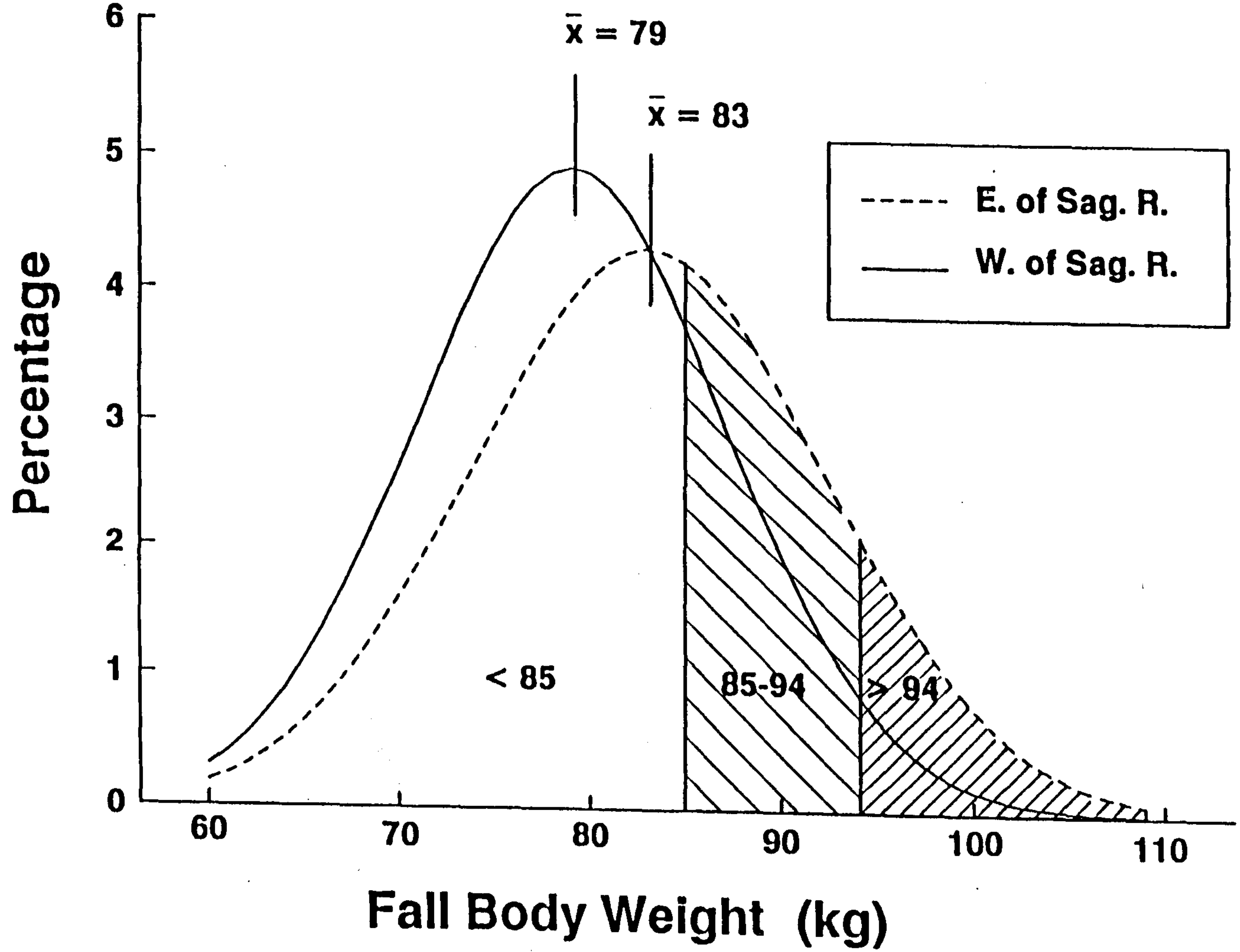

Figure 4. Hypothetical distributions of fall body weights of lactating female caribou of the CAH east and west of the Sagavanirktok River, 1987-90.

