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Authors: Colman, Jonathan E., Jacobsen, Bente W., and Reimers, Eigil

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Summer response distances of Svalbard reindeer *Rangifer tarandus platyrhynchus* to provocation by humans on foot

Jonathan E. Colman, Bente W. Jacobsen & Eigil Reimers

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The objective of our study was to examine response distances of Svalbard reindeer *Rangifer tarandus platyrhynchus* to direct provocation by humans on foot during summer in areas subject to combinations of high or low human activity, and hunting or no hunting. We hypothesised that Svalbard reindeer can become habituated to human activity even when hunted. Reindeer sight, fright, flight and running response distances were measured in response to direct provocation by humans on foot in five areas chosen for their degree of human activity and hunting. No differences in sight distance were found among the five areas. Reindeer in the area with the most human activity in summer and no hunting (Adventdalen) had shorter fright, flight and running distances than reindeer in the area with little human activity and no hunting (Reinsdyrflya). Reindeer response distances in the three areas with hunting and moderate human activity were similar and intermediate to areas with high and low human activity and no hunting There were significant negative correlations between the fright, flight and running distances and the amount of human activity in an area, and with the exception of running distance having a borderline significant value, there were no correlations with intensity of hunting. Our findings suggest that Svalbard reindeer become habituated to human activity and that hunting probably has only a weak or even no influence on it. Furthermore, these findings do not lend support to the hypothesis that reindeer that are hunted by humans are less likely to habituate to human activity than those that are not hunted.

Key words: behaviour, fright distances, habituation, human disturbance, hunting, Rangifer tarandus platyrhynchus, tourism

Jonathan E. Colman, Bente W. Jacobsen & Eigil Reimers, Department of Biology, University of Oslo, P.O. Box 1050, Blindern, N-0316 Oslo, Norway - e-mail: j.e.colman@bio.uio.no

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The arctic barren islands of Svalbard are inhabited by the world's northernmost population of *Rangifer*. When and from where they arrived is unknown. When Norway was assigned sovereignty of the Svalbard islands in 1925, the reindeer *Rangifer tarandus platyrhynchus* were close to extinction due to overharvesting (Wollebæk 1926). Protection from the same year led to a population increase to its present size fluctuating around 10,000 animals (Tyler 1993). None of their natural predators, parasitising insects or grazing competitors have established themselves in these high Arctic islands. Neither do Svalbard reindeer exhibit the nervous, always moving herd behaviour typically displayed by reindeer and caribou *Rangifer caribou* where predators and insects are present (Kastnes 1979, Reimers 1980).

Tourism and industrial activities in remote areas are

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steadily increasing, especially in northern and arctic areas. Tourism and human development on Svalbard has increased dramatically the last 10 years and it is forecasted to continue to increase substantially, especially in the areas with hunting (Kaltenborn 1991, Bjerga 1994, Kaltenborn 1994). The unique experience of viewing Svalbard reindeer often attracts visitors to the island. Visitors deliberately approach reindeer for better viewing or for the purpose of obtaining pictures, and they disturb reindeer which interrupt feeding and/or flee (Bjerga 1994, Governor of Svalbard and R. Hindrum, pers. comm., J.E. Colman, pers. obs.). Disturbances from humans on foot are claimed to elicit stronger fright reactions for Svalbard reindeer than motorised transportation (Tyler 1991, Bjerga 1994, Direktoratet for naturforvaltning 1994). Minimising time spent on avoidance activities and maximising time spent on energy acquisition (Reimers 1980) during summer allows Svalbard reindeer to store large fat reserves that promote survival through the harsh, Arctic winters and springs (Reimers & Ringberg 1983). Human disturbance from increasing summer tourism and fall hunting may negatively influence accumulation of body fat reserves and winter survival unless reindeer become habituated to humans. We investigated the behavioural response of hunted and non-hunted Svalbard reindeer towards humans on foot in areas that differ in their amounts of hunting and tourism.

Hunting is claimed to shape fright behaviour of ungulates towards humans (Dorrance, Savage & Huff 1975, Schultz & Bailey 1978, Klein 1980, McLaren & Green 1985, Jeppesen 1987, Behrend & Lubeck 1968, Geist 1975, Thomson 1977, Ferguson & Keith 1982), but this proposition has never been tested empirically. In fact, studies in Southern Norway showed that reindeer did not increase their flight distances in the month following the closing of the hunting season compared to the month before the opening of the hunting season (Dervo & Muniz 1994, Kind 1996, Eftestøl 1998). Nor did white-tailed deer *Odocoileus virginianus* increase their movement rates (Grau & Grau 1980) or mule deer *O. hemionus* abandon their home range (Kufeld, Bowden & Shrupp 1988) during the hunting season.

