Responses of West Greenland caribou to the approach of humans on foot

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Responses to the approach of a human were studied in two caribou populations (Akia and Isortoq) in West Greenland during calving, summer and after the hunt in 1997-98. For each group encountered the distance between the approaching person and the caribou at their first sign of fright ("fright threshold distance"), the distance between the person and the caribou when they began to move away ("flight threshold distance"), and the distance the caribou ran ("run distance") were measured with a laser range finder. Generally, groups of caribou had longer fright threshold, flight threshold and run distances, indicating more vigilance than single individuals. Groups with calves were more vigilant than female and male groups, while there was no difference between female and male groups. This pattern was most clear in the Akia population. The frequency of curiosity behaviour indicated that the Akia caribou were less vigilant than the Isortoq caribou after the hunting, while there was no locational difference during the other seasons. Caribou in Akia were most vigilant during calving, whereas in the Isortoq population the highest vigilance was found after hunting. Hunting seemed to have heightened awareness in the Isortoq population. It is concluded that flight and fright reactions of Greenland caribou are similar to those found among other caribou populations, and that precautions should be taken to minimize disturbing caribou during calving.

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Greenland's caribou/reindeer populations are either wild caribou (*Rangifer tarandus groenlandicus*), domestic reindeer (*R. t. tarandus*) or feral reindeer (*R. t. tarandus*). Caribou are found in the ice-free region of western Greenland where they have lived for centuries without natural predators like wolf, wolverine and bear. Today, most of these populations still live in areas with little human disturbance and without predators. But during recent years human activities, including tourism and mineral exploration, have increased in Greenland's formerly pristine areas. Quota-based hunting is permitted during a one month period from mid-August to mid-September. Hunters usually travel to the general areas by boat and then hike inland to hunt. Hunting close to the coast is preferred as the meat has to be carried out. Remote inland areas are more or less protected from hunting as hunters normally do not travel far from coastal areas. Mineral exploration activities in caribou calving areas during calving require approval by the Bureau of Minerals and Petroleum. Tourism is not regulated.

Bøving & Post (1997) found that caribou in Kangerlussuaq, Greenland, were less vigilant than caribou in Alaska and suggested that this was an adaptation to the absence of large natural predators. Klein (1980) claimed that habituation to humans would occur more readily in populations that were not hunted and lived in areas lacking natural predators. Greenland caribou could thus be expected to be only slightly affected by disturbances. The present study investigated the reactions of caribou/reindeer to an approaching human to elucidate the behaviour of caribou in areas relatively undisturbed by man and natural pre-

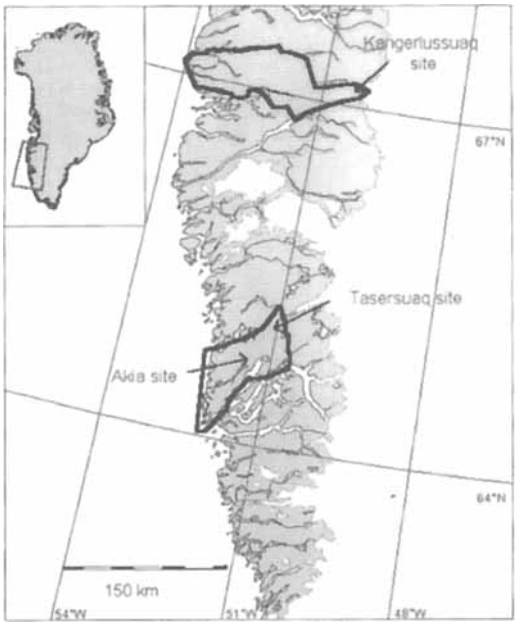

Fig. 1. Study sites (indicated by arrows) and range of the Isortoq population to the north and the Akia population to the south.

dators and to provide the background data for assessing possible effects on caribou if mineral activities in calving areas are approved.

Study areas

Study locations and ranges of herds studied are shown on Fig. 1. Studies were performed within an area of approximately 100 km^2 at each study location. Although natural large predators are not present in the two study sites, sporadic predation of calves by foxes and ravens may occur.

Akia and Tasersuaq are situated in the ranges of the Akia population (Thing & Falk 1990). Akia has a rich cover of lichens, while almost no lichens are found Tasersuaq, in the north-eastern part of this study area. The topography is moderately hilly, with relatively short viewing distances. Tasersuaq lies within the calving areas while it is assumed that only sporadic calving occurs in Akia (Cuyler & Linnell, unpubl. data). Both Akia and Tasersuaq are rarely visited by humans apart from a few hunters in August and September. Though traditional hunting has occurred in the area for centuries, the pressure is low.