DISCUSSION

The results indicate that the reproductive performance of CAH and PCH females was directly related to body weight during the previous fall. Heavier females were characterized by higher rates of parturition and perinatal calf survival, as well as a tendency to calve earlier. We therefore reject the hypotheses that parturition rate, calf survival and calving date are independent of fall condition.

Closely linked to pre-rut body weight, and hence the probability of reproductive success, is the pattern of weight change over the previous year. The metabolic burdens imposed by gestation and lactation exacerbate winter weight loss and reduce summer weight gain. Apparently the cost of fetal development cannot be met through additional feeding. The resultant weight loss, if excessive, may predispose females to produce nonviable offspring. Similarly, maternal females may be unable to fully compensate for the cost of milk production by foraging more frequently or intensively. Thus, failure to meet these demands may compromise subsequent reproductive success, both through higher calf mortality and through lower fall weights of maternal females, which decreases chances of a successful pregnancy the following year. On the other hand, periodic failure to produce and rear a calf should permit a recovery in condition, allowing reproductive activity to resume--but at the expense of not contributing to at least one cohort.

We observed no statistically significant differences in July or October body weights, summer weight gain of lactating females, frequency of successive 2-year calving events, or perinatal calf survival between caribou using areas east or west of the Sagavanirktok River. However, in all four comparisons the mean value obtained from caribou using areas exposed to oil development suggested lowered reproductive performance. Lack of statistical significance may have been a function of the low power of our tests to detect small differences which might be biologically meaningful.

Given that any effects of oilfield-related disturbance are likely to be manifested as a reduction in postcalving body weights and rates of summer weight gain (Smith and Cameron 1992), such differences, if real, may have biologically significant implications. To assess the theoretical consequences, we adjusted individual July body weights of western and eastern females according to the deviation of that year's mean from the 4 year means of 75 and 76 kg, respectively (Table 4). To each of these adjusted body weights, we then applied all observed rates of weight gain comprising each mean (Table 4), generating 2 matrices of projected fall body weights, to which normal curves were fitted (Fig. 4). For each distribution, reproductive success was computed as a "calf yield" [(% parturient x % perinatal survival)/100], based on the relationship between fall body weight and reproductive rates depicted in Figure 3. Hypothetically, a mean July body weight that was lower by a nominal 1 kg, together with a mean 41% reduction in the rate of summer weight gain, resulted in a mean 4 kg decrease in fall body weight. This could depress calf yield by 19% (i.e., from 42% to 34%); moreover, the projected proportion of females calving within 3 days of the peak of calving could decrease from 55% to 50%.

Therefore, seemingly minor differences in the rate of weight change during summer might result in lower initial calf production and/or lower calf survival for female caribou exposed to oil development west of the Sagavanirktok River (Fig. 5). If disturbance due to oil development causes lower nutrient retention during the calving and summer periods, western females, overall, might be unable to attain the same level of fall condition as their eastern counterparts. This could result in lower parturition rates because of more frequent breeding pauses, and reduced perinatal calf survival among females that continue to breed.

