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Effects of the Trans-Alaska Pipeline on Caribou Movements

BY

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

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Job No.: 3.18R Job Title: Effects of the Trans-Alaska Pipeline on Caribou Movements

Period Covered: July 1, 1979 through June 30, 1980

SUMMARY

Results of continued aerial and road surveys along the Trans-Alaska Pipeline (TAP) are described and compared with data from previous years. Local abnormalities in caribou distribution and group composition, primarily resulting from avoidance of the corridor by cows and calves, were already apparent when surveys first began in summer 1975. Avoidance by cow/calf pairs during summer has increased since 1975 and crossing of the corridor has remained fairly stable at levels well below those initially observed in 1975. Caribou sighting frequency initially declined but has now risen steadily to near the 1975 level. The latter effect may result from gradual replacement of cow/calf groups with non-calf (primarily bull) groups. Cow/calf avoidance during fall did not become apparent until 1976, but thereafter it became even more striking than in summer. Local calf representation, caribou sighting frequency, and corridor crossing rates all increased during 1979, although cow/calf avoidance was still significant.

Some avoidance of the corridor during summer may be attributed to contact with the Prudhoe Bay oil field, since caribou consistently use the adjacent coastal plain for calving and midsummer range. Use of fall range is more variable, and avoidance tends to increase in years when larger numbers overwinter on the coastal plain.

Further observations of visual- and radio-collared caribou corroborate the avoidance trends established through aerial and road surveys. Collared bulls have been sighted more frequently from the road and have crossed the TAP corridor more often than collared cows. Evidence that bulls do not retain collars as long as cows is accumulating.

The Central Arctic Herd has experienced excellent productivity and survival to yearling age since 1977. Nothing is

known about overall mortality, but in all likelihood it is well below recruitment.

Harvests of the CAH may have increased recently, but the kill of about 100 animals is well below the assumed recruitment to the herd. Whether the CAH has, in fact, grown in numbers could not be confirmed by a census during the past field season.

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BACKGROUND

The known distribtuion of caribou (*Rangifer tarandus granti*) on Alaska's central Arctic Slope prior to construction of the Trans-Alaska Pipeline (TAP), and the potential conflicts between caribou and the TAP/haul road complex have been described previously (Cameron and Whitten 1976, 1979b; Cameron et al. 1979). These, and other reports, also provided interim findings on herd identity, productivity, seasonal movements, and an analysis of observed abnormalities in caribou distribution and group composition along the TAP corridor from 1975 through 1977 (Cameron and Whitten 1976, 1977, 1978, 1979a; Cameron et al. 1979). More recently, Cameron and Whitten (1979c, 1980a) summarized trends in the local displacement of caribou through 1978 and discussed the observed seasonal and chronological changes in the context of caribou density and past patterns of disturbance within the Pipeline corridor.

This report deals with an interpretation of additional data obtained from the haul road during our 1979 field season, with particular emphasis on the relation to comparable findings from previous years. Also included is a current summary of collared caribou movements in relation to the corridor and an update on the status of the Central Arctic Herd (CAH).

OBJECTIVES

In accordance with stipulations 2.5.4.1* and 2.5.3.1 of the Stipulations for the Agreement and Grant of Right of Way for the Trans-Alaska Pipeline, this project was designed to accomplish the following principal objectives:

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* "Lessees shall construct and maintain the pipeline, both buried and above-ground sections, so as to assure free passage and movement of big game animals."

To determine herd identity, general numbers, productivity, and seasonal movement patterns of caribou which range in the vicinity of the pipeline corridor.

To characterize movement behavior of caribou which encounter the haul road, pipeline, and construction-related activities.

To assess the effectiveness of special crossings in allowing for unrestricted movement.

PROCEDURES

Past reports described the field methodology and analytical procedures which continue to be applied in aerial surveillance (Cameron and Whitten 1977, 1979a), haul road surveys (Cameron and Whitten 1977, Cameron et al. 1979), collaring and radio-tracking (Cameron and Whitten 1976, 1978), and sampling for herd productivity (Cameron and Whitten 1977, 1978).

Resighting percentages, frequencies, and crossing rates for collared caribou were compared using chi-square contingency analysis and Student's t-test. Significance was evaluated at the 95 percent confidence level.

FINDINGS AND DISCUSSION

Caribou Group Composition Determined by Aerial Survey

Systematic aerial surveys were conducted in late spring and late summer. Complete sex and age data were obtained by helicopter in mid-May. Bulls and calves comprised 35 and 24 percent, respectively, of the 499 caribou classified (Table 1).