Table 1. Population and season of observations.

	Akia pop.	Isortoq pop.	Total
Calving	48	25	73
Summer	20	61	81
After hunt	34	61	95
Total	102	147	249

The Kangerlussuaq study site, north of Akia and Tasersuaq, includes slopes covered with either dwarf shrubs like *Betula nana*, *Salix glauca* and *Vaccinium uliginosum* or with graminoids like *Kobresia myosuroides*. Between the slopes there are vast plains with grassland, fens and bogs. Kangerlussuaq is the traditional calving area of the Isortoq population (Thing 1984). The study area lies within 10 to 15 km from the international airport in Kangerlussuaq and helicopters often pass the area. The study area was a caribou reserve from 1967 to 1995; hunting has been permitted since 1996. Though hunting pressure is low here, it is higher than in the southern study area. The number of caribou killed at the Kangerlussuaq study site is about double the number killed at the Akia study site (Hangaard, pers. comm.). Moreover, Kangerlussuaq is visited in summer by hikers: in this area caribou encounter humans relatively frequently.

Methods

Studies were performed 1) during calving in early June 1997, 2) in late July and early August 1997, and 3) after the hunting season in late September 1998 (Table 1). Caribou groups were approached on foot. Approach to the group was initiated by slowly walking in a straight line towards it until flight actually took place. When caribou are first disturbed they show signs of awareness and fright by raising their heads, raising their tails and jumping (de Vos 1960). The initial flight is often followed by curiosity behaviour, where the disturbed animal circles around the intruder to catch the scent. During calving care was taken to avoid provoking panic reactions. Stops were made for each distance measurement. Distances were measured by a laser range finder (Leica 7 × 42 BDA, Geovid).

Parameters recorded during each encounter with caribou in the study are summarized in Table 2.

Table 2. Data recorded at each encounter with caribou during the study.

Parameter	Description/remarks
Date and time	
Temperature	All study periods were characterized by relatively stable weather conditions.
Insect harassment	Subjectively judged as none, low, or high based on observations of behaviour associated with avoidance of insects such as mosquitoes, oestrid flies and nostril flies.
Wind direction	Recorded as: none; blowing against the sides of the animals; blowing from the caribou to the observer; or blowing from the observer to the caribou.
Wind speed	Recorded as 0, light-brisk, or brisk.
Distance	The distance from observer to the group was recorded from first observation.
Vegetation type	Recorded as one of the following: dwarf shrub heath without lichens, fell field, golf green, grassland, lichen heath, snow patch and snow.
Topography	Recorded as flat, hilly or sloping.
Group size	The total number of individuals. Groups were categorized as follows: one individual = single; 2–15 individuals = small; 16–25 individuals = large; and >25 individuals = extra large. Data treatment was performed for two categories: single individuals and groups of two or more.
Group type	Recorded as "calf" if there were one or more calves in it, as "female" if it included adult females but no calves, and as "male" if there were only males in the group.
Sighting distance	Distance where one or more caribou became aware of the researcher either by sight or smell; often identical with the fright threshold distance and in some cases also with the flight threshold distance.
Fright threshold distance	Distance between caribou and approaching researcher where one or more individuals showed the first sign of fright.
Flight threshold distance	Distance between the researcher and the group when all individuals ran away.
Run distance	Distance from the point where one or more individuals took flight to where the group stopped and took up another activity; often difficult to measure as the groups often disappeared behind hills.
Run direction	Recorded as directly away from the researcher relative to his direction of approach, sideways relative to the direction of researcher's approach, or closer to researcher.
Curiosity distance	Distance covered by caribou exhibiting curiosity behaviour; the closest approach was also recorded.

These parameters included: "sighting distance", the distance between an approaching person and the caribou when the animals first showed signs of being aware of the researcher; "fright threshold distance," the distance between the approaching person and the caribou at their first sign of fright; "flight threshold distance", the distance between the researcher and the caribou when they began to move off; "run distance", the distance the caribou ran; and "curiosity distance", the distance covered by animals exhibiting curiosity behaviour.

