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Movements of Collared Caribou, *Rangifer tarandus*, in Relation to Petroleum Development on the Arctic Slope of Alaska

KENNETH R. WHITTEN and RAYMOND D. CAMERON

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, Alaska 99701

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Between April 1975 and May 1978, 160 Caribou (*Rangifer tarandus granti*) on the Central Arctic Slope of Alaska were marked with either visual numbered collars or radio collars. Through 1979, 92% of the Caribou with radio collars were relocated repeatedly within this region. Only 59% of the Caribou with visual collars were relocated, but comparable data on radio-collared Caribou suggest that most of the unobserved number-collared individuals remained in the study area. Resighting patterns corroborate the existence of a distinct Central Arctic Caribou Herd. A significantly higher proportion of collared bulls than of collared cows was observed from the road system associated with the Trans-Alaska Pipeline and Prudhoe Bay Industrial Area. Bulls were also resighted more frequently from the road system, and they crossed through the road corridor more often; in contrast, bull and cow resighting patterns in off-road areas were not significantly different. Thus, the cow/calf segment of the herd appeared to avoid disturbed areas more so than did bulls. The heavily developed Prudhoe Oilfield was an effective barrier to both bulls and cows.

Key Words: Caribou, *Rangifer tarandus*, collared, movements, petroleum, development, disturbance.

Construction of the Trans-Alaska Pipeline (TAP) and development of oil reserves near Prudhoe Bay focused considerable attention on the possible disruption of Caribou movements and range use patterns. Results of systematic aerial surveys conducted since 1975 have shown that this region of the Arctic Slope is inhabited by a distinct Caribou subpopulation, the Central Arctic Herd (CAH) (Cameron and Whitten 1979, 1980). Seasonal movements of the CAH are principally north-south between winter range in the northern foothills of the Brooks Range and summer/calving range on the coastal plain along the Arctic Ocean. In addition, east-west movements along the Arctic coast occur during midsummer. Surveys conducted along the Dalton Highway (previously known as the TAP haul road) through 1980 indicate that abnormally few cow-calf pairs occupy habitats within or near the Pipeline Corridor and Prudhoe Bay Industrial Area (PBA), particularly during summer (Cameron et al. 1979; Cameron and Whitten 1980, unpublished).

In 1975 a complementary collaring program was undertaken to examine, in greater detail, the population characteristics of Caribou in the Central Arctic region and to assess any disturbance-related deviations in seasonal distribution and movements. This

report deals with pertinent data gathered from collared Caribou between 1975 and 1979.

Study Area and Methods

The study area is on the Central Arctic Slope between the Canning and Itkillik rivers. The TAP Corridor is oriented north-south, roughly bisecting the study area, and the PBA lies near the Arctic coast at the origin of the TAP. Physiography and floristics of this region have been described by Spetzman (1959) and by Whitten and Cameron (1980).

Between April 1975 and May 1978, 160 Caribou were equipped with either visual or radio-transmitter collars (Table 1). Caribou were located opportunistically, generally within 20 km of the Corridor, and darted from a helicopter with Cap-Chur equipment. Anectine (Succinyl-choline chloride) was used to immobilize Caribou in 1975, and a combination of M99 (Etorphine hydrochloride) and Rompun (Diazepam) was used from 1976 through 1978; in the latter case the antagonist M50-50 (Diprenorphine hydrochloride) was administered to effect recovery. Visual collars consisted of red or blue background material with conspicuous yellow numbers on the top and sides. Radio-transmitter collars (Oceans Applied Research, San Diego, CA) used in 1975 were not

TABLE 1. Schedule of collar placement on CAH Caribou.

Date	Radio Collars	Visual Collars
April 1975	5F	10F, 10M
October 1975	4F	4F, 3M
April 1976	7F	44F, 3M
April-May 1977	12F	20F, 13M
May 1978	8F	13F, 4M
Totals	36F	91F, 33M

F = female, M = males

numbered, but some were color coded. All other radio collars (AVM Instrument Co., Champaign, IL) were attached to standard visual collars.