A helicopter was not available for the August survey and, consequently, reliable subclassification of adults (i.e. to bulls, cows, and yearlings) was not possible. Also, because of wide dispersal of small bands ($\bar{x}$ = 3.0) and a probable movement of some individuals from the primary study area (Cameron and Whitten 1979a), the total number of caribou observed over the standard survey route was extremely low (N=134, Table 1). This was the smallest sample obtained to date for any season. Nevertheless, we believe that the recorded overall mean of 20 percent calves (Table 1) is reasonably accurate and probably a minimum estimate. A sample of 1,340 caribou classified by helicopter survey in April/May 1980 yielded a mean of 18 percent calves. Although this implies overwinter calf mortality that is quite low by other herd standards, it is similar to other recent estimates for the CAH (see below). Further, the calf percentage observed in summer 1979 falls within the range of 15-22 percent obtained between 1975 and 1978 (Cameron and Whitten 1980a). Thus, despite questionable precision resulting from small sample size, we consider the summer estimate of 20

Table 1. Aerial Surveys: caribou numbers and group composition, May-August 1979.

Incl. Dates	Total Obs.		Total Classified[1]					Groups w/Calves[2]					Groups w/o Calves[3]			
	N	G	N	G	%B	%ca	%A	N	G	%B	%ca	%A	N	G	%B	%A
5/11-12	4994	82	499	82	35	24	0	357	52	17	34	0	142	30	82	0
8/25	134	44	134	44	(20)	20	54	85	18	(2)	32	58	49	26	(51)	49

[1] Excludes "unknowns" (unclassified as to sex or age).
[2] Total caribou in groups with one or more calves present.
[3] Total caribou in groups with no calves.
[4] Composition counts by helicopter.

Note: N = number of caribou, G = number of groups, B = bulls, ca = calves, A = adults; values in parentheses include only obvious adult bulls (see Cameron and Whitten 1977) and are minimum percentages.

percent calves to be a reliable approximation of caribou group composition in the general region, if not for the CAH as a whole.

Because of a combination of logistic difficulties and financial constraints, no aerial surveys were conducted during fall 1979. However, because extremely low rates of calf mortality were noted between midsummer and fall in past years (Cameron and Whitten 1979c), the same summer value of 20 percent calves was applied to fall.

Caribou Group Composition Along the TAP Corridor

The numbers and group composition of caribou observed from the haul road between May and November 1979 are given in Table 2. Mean calf percentages for late spring, summer, and fall were 6, 5, and 14 percent, respectively. Comparable spring and summer percentages determined by area-wide aerial survey were four-fold higher (Table 1). In fall, estimated differences were less extreme (14% vs. 20%) but, nonetheless, indicate that calves were present in abnormally low numbers along the Pipeline corridor even then.

Of the six haul road surveys conducted in summer 1979, one stands out as an anomaly. On 9-10 July, during a period of particularly severe insect harassment, over 2,000 caribou were observed (Table 2) as they moved rapidly northward toward the coast. This occurrence seems to conflict with most other observations along the haul road. Surveys are intended to provide data on the distribution and group composition that are "typical" of caribou occupying areas within or immediately adjacent to the corridor during a given season. Sudden and transient influxes are, therefore, inconsistent, and we have deleted these particular survey results in reporting mean summer values. Furthermore, all results of that survey, rather than only observations near the coast, were eliminated to avoid biasing the results toward inland distribution. Elimination of these data reduces the seasonal mean calf percentage only slightly, from 5 to 2 percent. Clearly, the observations in question were, in themselves, abnormal in terms of group composition. Calves comprised only 7 percent of the total caribou observed and only 16 percent of the caribou in groups with calves (Table 2). The latter observation is the lowest of such values obtained in 1979.

In previous reports we hypothesized that cow/calf avoidance is a group mechanism resulting in lower numbers of groups with calves along the corridor rather than a reduction in the proportion of cow/calf pairs in such groups (Cameron et al. 1979, Cameron and Whitten 1980a). Accordingly, deletion of the 9-10 July survey results and recalculation of the mean summer calf percentage for groups with calves yields 27 percent calves. This compares more favorably to the corresponding value of 32 percent obtained by aerial survey in

Table 2. Haul road surveys: caribou numbers and group composition, May-November 1979.