Prior to statistical analysis of the data, a Shapiro-Wilk test was performed to test for normal distribution. The test indicated that distance data should be logarithmically transformed to achieve normal distribution and variance homogeneity. Each of the variables of fright threshold distance, flight threshold distance and run distance were analysed in one model by a GLM procedure (SAS 1989) for the effects of the following parameters: season, locality, group type, group size, wind direction, insect harassment, vegetation type, topography and interactions. Parameters with insignificant effects were removed from the model and the model was run again. It could be expected that the parameter locality would be auto-correlated with vegetation type and topography. Therefore the model was run initially without locality. Neither vegetation type nor topography had significant effects. These parameters were then removed and substituted with locality which had significant effects in some cases, indicating that locality was an important factor which could be related to differences in behaviour among caribou from the two localities. Means were compared by a Bonferroni means test and least square means, and 95% confidence levels were computed.

Results

Sighting distance: Group size and locality were significantly correlated with the distance at which caribou became aware of the approaching person (Table 3). Groups became aware of the researcher earlier than solitary individuals. In the Isortoq population, caribou became aware of the researcher earlier than those in the Akia population.

Table 3. Sight distance for group types and localities.

	Mean	Upper 95% confidence limit	Lower 95% confidence limit	Significance
Group	188.7	169.9	207.5	0.0001
Single	132.3	108.2	156.3	
Isortoq pop.	190.0	169.3	210.7	0.0139
Nuuk	156.4	132.5	180.4	

Table 4. Flight threshold distances for single individuals/groups and for populations.

	Mean	Upper 95% confidence limit	Lower 95% confidence limit	Significance
Group	145.6	159.9	132.6	0.0001
Single	93.4	111.3	78.3	
Isortoq pop.	129.5	147.0	114.0	0.0108
Akia pop.	103.6	118.4	90.6	

Fright threshold distance: Both season ($p = 0.0389$) and group size ($p = 0.0005$) had significant effects on the fright threshold distance and there was significant interaction between season and group size ($p = 0.0074$) (Fig. 2). Generally fright threshold distance was shortest for single individuals. There was no clear pattern in relation to season.

Flight threshold distance: Both group size and locality had significant effects on flight distance (Table 4). Flight distances were shortest for single individuals in the Akia area.

Run distance: The effect of group size on run distance was tested for several group size categories. Only the distinction between singles and groups had significant effects. The analysis was then concentrated on these two categories. Group size and season had significant effects on the run distance (Table 5). Solitary individuals ran significantly shorter distances than groups. Run distance was significantly longer during calving than in summer and following hunting.

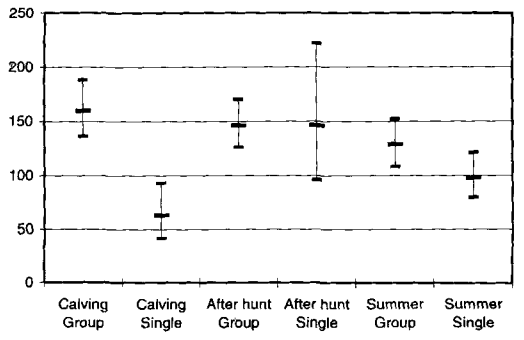

Fig. 2. Fright threshold distance (m) for seasons and for single individuals and groups (both sexes and populations). 95% confidence intervals are indicated.

Curiosity behaviour: None of the recorded parameters had a significant effect on the curiosity distance, which was on average 142.6 m (105 observations; lower and upper 95% confidence limits 128.5 m and 156.7 m, respectively). Significant differences between localities (Table 6) were found after hunting ($p = 0.0482$) where relatively fewer caribou in the Akia population were curious than in Kangerlussuaq. Differences between male and female groups were not significant. In Akia, calf groups exhibited curiosity behaviour significantly less frequently than both female ($p < 0.003$) and male groups ($p < 0.036$) while in Kangerlussuaq only the difference between calf and male groups ($p < 0.052$) was significant.

Comparison between seasons (Table 7) showed that in the Akia population there were significantly fewer curiosity events during calving than in summer ($p = 0.0089$). The proportion of curiosity events was also smaller during calving than after hunting although this was not significant. In the Isortoq population there were significantly fewer curiosity events after hunting than in summer

Table 5. Run distances for various seasons and group sizes.

	Mean	Upper 95% confidence limit	Lower 95% confidence limit	Significance
Calving	146.6	186.8	115.1	
Summer	92.0	114.5	73.9	0.0049
After hunt	98.4	125.9	76.8	
Single	93.0	124.6	69.4	0.0134
Group	129.9	148.7	113.4	

($p < 0.0107$). There were also fewer curiosity events in this population after hunting than during calving, but the difference was not statistically significant.