Caribou with visual collars were sighted incidental to routine ground surveys along the Dalton Highway (Cameron et al. 1979) and aerial surveys of the entire study area (Cameron and Whitten 1979), as well as during unscheduled trips and flights; no special effort was made to relocate any individual. Radio-collared Caribou were located on an opportunistic basis during most survey flights and were also specifically tracked from fixed-wing aircraft in November and February/ March, and at approximately 10-day intervals between April and October each year. Crossings of the TAP Corridor were occasionally witnessed but were more often inferred from consecutive resightings.

Because sampling effort was presumed to be the same for all visual-collared individuals, any observed differences in resighting patterns between visual-collared bulls and cows and/or between road and off-road areas should reflect corresponding differences in distribution. Chi-square contingency analysis was used to test differences in the proportions of bulls and cows resighted. Mean rates of resighting and Corridor crossings were compared through Student's *t*-test, with the activities of individual Caribou serving as the sample unit. Significance was evaluated at the 95% confidence level.

Results and Discussion

Herd Identity

Transmitters used in 1975 functioned less than eight months, but all Caribou radio-collared that year were subsequently accounted for by known mortality, recollaring, or visual sightings. All but three radio transmitters used after 1975 were still operating in 1979. Of the 36 Caribou equipped with radio transmitters, one emigrated from the study area, two were not relocated, and 11 were never seen without the aid of radio-tracking equipment. Thus, only 22 (61%) of the radio-collared Caribou would have been resighted had they worn only visual collars, even though at least 33 (92%) were present in the study area.

Seventy-three of the 124 Caribou with visual collars (59%), including 22 of 33 males and 51 of 91 females, were observed at least once within the study area. These figures are similar to the proportion of radio-collared Caribou that would have been resighted without the aid of radio-tracking equipment. At least six different visual-collared female Caribou were later observed in either the Porcupine or Western Arctic Caribou Herds. Based on the radio collar findings, however, it is likely that most of the unobserved visual-collared Caribou remained in the Central Arctic area.

High rates of resighting of both radio- and visual-collared Caribou within the study area provide evidence for the discreteness of the CAH. At least 59%, and probably more than 90%, of the Caribou marked in the Central Arctic area remained within that area over a 4-5 year period. Demographic data, including population size, recruitment, mortality, and seasonal movements also indicate that the Central Arctic Herd behaves as a discrete unit (Cameron and Whitten 1979; Whitten and Cameron 1983). The few cases of known emigration of CAH Caribou support the contention that, while Alaskan Caribou occur in separate herds, interchange is sufficiently frequent that all Caribou in the state constitute a single breeding population (Skoog 1968). To our knowledge, this is the first fully documented report of inter-herd movements in Alaska.

Caribou Occupancy of the Tap Corridor and PBA

Based on the tendency for female Caribou and their calves to avoid the PBA and TAP Corridor (Cameron et al. 1979, Cameron and Whitten 1980), one might expect differences in the resighting patterns for collared cows and bulls observed from the TAP haul road. In fact, the proportions of visual-collared bulls and cows resighted at least once during surveys conducted from the road were significantly different (61% of the males and 35% of the females), while the proportions resighted during aerial surveys away from the road (39% of the males and 51% of the females) did not differ significantly.

The mean number of resightings per visual-collared bull (3.6) and cow (2.0) did not differ significantly. However, this comparison may be misleading, since cows apparently retained collars longer than did bulls. Most resightings of collared bulls occurred within the first calendar year, but cows were frequently seen two or three years after collaring (Table 2). Collars were attached loosely to bulls to accommodate neck swelling during rut and, consequently, may have slipped off during winter months when most adult bulls would have been antlerless. Overwinter loss of radio collars by bulls has been observed in other Alaskan Caribou

TABLE 2. Relationship of last resighting to date of collaring for visual-collared Caribou.

