Caribou Distribution and Group Composition Associated with Construction of the Trans-Alaska Pipeline

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Caribou surveys were conducted periodically along the Trans-Alaska Pipeline haul road on the central Arctic Slope between June and November 1975. Mean calf percentage observed in summer was approximately one-third lower than that obtained from concurrent aerial surveys of both the pipeline corridor and adjacent areas; however, fall means were identical. In both summer and early fall, mean latitudes calculated for groups with and without calves along the haul road were more southerly than for the corresponding group types observed through aerial survey. A more detailed regional comparison of survey data revealed corridor-related abnormalities in Caribou distribution and group composition. No Caribou, or relatively low numbers, were observed in the northernmost segment of the pipeline corridor near Prudhoe Bay, and calf percentages in summer were consistently lower for each of four arbitrarily established regions of the haul road than expected on the basis of aerial survey results; fall calf percentages did not differ appreciably. Mean group size was generally lower along the haul road than for comparable areas to the east and west. Responses of Caribou to the pipeline corridor in general, and of cows and calves in particular, are discussed in relation to inherent avoidance tendencies as modified seasonally by terrain, group dominance, and human activity.

Key Words: Caribou, *Rangifer*, pipeline, disturbance, group composition, Prudhoe Bay, ecological distribution.

The discovery of vast petroleum reserves at Prudhoe Bay in 1968 resulted in construction of the Trans-Alaska Pipeline, designed to transport crude oil to Valdez on the Gulf of Alaska. North of the Yukon River, the pipeline and its associated haul road were to traverse the ranges of two major subpopulations of Barren-ground Caribou (*Rangifer tarandus granti*), the Porcupine and Western Arctic herds (Skoog 1968; Hemming 1971), and concern was focused on the potential restriction of Caribou movements.

In 1971 and 1972 K. N. Child (1973, Completion Report, Alaska Cooperative Wildlife Research Unit, University of Alaska), using simulated pipeline and pipeline crossing structures at Prudhoe Bay, attempted to assess the effectiveness of various above-ground designs in permitting free movements of Caribou. The majority of approaching Caribou avoided the simulation and, of the successful crossings, about 3 times as many were by use of ramps than by passage under the structure. This detailed study provided valuable preliminary data but was limited to observations on summer range. Thus, little was known of the seasonality of Caribou responses to pipelines and construction-related human activity. Consequently, a major study was undertaken to evaluate the reactions of Caribou to the Trans-Alaska Pipeline on a seasonal basis and to document any associated shifts in annual movement patterns and range occupancy. To date, this investigation has been largely restricted to the Arctic Slope.

Based on summer and fall surveys in this region between 1969 and 1972, A. Gavin (1973, Report by Atlantic Richfield Company) reported a decline in Caribou numbers from 26 000 to 2500, and he thought these Caribou to be "offshoots" from the Porcupine and Western Arctic herds. Cameron and Whitten (1979), however, have recently identified a third subpopulation of about 5000 Caribou whose range is centered on the pipeline route along the Sagavanirktok River (Figure 1). Seasonal movements are primarily north–south, between calving grounds near the coast and winter range in the northern foothills of the Brooks Range. The identity of this "Central Arctic herd" has apparently been confounded by periodic influx from one or both of the larger adjacent herds, although such outside influence was thought to be minimal during the course of the present