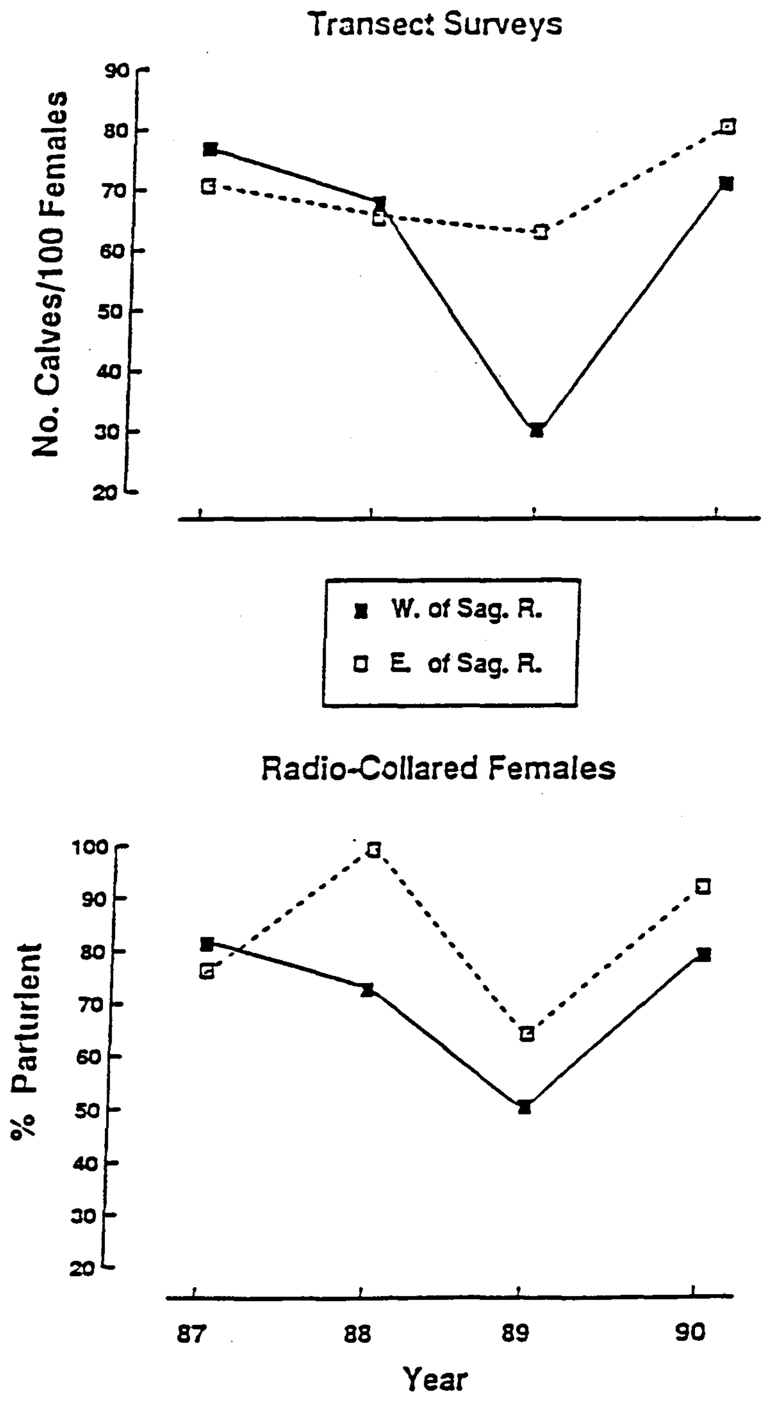

Figure 5. Changes in initial calf production (based on transect survey results) and parturition rate (of radio-collared females) of CAH caribou west and east of the Sagavanirktok River, 1987-90.

MANAGEMENT IMPLICATIONS

The correlations between fall body condition and reproductive success, and the constraints of pregnancy and lactational status on weight gain indicate a certain sensitivity to circumstances that might further reduce nutrient acquisition or retention. For example, snow depth during the calving period, the severity of summer insect harassment, and the level of disturbance associated with industrial development may collectively influence foraging success and energy expenditure in an additive, compensatory, or synergistic fashion.

Perhaps it is only where accompanied by extremes in the natural environment that oilfield-related disturbance may be manifested as a decline in body condition and reproductive performance of caribou. The possibility of such adverse effects under certain circumstances should be sufficient justification for a slow, cautious approach to petroleum development on the Arctic coastal plain.

Aspects of this research program addressing west-east differences in herd productivity continue to be hampered by inadequate sample sizes. Specifically, the need to subclassify radio-collared females on the basis of reproductive status (i.e., pregnant/lactating vs. nonpregnant/nonlactating) often diminishes our data sets to such small sizes that statistical analyses are not possible; hence, the present necessity to combine data across years. Accordingly, future efforts will be directed toward augmenting our sample of collared females and intensifying our capture and weighing program.

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