Survey dates	Total Obs.		Total Classified[1]							Groups with Calves[2]							Groups w/o Calves[3]					
	N	G	N	G	%B	%C	%Y	%ca	%A	N	G	%B	%C	%Y	%ca	%A	N	G	%B	%C	%Y	%A
5/11-14	101	22	101	22	58	18	1	12	11	34	7	9	36	1	36	18	67	15	84	9	0	7
5/29-30	119	32	119	32	87	4	9	0	0	0	0	0	0	0	0	0	119	32	87	4	9	0
		Spring Mean			74	10	5	6	5			9	36	1	36	18			86	6	5	3
6/13-14	354	80	354	80	83	3	8	1	5	4	2	0	50	0	50	0	350	78	84	3	8	5
6/28-29	342	42	342	42	67	8	2	7	16	100	4	5	33	5	27	30	242	38	88	0	1	11
7/9-10	2,113	34	2,113	34	66	7	1	7	19	1,071	3	30	16	0	16	38	1,042	31	97	0	1	2
7/25-26	440	73	440	73	93	2	1	1	3	6	3	0	50	0	50	0	434	70	95	1	1	3
8/7-8	152	99	152	99	90	4	0	3	3	8	4	0	50	0	50	0	144	95	96	1	0	3
8/25-27	52	27	52	27	79	4	2	4	11	5	1	20	40	0	40	0	47	26	85	0	2	13
		Summer Mean			73	6	2	5	14			28	18	1	18	35			93	1	2	4
9/11-12	70	18	70	18	79	9	3	9	0	16	4	13	37	13	37	0	54	14	100	0	0	0
9/24	7	3	3	2	100	0	0	0	0	0	0	0	0	0	0	0	3	2	100	0	0	0
10/11-12	131	30	131	30	29	40	8	23	0	109	19	21	43	8	28	0	22	11	68	23	9	0
10/29-30	40	6	40	6	35	30	10	20	5	30	3	20	40	13	27	0	10	3	80	0	0	20
11/26-27	274	29	246	27	34	10	4	10	42	112	7	11	23	0	29	37	134	20	45	4	6	45
		Fall Mean			40	20	6	14	20			17	36	7	29	11			64	4	4	28

[1] Excludes "unknowns" (unclassified as to sex or age).
[2] Total caribou in groups with one or more calves present.
[3] Total caribou in groups with no calves.

Note: N = number of caribou, G = number of groups, B = bulls, C = cows, Y = yearlings, ca = calves, A = adults

August (Table 1). The abnormally low calf representation in groups with calves noted on 9-10 July also suggests that, overall, these were not normal cow/calf groups but temporary associations formed by the coalescence of a few groups with calves with large numbers of nonmaternal adults under the strong stimulus of insect attack.

The combined data indicate continued avoidance of the corridor area by cows with calves (Cameron and Whitten 1980a) in 1979. During late spring and summer calf percentages observed from the haul road were substantially lower and bull percentages substantially higher than the respective values obtained by comparable aerial survey of a larger surrounding area. During fall, calf percentages observed along the road were also abnormally low relative to estimated area-wide values, although the differences were not as great.

Calf percentages have been used routinely as a basis for quantifying the degree of abnormal caribou sex and age representation within the corridor. Although it is often difficult to accurately classify adults as bulls, cows, or yearlings, the identity of calves is seldom in question. Local calf representation and, therefore, minimum numbers of cows, can be conveniently described for a given season as a ratio of the mean calf percentage observed from the haul road to that determined by aerial survey. Cameron and Whitten (1980a) reported changes in this ratio during summer and fall from 1975 through 1978. The 1979 calf ratio was added to these previous data for a 5-year summary (Fig. 1). Also shown are the corresponding changes in caribou sighting frequency along the haul road and rates of corridor crossing by caribou. For summer 1979, all three variables are shown with and without data obtained on 9-10 July.

The summer data show that, since the initial decline in 1975 and 1976, the proportion of calves in groups observed from the haul road was only about one-eighth of the estimated "expected" proportion as determined by aerial survey; the proportion of percent calves observed along the road to that area-wide was 0.15. Fall data show that after the initial abnormalities in local calf representation appeared in 1976, the proportion continued to decline through 1978. The current-year proportion of 0.70 reflects a rather striking reversal of the previous downward trend; thus, more than two-thirds of the expected calf proportion was actually observed from the haul road. This apparent recovery toward more representative caribou group composition within the corridor is an encouraging possibility, but one which remains to be confirmed as a permanent trend. That accommodation should first appear during fall is consistent with the past delay in the onset and progress of the fall avoidance response, relative to summer, and the general hypothesis that maternal cows are less sensitive to disturbance in fall (Cameron et al. 1979, Cameron and Whitten 1980a).