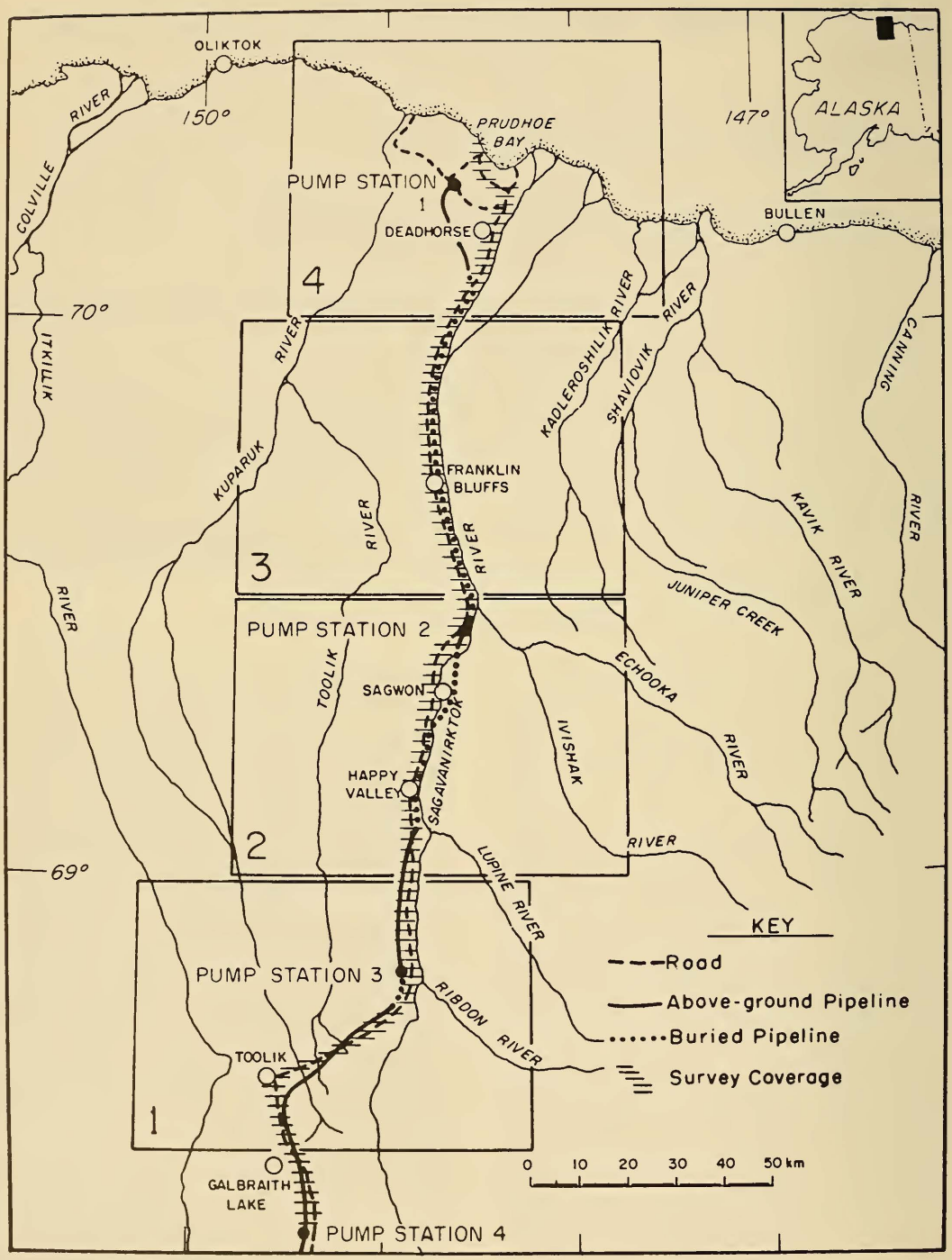

FIGURE 1. Survey coverage along the Trans-Alaska Pipeline corridor and regional boundaries established for comparison of haul road and aerial survey results.

study. This report deals with changes in latitudinal position, group size, and composition of Caribou along the Trans-Alaska Pipeline haul road during summer and fall 1975. These data are compared with similar values obtained through concurrent aerial survey of a larger area extending east and west of the corridor.

The haul road between the Yukon River and Prudhoe Bay was completed in fall 1974, and pipeline construction efforts were near maximum during the major portion of this investigation. The pipeline is 122 cm in diameter and is alternately buried and above ground depending on soil stability; ground clearances of elevated sections range from less than 1 m to a maximum of about 5 m.

Methods

Systematic surveys were conducted from the Trans-Alaska Pipeline haul road between June and November 1975. Generally these were scheduled twice-monthly, each survey consisting of two complete trips over the 263-km distance between Pump Station 4 and Prudhoe Bay (Figure 1). As only half of the route could be covered in 1 d, most surveys required 4 d for completion. Owing to inclement weather, survey components were not necessarily on consecutive days, but an attempt was made to minimize the time interval for each series. Inclusive dates are given in Table 1.

A pickup truck, generally with one driver/observer, was used for all road surveys. Speeds were adjusted to 40–65 km/h, depending on visibility, to provide reasonably constant perceptibility of Caribou for an estimated 1.5 km on either side of the haul road. Only Caribou observed initially with the naked eye were recorded, but binoculars and spotting scope were used as required to obtain additional information. Pertinent data recorded for each Caribou sighting included the following:

Location — road distance from a known point;
Number of Caribou per group (defined arbitrarily as a single Caribou, or two or more Caribou separated by less than an estimated 300 m);
Group composition —
calf — less than 1 yr old,
yearling — more than 1 yr old but less than 2 yr old,
cow — female more than 2 yr of age,
bull — male more than 2 yr of age,
adult — more than 1 yr old, sex unknown,
unknown — unclassified as to sex or age.