Cohort	Year Collared	Last resighting (years past collaring date)				
		<1	1	2	3	4
Males	1975	2	4	3	0	0
	1976	1	0	0	0	
	1977	9	1	0		
	1978	2	0			
		64%	23%	14%	0%	0%
Females	1975	2	1	1	3	1
	1976	5	6	7	5	
	1977	8	4	3		
	1978	4	2			
		37%	25%	21%	15%	2%

¹Percentage of last resightings occurring in year group.

(J. Davis and P. Valkenburg, personal communication). In contrast, collars on cows were tightly secured and were less likely to be lost during the antlerless period each summer.

Considering only Caribou that were resighted, and assuming collar retention only until last date seen, the resighting rates per unit time were significantly higher for bulls than for cows ($X = 11.9$ resightings/year per individual bull vs. $X = 4.1$ resightings/year per individual cow). When these adjusted resighting rates were subdivided into observations adjacent to and away from the road, the rate for bulls along the road was significantly higher than that for cows ($X = 9.6$ resightings/year vs. $X = 2.4$ resightings/year), while the rates away from the road did not differ significantly ($X = 5.3$ resightings/year vs. $X = 3.0$ resightings/year). Clearly, a higher proportion of the collared bulls was resighted from the road system, and those resighted along the road were seen more often than were the collared cows. Away from the road system there were no significant differences in bull and cow resighting patterns. These data are consistent with previous reports of cow/calf avoidance of the Corridor (Cameron et al. 1979; Cameron and Whitten 1980).

Crossings of the TAP Corridor

Crossings of the TAP Corridor also reflect differential use of the area by bulls and cows. A significantly higher proportion of visual-collared bulls than cows crossed the corridor (68% of all bulls resighted vs. 41% of all cows resighted). Among the visual-collared Caribou resighted, bulls also crossed more frequently ($X = 6.3$ crossings/year) than did cows ($X = 2.1$ crossings/year). However, recognizable bull groups were often observed on successive trips along the haul road,

while individual cow groups were rarely seen more than once. Repeated crossings by collared bulls in such "resident" groups inflate the mean crossing rate for bulls and may not be an accurate reflection of annual crossing activity (i.e., seasonal migrations across the Corridor). Nevertheless, these data indicate greater use of the area by bulls. Unfortunately, baseline data are insufficient to determine if recent crossing patterns differ from those before road and pipeline placement. A comparison of seasonal movements by radio-collared cows and bulls, disregarding observations from the road, is required to determine if bulls actually do cross the Corridor more readily than cows.

Caribou Movements in Relation to the PBA

Midsummer movements of large post-calving aggregations of CAH Caribou have frequently included a gradual eastward drift along the Arctic coast during July, followed by a rapid westward movement and inland dispersal in early August (Roseneau et al. 1974; Roseneau and Stern 1974; Cameron and Whitten, unpublished observations). In the early 1970's such movements extended through the PBA (R. White, personal communication). Since 1975, however, no collared Caribou have been observed to move through the PBA during midsummer. On several occasions, large post-calving groups including both radio- and visual-collared Caribou have approached the oilfield complex from both the east and west but have fragmented and dispersed; only individuals or small groups (mostly adult males) actually entered the field.

Conclusions

Resightings of collared Caribou support the existence of a distinct Central Arctic Herd. The data also substantiate previous evidence that female Caribou avoid areas of petroleum-related activity within their range; bulls appear to be far less sensitive. Although reduced occupancy of the TAP Corridor by cows and calves suggests a concomitant decrease in crossing success, further study is required to determine if the Pipeline and/or haul road constitute a serious impediment to seasonal movements of Caribou. Nonetheless, the Prudhoe Bay Oilfield does appear to disrupt midsummer movements of CAH Caribou.

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