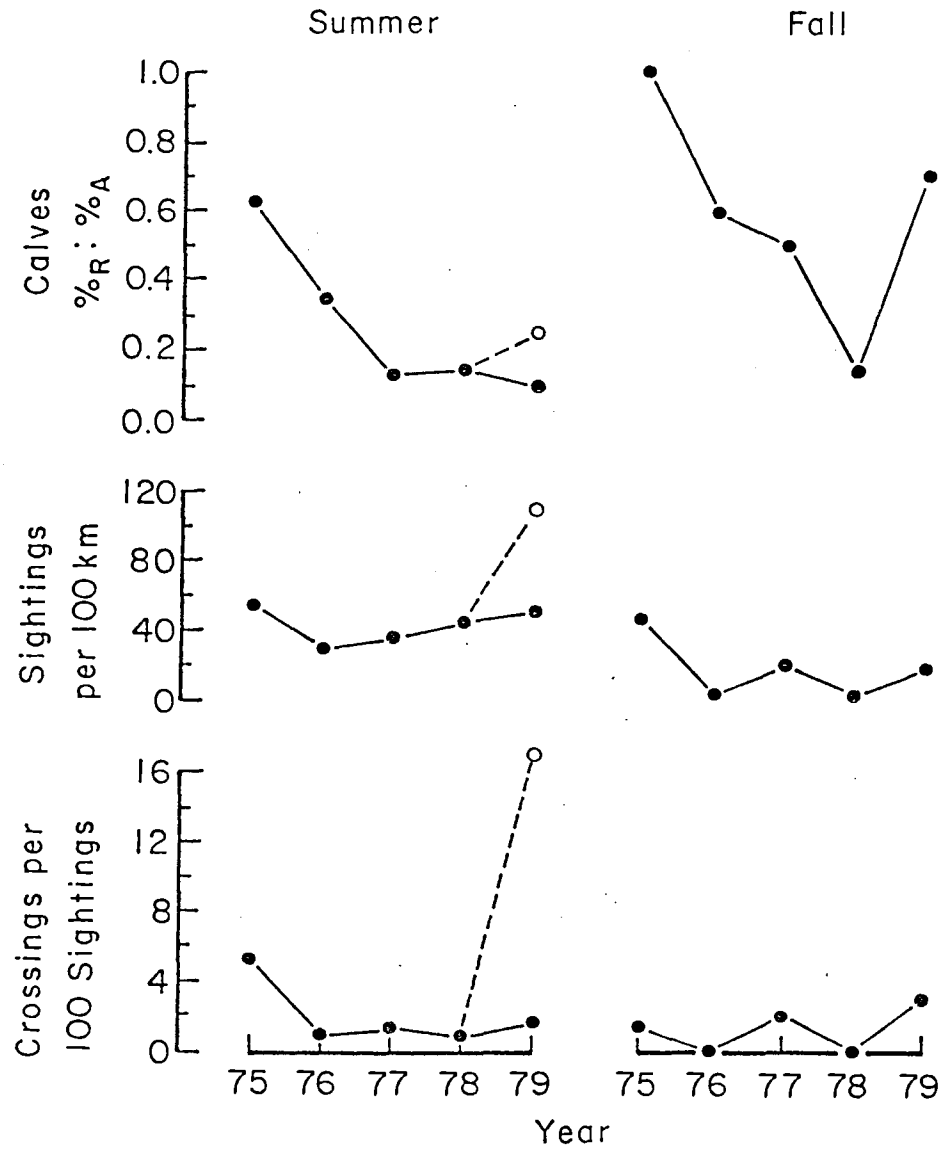

Fig. 1. Changes in relative calf representation, caribou sighting frequency, and crossing rate associated with the Trans-Alaska Pipeline Corridor, summer and fall 1975-79.

Notes: $\%_R:\%_A$ = ratio of calf percentage observed from the haul road to that determined by aerial survey. Open characters include data from road survey on 9-10 July 1979 (see text).

The frequency of caribou sightings from the haul road during summer declined initially in 1976, but has since shown a gradual increase (Fig. 1). The adjusted 1979 value was only slightly lower than that obtained in 1975 (i.e. 51 vs. 54 caribou/100 km, respectively). The unadjusted sighting rate for 1979 is double the initial 1975 value. This is an unlikely increase considering the 5-year trend, as depicted, and probable changes in herd size (see below). Sighting frequency in fall remained lower and slightly more variable than in summer, and no long-term pattern is apparent.