Immediate response: With the exception of male groups in the Akia population, about 90% of encounters resulted in an immediate response: the individual responded by fright or flight as soon as it discovered the intruder, i.e. sighting distance equalled flight/fright threshold distance (Table 8). Male groups in the Akia population responded immediately in only 57% of the encounters. This is significantly different than the other group types in the Akia population ($p < 0.049$).

Other parameters: No significant effects on fright threshold and flight threshold distances were recorded for vegetation, topography, wind direction, wind speed and level of insect harassment.

Summing up

- Generally, groups of caribou had longer fright threshold, flight threshold and run distances – indicating greater vigilance – than solitary animals.
- Groups with calves were generally more vigilant than female and male groups, while there was no difference between female and male groups. This pattern was most clear in the Akia population.
- The frequency of curiosity behaviour indicated that caribou were less vigilant in the Akia population than in the Isortoq population after the hunting, while there were no locational differences during the other seasons.
- Caribou in the Akia population are most vigilant during calving, while in the Isortoq population the highest vigilance was found after hunting.

Table 6. Frequency of curiosity behaviour in relation to group type and population.

	Calf	Female	Male
Isortoq pop.	32.2	47.1	54.5
Akia pop.	29.4	68.0	54.1

Discussion

Greenland is still a relatively pristine environment, largely undisturbed by human activities and lacking natural large predators. It was expected that under these circumstances differences would be detectable in the reactions of Greenland caribou compared with caribou elsewhere. Bøving & Post (1997) reported that Greenland caribou displayed less vigilance during feeding and adopted a vigilant posture less often than caribou in Alaska. They postulated that this was an adaptation to the absence of natural predators. In the study reported upon here, caribou showed weak responses to mild provocations but in almost all cases a reaction was elicited. Curiosity behaviour was seen in nearly 70% of the encounters, flight threshold distances were about 95 m, and mean run distances were between about 95 m and 145 m.

Table 7. Frequency of curiosity behaviour expressed as a percentage of encounters, in relation to season and locality. In the Akia population the proportion of curiosity events was significantly lower ($p < 0.0089$) during calving than in summer. In the Isortoq population the proportion of curiosity events was significantly lower ($p < 0.0107$) during after hunt than in summer. Comparisons between localities gave significantly different proportions after hunting, where the proportion was lowest in the Isortoq population ($p < 0.0482$).

	Calving	Summer	After hunt
Isortoq pop.	32.0	52.5	26.2
Akia pop.	35.4	64.7	50.0

Table 8. Percentage of immediate responses (when the caribou responded with fright or flight at the same distance as they discovered the intruder), broken down by population and group type.

	Calf	Female	Male
Isortoq pop.	89	88	82
Akia pop.	91	88	57*

*Statistically significant result.

Among reindeer in southern Norway, Eftestøl (1998) found flight threshold distances between 110 m and 190 m, and run distances from ca. 200 m to almost 500 m – both greater than we observed in Greenland. In Svalbard fright threshold distances varied between approximately 100 m and 160 m, flight threshold distances between about 50 m and 140 m, and run distances from about 80 m to more than 300 m (Colman & Jacobsen 1996). Generally, Greenland caribou fright reactions were similar to Svalbard reindeer. This probably reflects the similar histories of the two populations, both having existed for an extended period without large predators and with little hunting (see also Klein 1980).

In this study, the highest vigilance levels – as gauged by fright threshold, flight threshold and run distances – occurred in groups with calves during calving and post-calving. In Canada's barren-grounds de Vos (1960) made similar observations. Vigilance during calving is probably inherent in caribou and serves to protect calves from predators (de Vos 1960; Bergerud 1974; Dau & Cameron 1986). On the other hand, expenditures of energy should be minimized when caribou are nutritiously stressed following winter and when females are rearing calves. In an area without large natural predators, as in Greenland, there is currently no obvious advantage in running long distances during any period. It could, however, be an adaptation to avoid hunters.

Caribou that are heavily hunted and/or preyed upon by natural predators can be expected to show high vigilance, while caribou not hunted or preyed upon would be expected to show mild reactions and low levels of vigilance (see Reimers & Kolle 1988). This study found that immediately following hunting, response to approaching humans was similar to that at calving time. Indeed, in the Isortoq population vigilance was even higher just after hunting than during calving. (It is also possible that the behaviour of caribou in this post-hunting period is influenced by the approaching rutting period.)