TABLE 1—Changes in Caribou numbers and mean group composition along the Trans-Alaska Pipeline haul road, June–November 1975

Survey dates	Total number of caribou observed	Total classified			Groups with calves			Groups without calves	
		Number of caribou[a]	Bulls, %	Calves, %	Number of caribou[b]	Bulls, %	Calves, %	Number of caribou[c]	Bulls, %
June 11–18	91	79	66	0	0	0	0	79	66
June 24–July 2	361	342	86	3	19	8	21	323	92
July 10–17	677	677	52	32	499	35	43	178	100
July 24–August 2	136	136	98	1	5	60	20	131	100
August 7–13	273	273	77	7	57	2	32	216	97
August 20–28	156	149	92	1	11	19	18	138	98
September 3–6	202	200	83	3	23	30	26	177	90
Summer mean[d]			65	13(21)		31	40(35)		94
September 20–28	602	416	44	17	333	30	23	83	99
October 24–28	54	31	36	24	25	26	30	6	80
November 5–10	176	37	49	10	19	25	19	18	74
November 19–25	92	36	43	11	25	30	17	11	73
Fall mean[d]			43	17(17)		29	23(21)		92

[a]Total caribou in groups with no "unknowns" (see Methods).
[b]Total caribou in groups with one or more calves present.
[c]Total caribou in groups with no calves.
[d]Aggregate percentages; those in parentheses were determined from aerial surveys (Cameron and Whitten 1979).

Road locations were converted to their latitudinal equivalents using 1:63 360 scale maps of USGS Topography Series. For each survey series a mean latitudinal position of Caribou was calculated as described by Cameron and Whitten (1979).

Results and Discussion

Caribou Numbers and Group Composition

Numbers and group composition of Caribou observed from the haul road during each survey period are given in Table 1. Groups with one or more "unknowns" (see Methods) were excluded from composition calculations. Ninety-eight percent of the total Caribou sighted during summer were successfully classified. During fall, however, bright sun and snow frequently created distortion which precluded classification at distances greater than about 400 m, and entire groups were recorded as unknowns; the proportion classified decreased to 56%. Cows and yearlings were often difficult to distinguish, and many such individuals were classified as "adults" (see Methods) when more specific identification was impossible. Calves, however, were relatively easy to recognize and reported percentages are thought to be very reliable. Similarly, identification of bulls was rarely in question.

During summer 13% of total Caribou observed from the haul road were calves, compared with a corresponding value of 21% obtained by systematic aerial survey of a larger area roughly centered on the pipeline route (Table 1). In contrast, a mean of 17% calves was observed in fall during both road and aerial surveys, indicating that a representative portion of the herd was present along the corridor. Within each season, calf percentages for groups with calves were similar for road and aerial observations (Table 1). It can be calculated from the summer road data in Table 1, however, that the number of Caribou observed in groups with calves averaged 33% of the total classified, whereas 60% of Caribou classified by air were observed in groups with calves (see Cameron and Whitten 1979); respective mean values for fall were similar at 77 and 81%. In addition, observations from the haul road indicate that bulls were present in low numbers in groups with calves but consistently predominated in groups without calves, and the percentages did not differ appreciably with season for either group type (Table 1). Clearly then, the low proportion of calves recorded during haul road surveys in summer was due primarily to a local reduction in the relative number and/or size (see below) of groups with calves rather than a lower percentage of calves in such groups.