The highest summer rate of corridor crossings was recorded in 1975 (Fig. 1). Subsequent values, excluding the unadjusted rate for 1979, have remained at 20-30 percent of this initial estimate. Fall rates have been similarly low through 1978, but increased to a seasonal maximum in 1979. It is noteworthy that local calf representation, caribou sighting frequency, and the corridor crossing rate all increased in fall 1979.

Summer results summarized in Fig. 1 show that despite a gradual increase in sighting frequency since 1976, calf representation during the same period declined to, and then stabilized at, a low value. Assuming that general herd growth has resulted in range expansion rather than an overall increase in caribou density within the study area (Cameron and Whitten 1980a), this pattern suggests that groups with calves displaced from the Pipeline corridor are being gradually replaced by other, less sensitive groups of adults. This apparent substitution phenomenon could reflect either gradual accommodation of nonmaternal adults to existing local disturbance or a positive response of these caribou to the general decline in activity along the corridor since 1976 (Cameron and Whitten 1980a). In either case, the progressive increase in sighting frequency to near the 1975 level suggests a tendency toward regaining an "equilibrium" density of caribou along the corridor, albeit with continued abnormalities in local sex and age representation.

Patterns observed in fall are somewhat more complex. Although the summer range of the CAH is more or less fixed by the distribution of calving (Cameron and Whitten 1977, 1979b, 1980b), phenological progression of forage (Whitten and Cameron 1980) and a need for ready access to insect relief habitat along the coast (Child 1973; White et al. 1975; Cameron and Whitten 1976, 1979b, 1980b; Roby 1978), occupancy of transitional fall range and rutting areas is quite variable and probably weather-dependent. Specifically, widespread or heavy snowfall appears to be the catalyst necessary for rapid, mass movements southward toward "typical" winter range (Cameron and Whitten 1979a, Roby 1978). When such inland movements occur, caribou are removed from contact with widespread disturbance associated with the oil field environment, and respond more favorably to the lower levels

of human activity along the linear corridor to the south. Conversely, when occupancy of coastal summer range continues into or through fall and/or winter, local avoidance of the Prudhoe Complex tends to be sustained. For example, in 1975, 1976, and 1979, when local calf representation was relatively high (Fig. 1), fall movements proceeded rapidly inland and the majority of the herd overwintered in or near the foothills. In contrast, the occurrence of relatively few calves along the corridor in fall 1977 and 1978 was associated with little southward movement and considerable overwintering activity on the coastal plain. Therefore, we believe that during fall the degree of cow/calf avoidance, as well as the associated local density of caribou, is more a function of range occupancy with respect to the coast than a response to variations in the level of disturbing stimuli. This is not to say, however, that petroleum-related conflicts are necessarily less important in fall, but rather that natural environmental phenomena may be quantitatively more influential in regulating the exposure of CAH caribou to adverse stimuli.

While the 1979 summer data show some encouraging trends in overall density of caribou along the corridor, local calf representation continues to be abnormal. Similarly, since 1976 local calf occupancy during fall has remained below the estimated normal level. As discussed above, natural forces undoubtedly contribute to the observed variability; however, it seems clear as a generalization that whenever summer or fall caribou habitat is the site of intensive development, "normal" coexistence is not possible. We believe that the relative scarcity of cow/calf pairs is a reflection of that conflict. To what degree sensitivity of cows and/or calves extends into or through the winter and spring months is not known, although incomplete spring data for 1977 (Cameron and Whitten 1978) and 1979 (Table 2) suggest that local abnormalities occur prior to calving. This is consistent with Lent's (1966) findings that cows are most sensitive to unusual stimuli immediately before parturition.

Cameron and Whitten (1980a) reported indices of disturbance within the TAP corridor and Prudhoe Complex between 1975 and 1978, noting that peak activity occurred in 1975 and 1976, with a general decline thereafter. Despite continued low levels of disturbance along the corridor south of the Prudhoe Complex, local calf representation has failed to improve in response to what are presumably more favorable conditions in terms of human activity. Perhaps even existing levels of disturbance exceed the lower threshold for cow/calf avoidance or, alternatively, failure to recover might reflect a response lag following the 1975-76 peak in corridor activity. It should be recognized that future use of the haul road and development within the corridor could further delay or even preclude a reversal to normal group composition locally. Increased public access to the haul road and imminent

construction of the Alaska Highway Natural Gas Pipeline will likely sustain or intensify existing conflicts with caribou.