Of the animals in the two study areas, caribou from the Akia population exhibited less curiosity (and had shorter flight threshold distances) when confronted by the approaching researcher. In the Akia population curiosity was lowest in groups with calves and during calving. The curiosity rate increased in summer and decreased slightly after hunting. The small size of the decrease can be accounted for by the low level of hunting in this area, which is difficult to reach from the coast.

In the Isortoq population, where curiosity was higher than in the Akia population, curiosity levels were similar during calving and during summer but after the hunt the curiosity rate fell below the level during calving. This can be interpreted as an adaptation to hunting by humans. However, this lesson seems to be short-lived, as the curiosity rate increased during summer.

Environmental regulation of activities in calving areas during calving

This study has provided: 1) documentation that Greenland caribou normally respond by fright or flight when approached by humans and behave much like caribou in e.g. Norway and Svalbard; 2) support for the assumption that caribou in Greenland are more sensitive during calving than in summer and to some degree also after hunting; and 3) documentation that the effect of disturbance, measured as frequency and strength of energy consuming reactions, is greater during calving than in summer and in autumn after hunting.

Negative impacts on caribou of disturbances include reduced feeding and resting time, avoidance of sites of disturbance, increased risk of detection by predators and injuries related to severe harassment. Bradshaw et al. (1997) suggested for woodland caribou in Alberta that increased movement may result in higher energy expenditure during winter and that disturbed caribou may switch habitat type for cover or escape terrain. They recommended limiting total disturbance during winter instead of restricting timing of industrial activity as a mitigating procedure.

Calving areas may merit particular care. Caribou usually calve in more or less well-defined calving grounds (Miller & Broughton 1973). These calving grounds have long been considered critical habitats for large migratory caribou herds

in North America (Kelsall 1968; Thomas 1969; Klein 1991; McCabe 1994). The International Porcupine Caribou Board (1995) ranked calving grounds highest among sensitive habitats for the Porcupine Herd in Alaska and Yukon.

In Greenland, high fidelity to specific calving grounds has been documented for four herds: one with calving grounds north-east of Kangerlussuaq (Thing 1984); one south of the Ameralik Fiord, which is south of Nuuk (Aastrup 1986); one north of Lake Tasersuaq, which is north of the Nuuk Fiord (Cuyler & Linnell, unpubl. data; Aastrup, unpubl. data.); and one in the area of Nassuttuup Nunaa (Aastrup, unpubl. data). Calving also occurs in the Qorqut area in the ranges of the former domestic reindeer herd in Itinnera and among the domestic reindeer in Isortoq in southern Greenland (Lund et al.). Calving may occur in other localities as well, some of which may be important.

Environmental guidelines (GBP 1998) for mineral exploration in Greenland stipulate that mineral activities in calving grounds during calving require approval by the Greenland Bureau of Minerals and Petroleum (GBP) while tourism and other kinds of public access to the calving grounds is not regulated. Although not spelled out in the regulations, the reason for protecting calving caribou is the risk of negative effects on calf survival via harassment induced injuries, decreased time for food intake, increased time of energy consumptive activities, and displacement from optimal foraging areas. As confirmed by the present study, it was assumed that groups with calves were more sensitive to disturbance than other groups and they were most sensitive to disturbance during calving.

This study indicated that a single encounter between a human and a group of caribou seems to have little lasting impact. There is little doubt, however, that very close contact such as close photographic efforts or helicopter landings would impose a high risk of injuries to newborn calves. And it must be noted that even minor disturbances – if repeated often enough – may affect feeding time and energy balance negatively, and may displace animals from optimal foraging areas (Cameron et al. 1992). It seems probable that small-scale activities with one or two persons moving around in the area without intent to disturb the caribou will have a minimal effect, but activities on a larger scale – with much traffic and use of all terrain vehicles – could cause displacement of caribou to less optimal sites and/or result in competition for food resources.

In the future, special attention should be paid to caribou calving grounds in Greenland, with continued emphasis on the requirement of approval of all mineral exploration and development activities during calving time.

Acknowledgements. – I wish to thank Jonathan Colman and Sindre Eftestøl for inspiration and willingness to help during the initial phase of the study. Josephine Nymand and Christine Cuyler are thanked for good companionship in the field. Two anonymous reviewers are thanked for valuable comments and suggestions. The study was funded by the Danish Environmental Protection Agency.

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