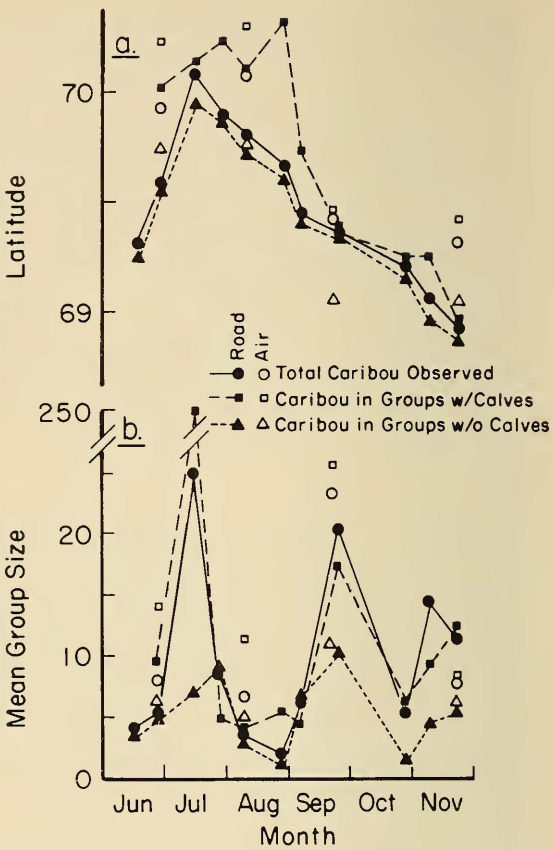

FIGURE 2. Seasonal changes in mean latitudinal position and mean group size of Caribou along the haul road and a comparison with corresponding results from aerial surveys.

Latitudinal Movements

Changes in mean latitudinal position of Caribou along the haul road are depicted in Figure 2a. Throughout summer, groups with calves remained farther north than groups without calves. A similar trend was obtained from concurrent aerial surveys (Cameron and Whitten 1979), and these results are plotted for comparison. Thus, the more northerly location of the mean shown for aggregate sightings by air

is partially attributable to a greater proportion of groups with calves (see previous section) because they tend to occupy higher latitudes. Positions determined by aerial survey for groups both with and without calves, however, were also farther north than those calculated from road survey observations. Corresponding means did not differ appreciably in September, but the same general trend was again apparent in November (Figure 2a), despite the fact that no overall differences in calf percentage were observed (Table 1). Thus, dissimilar composition does not fully account for the more southerly distribution of Caribou along the pipeline corridor. Rather, local abnormalities are indicated.

Group Size

Two distinct peaks in group size are shown in Figure 2b for haul road observations, one in mid-July during post-calving aggregation and another in September just prior to the rut. Except for late July and early September, the mean size of groups with calves was greater than that for groups without calves. A further comparison of these means with those determined from aerial surveys indicates that in June, August, and September the size of corresponding group types was higher for aerial than for haul road surveys. A valid comparison is not possible for November because of the extremely small sample size (Table 1). Because the same criteria for group identification were used in both survey procedures (see Methods), these data suggest avoidance of the area by larger groups, group fragmentation, and/or a decreased tendency for group coalescence near the pipeline corridor.

Differences in Regional Distribution and Group Composition

To permit a more accurate assessment of latitudinal distribution and group composition of Caribou, four regions were delineated along the pipeline corridor for direct comparison of aerial and road survey observations. These regions were centered on the corridor, and each was bounded arbitrarily by ½ degree of latitude and 2 degrees of longitude (Figure 1). The regional distribution of total Caribou observations for both aerial and road surveys is shown in Figure 3, and applicable calf percentages are presented in Table 2. It was assumed that aerial survey results reflected the true distribution of Caribou among the four regions and provided representative data on composition within each region. Corresponding data from the haul road, obtained concurrently, are compared with these "expected" values. As sample sizes were frequently low, statistical analysis of differences in group composition was not feasible, but some overall and regional trends are apparent.

Figure 3 demonstrates a distinct north–south gradient in regional density of Caribou for both