The progressive expansion of the oil and gas fields near Prudhoe Bay remains a matter of principal concern. Since completion of the TAP, the oil field/industrial complex has persisted as the principal source of disturbance to caribou on the Central Arctic Slope, both spatially and in terms of intensity. Our standard surveys along the haul road include a single road extension through the Complex, terminating at the coast just west of Prudhoe Bay itself (Cameron et al. 1979). In summer 1978, however, a series of ground surveys were conducted from the entire road system north of Deadhorse Airport; observed calf percentages were compared with those obtained along the corresponding standard transect. The results demonstrate clearly that group abnormalities identified by sampling along a single road through the Complex apply to the entire road system within the developing oil field. (A detailed report of these results is being prepared for publication in the Canadian Field-Naturalist.)

To date, displacement of caribou from the TAP corridor/Prudhoe Complex has not been linked to changes in productivity of the CAH, which, on the contrary, has been stable or increasing for at least the past 3 years (see below). However, with progressive industrial development related to petroleum extraction and transport, the cumulative level of activity on the Central Arctic Slope will doubtless increase. Widespread disturbance of sufficient magnitude will further displace caribou from traditional calving, summer, and, to some extent, fall ranges. Although the long-term consequences to the CAH remain conjectural, it seems clear that the tolerance exhibited by caribou to conflicting activities will be a function of the habitat options available and the intrinsic plasticity of the species in terms of its ability to cope with interruption of established tradition. (A general review of relevant data and a consideration of the nature, extent, and possible consequences of this conflict have been incorporated in a popular article submitted to ALASKA Magazine.)

Movements of Collared Caribou

Between April 1975 and May 1978, 124 CAH caribou were equipped with numbered neck collars. As of 31 December 1979, 73 (60%) have been observed within the study area one or more times, for an aggregate total of 309 resightings.

Sequential resightings indicate that 37 collared caribou have crossed the Pipeline corridor a minimum of 85 times. Of those resighted once or more from the haul road, a significantly greater proportion were collared bulls (20 of 22 bulls vs. 32 of 51 cows). In fact, road observations account for a higher percentage of all bull resightings than of cow

resightings (78% vs. 45%, respectively). Also, proportionately more bulls have crossed the corridor at least once (15 of 22 bulls vs. 22 of 51 cows), and bulls have crossed more frequently ($\bar{x}$=2.9 crossings/bull vs. 1.9 crossings/cow). However, the overall proportions of bulls and cows resighted (22 of 33 bulls collared vs. 51 of 91 cows collared) do not differ significantly, nor do total resightings per animal ($\bar{x}$=5.4 resightings/bulls vs. 3.7 resightings/cow).

There is a strong possibility that cows retain collars longer than bulls. Bull collars must fit loosely to accommodate neck swelling during rut, and, consequently, may slip off during winter months when most adult bulls remain antlerless. In contrast, cow collars may be tighter and for most adult females there is only a short period each year when absence of antlers might allow collar shedding. Most resightings of collared bulls were made within the same calendar year the animals were marked. Only three collared bulls have been sighted since 1977, the last year that appreciable numbers of bulls were marked; and two of those were male yearlings collared in 1978 and resighted the same year. No collared bulls were seen in 1979. Thus, the progressive increase in the proportion and frequency of collared cows resighted may be due to sexual differences in collar retention. Nevertheless, the data clearly show that bulls cross the corridor more frequently and are more often seen from the road system than cows. This conclusion is in general agreement with cow/calf avoidance of the corridor area, as described above.

Between 1975 and 1978, 37 CAH cows were equipped with radio-transmitter collars. An additional 13 cows were radio-collared in late spring 1979, but their subsequent movements will not be discussed in this report. Of the former, 34 were successfully tracked, 1 emigrated, and 2 are suspected of having inoperative transmitters. No deaths of radio-collared cows were documented in 1979. The sum of known losses of radio-collared caribou and those never resighted (except with the aid of tracking equipment) is 44 percent of the number originally tagged. This is the identical percentage determined for cows with numbered collars.

As of 31 December 1979 radio-collared cows collectively crossed the corridor a mean of 2.4 times each. This is higher than the same rate for cows with numbered collars (1.9), but the values are not directly comparable. Only one composition survey was conducted by helicopter during the past field season, and far fewer resightings of number-collared individuals were made away from the road system. It is from such incidental observations that most previous crossings have been inferred. (The preceding summarizes a manuscript being prepared for the Journal of Wildlife Management.)

Status of the Central Arctic Herd

Size and Productivity

A summary of the sex and age composition of CAH caribou between July 1976 and May 1980 is presented in Table 3. Initial production of calves has been excellent since 1977; over 80 calves:100 cows were observed on the calving grounds in 1978 (Cameron and Whitten 1979b) and 1979 (Cameron and Whitten 1980b). In both 1977 and 1978 calf:cow ratios decreased by late July, in part a result of neonatal mortality, but probably due also to the addition of barren cows to the post-calving groups. Increases in the calf/cow ratio between July and October for most years are likely a reflection of more accurate sex identification of adults during fall surveys. In reality, summer mortality of calves is probably quite low, as indicated by moderate decreases in the calf:cow ratio between June and October. This is perhaps the best available measure of early calf mortality (Cameron and Whitten 1978). Rates of overwinter calf survival in the CAH have been high for all cohorts since 1976, and particularly in 1978 and 1979.

Bull:cow ratios show wide variation between seasons for any given cohort year. Although possibly resulting from inaccurate classification, it is more likely a result of inconsistent sampling because of nonrandom distribution of bulls and cows within the study area. Even during rut, when individual groups of CAH caribou are well mixed sexually, the geographic distribution of bulls and cows remains skewed (Cameron and Whitten 1979a). Various attempts to stratify the study area and weight subsamples accordingly suggest that the adult sex ratio is more nearly 1:1 (unpubl. data). Only survey data obtained in fall 1978 directly support this empirical estimate, however (Table 3).

If a 1:1 adult sex ratio is assumed during spring, the adjusted calf percentages would be slightly lower than those reported in Table 3 for the 1976-78 cohorts and slightly higher for 1979. A reasonable mean for the past 3 years is 20 percent, which represents the maximum possible recruitment of yearlings into the herd. Adult mortality in the CAH has never been investigated, but is assumed to lie between 7 and 13 percent annually (Bergerud 1978). The annual herd increment equals yearling recruitment less adult mortality. Thus, at an annual recruitment rate of 20 percent since 1977, this increment would be on the order of 7-13 percent per year for the CAH.

The most accurate count of the CAH was made in July 1978 when 5,000 caribou were counted, 4,043 of which were classified. However, since the bull:cow ratio was unrealistically low (50 bulls:100 cows), and because an unknown number of cows and calves were undoubtedly missed (based on subsequent

Table 3. Summary of sex and age composition of the Central Arctic Herd, 1976-79.

Cohort	Season	Cows		Calves			Yearlings			Bulls			Total
		No.	%	No.	%	/100C	No.	%	/100C	No.	%	/100C	
1976	Post-calving (July)	572	41	247	18	43	77	6	13	493	35	86	1386
	Rut (October)	440	36	204	17	46	40	3	9	539	44	125	1223
	Spring (May)	430	48	138	16	32	--[a]	--	--	321	36	75	889
1977	Post-calving (July)	1585	41	886	23	56	227	6	14	1149	30	72	3847
	Rut (October)	198	32	127	20	64	64	10	32	239	38	121	628
	Spring (May)	198	56	80	23	40	--	--	--	73	21	37	351
1978	Calving (June)	424	44	346	36	82	166	17	39	14	1	3	964[b]
	Post-calving (July)	1831	45	997	25	54	302	7	16	913	23	50	4043
	Rut (October)	293	36	187	23	64	56	7	19	280	34	96	816
	Spring (May)	201	40	121	24	60	--	--	--	177	35	88	499
1979	Calving (June)	833	43	710	37	85	216	11	26	56	3	7	1923[b]
	Post-calving (August)	--	--	--	20[c]	--	--	--	--	--	20[c]	--	134
	Spring (April/May)	470	36	242	18	50	--	--	--	597	45	125	1309

[a] "Long" yearlings classified as adult cows or bulls in May surveys.
[b] Total includes some unclassified adults.
[c] Only calves and mature bulls were classified.

fall and spring survey data; Table 2), it is probable that the herd actually numbered about 6,000 in July 1978. Adjusting adult composition to 1 bull:cow reduces the observed calf percentage from 25 percent to about 20 percent and yields an estimated 4,800 adults in the herd. Using an annual increment of 7-13 percent, the pre-calving herd size would be between about 5,100 and 5,400 caribou in 1979, and 5,500-6,200 in 1980.

Yearling:cow ratios and yearling percentages obtained during midsummer and fall have been consistently lower than those from the previous May calf (short yearling) counts (Table 3). High mortality at or around yearling age or emigration from the study area are possible explanations, but such disparities more likely result from our inability to accurately distinguish yearlings from adults. An accurate census is necessary to determine whether suspected growth of the CAH has actually been achieved. Unfortunately, continued cool weather in mid- and late July 1979 discouraged the post-calving aggregation required for an accurate total count.