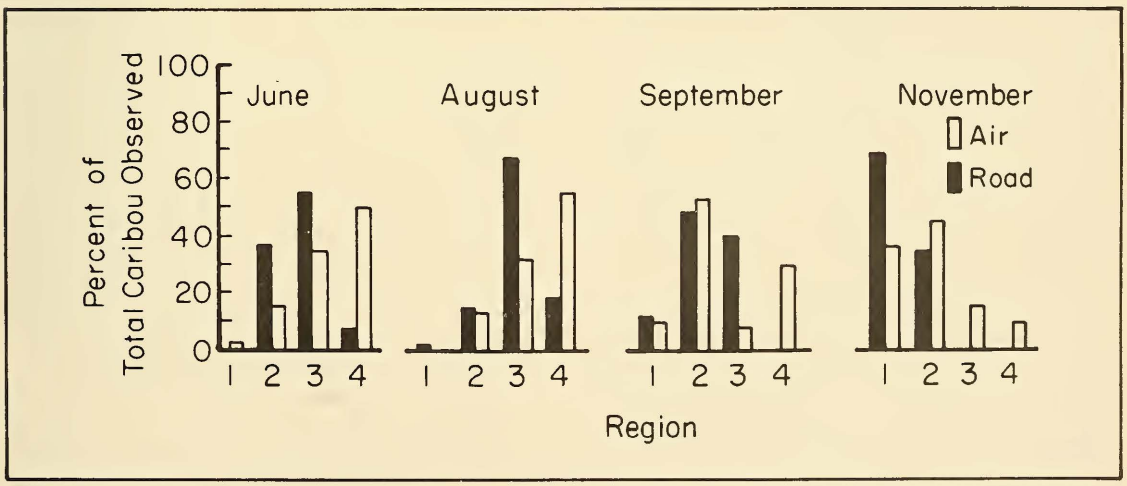

FIGURE 3. Regional distribution of Caribou (see Figure 1) determined from corresponding aerial and haul road surveys.

TABLE 2—Regional comparison of calf percentages determined from corresponding aerial and haul road surveys, June–November 1975

Month[a]	Survey method[a]	Region 1 Number of caribou[b]	Region 1 Calves, %	Region 2 Number of caribou[b]	Region 2 Calves %	Region 3 Number of caribou[b]	Region 3 Calves, %	Region 4 Number of caribou[b]	Region 4 Calves, %
June	Air	4	0	65	2	159	10	231	27
	Road	0	—	121	0	195	4	26	12
August	Air	0	—	49	0	122	9	200	34
	Road	4	0	37	0	183	3	49	27
September	Air	32	0	174	21	18	22	99	20
	Road	59	6	125	9	232	25	0	—
November	Air	238	7	256	17	101	27	57	44
	Road	36	11	0	—	0	—	0	—

[a]Aerial surveys (Cameron and Whitten 1979) or haul road surveys within the regions shown in Figure 1.
[b]Number of caribou classified, i.e., total caribou in groups with no "unknowns" (see Methods).

June and August, with aerial sightings in region 4 representing 50 and 55% of the total, respectively. In contrast, the majority of haul road observations during summer were in region 3, and relatively few Caribou were observed near the coast. Calf percentages for regions 3 and 4 of the haul road were appreciably lower than expected, while few calves were noted in regions 1 and 2 from either road or air (Table 2). For all regions combined, calf percentages determined from aerial and haul road surveys, respectively, were 17 and 3 in June, and 20 and 7 in August. Thus, the more southerly distribution of Caribou within the pipeline corridor in summer was due in part to a general avoidance of northern sections near Prudhoe Bay. In addition, aggregate and regional calf percentages were consistently lower than the expected values, indicating a disproportionate avoidance of the pipeline corridor by groups with calves. The resulting preponderance of bulls (i.e., groups without calves), by virtue of their latitudinal preference (Figure 2a), contributed further to a southward displacement of Caribou along the haul road.

By late September a southward movement of Caribou had occurred. Approximately half of the total sightings from both air and haul road were in region 2, but no Caribou were observed along the corridor in region 4 where nearly one-third of the total was observed during aerial surveys (Figure 3). During both aerial and road surveys the majority of Caribou were found in groups with calves (Table 1), and mean group size increased (Figure 2b) as pre-rut aggregations formed. Although aerial observations indicated that groups without calves remained substantially farther south (Figure 2a), such differences are of little quantitative importance as these Caribou represented less than 10% of total sightings. Regional differences in calf percentage demonstrate no consistent trend (Table 2), but combining data for regions 1, 2, and 3 results in an estimated 17% calves for both air and road surveys. Thus, in September a strong avoidance of the Prudhoe Bay area is indicated, but sightings of Caribou elsewhere along the haul road appear to reflect overall herd composition, and disproportionate avoidance by groups with calves was not apparent. In November aerial surveys established that fewer Caribou were occupying coastal areas. Most Caribou within the corridor were in region 1, and none were observed in regions 3 and 4 (Figure 3). Total haul road sightings in November were among the lowest recorded (Table 1), and any conclusions regarding differences in calf composition would be equivocal because of small sample size. Nevertheless, combined data for fall again indicate that a more representative portion of the herd approached and was observed from the haul road, although continued avoidance of northern areas is indicated.

Relatively low numbers of Caribou near the haul road in region 4 during summer and fall may partially explain the small group size observed within the pipeline corridor (Figure 2b). Groups with calves observed along the coast

by air were generally larger than comparable inland groups, and their avoidance of the haul road area would tend to depress the calculated mean irrespective of other influences on group size. Groups without calves, however, exhibited a similar decrease in summer and a corridor-related reduction in group size remains suspect.

Avoidance Behavior of Caribou

Avoidance of the Prudhoe Bay area was noted throughout the course of this study. The coastal region near Prudhoe Bay, recently the site of increased construction and exploration activity, was previously a portion of the calving grounds for the Central Arctic herd. As late as 1972 K. N. Child (1973, *op. cit.*) and A. Gavin (1973, *op. cit.*) reported calving within or immediately adjacent to the Prudhoe Bay complex. With facilities expansion and continued human activity over the past 3 or 4 yr, local occupancy by Caribou has generally decreased, and in 1975 we observed no neo-natal calves from this northernmost section of the haul road. The area was also previously invaded by Caribou during annual post-calving movements along the coast (Cameron and Whitten 1979) and during oscillatory movements to and from the coast in response to changing insect density (Child 1973, *op. cit.*; White et al. 1975). Evidence for these occurrences is still visible as Caribou trail systems and, although movements within the Prudhoe complex are still detectable, they are now mere remnants of past activities. Post-calving and insect-induced movements, however, still occur elsewhere along the coast between the Colville and Canning rivers, indicating avoidance of a specific portion of summer range with continued occupancy of adjacent regions. Disturbance-related abandonment of range is thought to be a gradual process, occurring with increasing avoidance of adverse stimuli (Klein 1971; Calef 1974), and the recent history of changing Caribou occupancy near Prudhoe Bay appears to reflect this pattern.

In summer, avoidance of the pipeline corridor was primarily by cows and calves. Cows are most sensitive to unusual stimuli just before parturition or during the early stages of labor (Lent 1966), but the present results suggest that heightened sensitivity extends through the first 2 or 3 months post-partum. Other reports indicate that cows and young calves are more easily alarmed by, and more likely to flee from, a potential threat than are male Caribou, barren cows, or cows with older calves (de Vos 1960; Lent 1966; Bergerud 1974). Loud noises, unless associated with moving objects, do not generally alarm Caribou which perceive and identify adverse stimuli through visual and olfactory means (Bergerud 1974). Cows with young calves, however, consistently take flight from distant stimuli, using visual analysis without verification by scent (Bergerud 1974). Bergerud (1974) and Lent (1966) reported that alert posture assumed by individuals within a group did not generally induce group flight unless cows and neo-natal calves were present. Also, we noted that cow-calf pairs on the calving grounds were difficult to approach on foot to within 400 m.

Because of the importance of visual stimuli, local terrain relief may influence the degree of avoidance of the pipeline corridor. North of Pump Station 2 the haul raod traverses more than 100 km of continuous coastal plain (see Figure 1) which is preferred summer range for the Central Arctic herd. Construction activity is frequently visible for 20 km or more, and the greater inherent sensitivity of cows and calves together with greater visibility provided by flat terrain may account for the observed avoidance of the haul road during summer. Bulls do not appear to be as sensitive to local human activity; however, since the mean latitude of groups without calves (i.e., principally bulls) was also displaced southward some evidence exists for low-level avoidance of northern areas.

Avoidance of the Prudhoe Bay complex continued during fall, and most Caribou were observed farther inland. In September and October groups along the haul road were well mixed sexually, and cow-calf avoidance of the pipeline corridor appears to have diminished. This may be partially a result of a change in group dominance associated with breeding; rutting bulls clearly influence group activity (Bergerud 1973; Cameron and Whitten, unpublished observations; Roby 1978) and may alter the "normal" avoidance behavior of cow-calf pairs. Perhaps more importantly, the advanced age of calves may have reduced the sensitivity of maternal cows to human disturbance.

Continued study is necessary to assess the long-term responses of Caribou to oil development in the Arctic. Sustained exposure of Caribou to these stimuli may increase the degree of avoidance, stabilize it at the current level, or ultimately result in a reversal with subsequent accommodation. Further, it is not known whether this avoidance response, by virtue of its probable influence on free movement, will seriously alter herd productivity. Such are matters for conjecture, and should be addressed by future investigations.

Acknowledgments

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