Harvest

In spite of a mandatory permit system for all caribou hunting within the range of the CAH and the Western Arctic Herd (WAH), local subsistence harvests remain totally unreported. No harvest was reported from the Nuiqsut area during the 1979-80 open season. Of 31 caribou reported taken by Anaktuvuk residents, all were from areas occupied by WAH caribou. In actuality, Nuiqsut hunters probably did take some CAH caribou, while Anaktuvuk hunters probably supplied their needs locally without traveling north or east to the CAH range. The reported sport harvest (i.e. by hunters who obtained their permits outside the range of the CAH or WAH) was 47 CAH caribou, or about 25 percent of the total reported sport harvest of the WAH and CAH combined. This probably represents an increase over previous years, since for the first time hunters were observed operating from the haul road. Although the road is closed to the general public, those having property, mining claims, or business interests along the corridor area (including guides and their clients) can obtain permits, and, once past the Yukon River checkpoint, their travel is unrestricted. There was a high rate of return (78%) among sport hunting permittees, at least during the fall season. Allowing for some unreported sport harvest and for the unreported subsistence take at Nuiqsut, the total harvest of the CAH was probably about 100 caribou, predominantly bulls. This is well below the minimum annual increment estimated for the herd.

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LITERATURE CITED

Bergerud, A. T. 1978. Caribou. Pages 83-101 *In* J. L. Schmidt and D. L. Gilbert, eds. Big Game of North America (Ecology and Management). Stackpole Books, Harrisburg, PA.

Cameron, R. D., and K. R. Whitten. 1976. First interim report on the effects of the Trans-Alaska Pipeline on caribou movements. Joint State/Federal Fish and Wildlife Advisory Team, Spec. Rep. No. 2.

_____, and _____. 1977. Second interim report on the effects of the Trans-Alaska Pipeline on caribou movements. Joint State/Federal Fish and Wildlife Advisory Team, Spec. Rep. No. 8.

_____, and _____. 1978. Third interim report on the effects of the Trans-Alaska Pipeline on caribou movements. Joint State/Federal Fish and Wildlife Advisory Team, Spec. Rep. No. 22.

_____, and _____. 1979a. Seasonal movements and sexual segregation of caribou determined by aerial survey. J. Wildl. Manage. 43:626-633.

_____, and _____. 1979b. Distribution and movements of caribou in relation to the Kuparuk Development Area. First Interim Rep. to ARCO, EXXON, and SOHIO/BP, March 1979. 32pp.

_____, and _____. 1979c. Effects of the Trans-Alaska Pipeline on caribou movements. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. W-17-10 and W-17-11. Juneau. 36pp.

_____, and _____. 1980a. Influence of the Trans-Alaska Pipeline corridor on the local distribution of caribou. Proc. Second Intl. Reindeer/Caribou Symp., Røros, Norway, 1979 (in press).

_____, and _____. 1980b. Distribution and movements of caribou in relation to the Kuparuk Development Area. Second Interim Rep. to ARCO, EXXON and SOHIO/BP, May 1980. 35pp.

_____, _____, W. T. Smith, and D. D. Roby. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Can. Field-Nat. 93:155-162.

Child, K. N. 1973. The reactions of barren-ground caribou (*Rangifer tarandus granti*) to simulated pipeline and pipeline crossing structures at Prudhoe Bay, Alaska. Completion Report, Alaska Coop. Wildl. Res. Unit, Univ. Alaska, Fairbanks.

Lent, P. C. 1966. Calving and related social behavior in the barren-ground caribou. Zeitsehrift fur Tierpsychologie 6:701-756.

Roby, D. D. 1978. Behavioral patterns of barren-ground caribou of the Central Arctic Herd adjacent to the Trans-Alaska Pipeline. M.S. thesis, Univ. Alaska, Fairbanks.

White, R. G., B. R. Thomson, T. Skogland, S. J. Person, D. E. Russell, D. F. Holleman, and J. R. Luick. 1975. Ecology of caribou at Prudhoe Bay, Alaska. *In* Ecological investigations of the tundra biome in the Prudhoe Bay region, Alaska. Biol. Pap., Univ. Alaska, Fairbanks, Spec. Rep. No. 2.

Whitten, K. R., and R. D. Cameron. 1980. Nutrient dynamics of caribou forage on Alaska's Arctic Slope. Proc. Second Intl. Reindeer/Caribou Symp., Røros, Norway, 1979 (in press).

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