The objective of our study was to examine response distances of Svalbard reindeer to direct provocation by humans on foot during summer in areas subject to combinations of high or low human activity and hunting or no hunting. We expected the Svalbard reindeer that were hunted by humans to be less likely to habituate to human presence and, therefore, to be more responsive to the presence of humans on foot than those that were not hunted (the hunting hypothesis). In addition, we expected the reindeer that were exposed to high levels of non-hunting human activities to be likely to habituate to human presence and, therefore, to be less responsive than reindeer inhabiting areas with little or no human activity (the human activity hypothesis). We derived two testable hypotheses: 1) reindeer that are hunted respond to humans on foot at farther response distances in summer than reindeer in protected areas, and 2) animals living in areas with a high level of non-hunting human activity show a weaker response (shorter response distances) towards humans on foot in summer than animals living in areas rarely frequented by humans. We also measured environmental variables and reindeer group characteristics that could influence behavioural responses of Svalbard reindeer to human disturbances in order to control for these variables. A third hypothesis could be formulated, but was not possible to test in our study; hunted reindeer which live in areas with no other human activity show longer response distances than animals not hunted in areas with no other human activity.

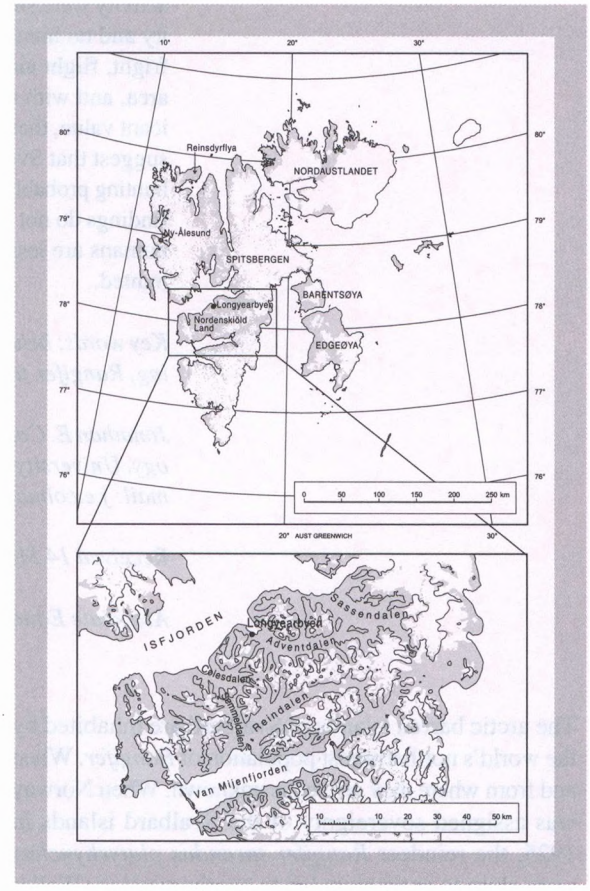


Figure 1. Location of the five study areas: Reinsdyrflya, Sassendalen, Adventdalen (including Longyearbyen), Colesdalen and Semmel-/Reindalen.

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Material and methods

Study areas

For the study we selected five areas of which four were located on the inlet Nordenskiöld Land (Fig. 1). The major settlement Longyearbyen (1,500 inhabitants) with an airport and a harbour is located in Adventdalen (ADVE, 150 km^2, 2.7 reindeer/km^2; R. Hindrum, unpubl. data). Tourists visiting Svalbard by boat or plane usually first arrived in Longyearbyen before departing to other locations either by foot or boat (Kaltenborn 1991). The other three study areas on Nordenskiöld Land, Semmel-/Reindalen (SERE, 361 km^2, 1.7 reindeer/km^2), Sassendalen (SASS, 193 km^2, 2.9 reindeer/km^2) and Colesdalen (COLE, 94 km^2, 4.3 reindeer/km^2) were located 1-2 days away on foot or 4-20 hours by boat (R. Hindrum, pers. comm.). The fifth study area, Reinsdyrflya (REIN, 300 km^2, 1.0 reindeer/km^2), was located 2-3 days away by boat (R. Hindrum, pers. comm., Kaltenborn 1991; see Fig. 1).

All the areas, except REIN, which is a flat peninsula, are wide, supine valleys bordered by steep mountains, glaciers or the ocean. Summer reindeer range on Svalbard occurs below 250 m (Tyler & Øritsland 1989) and is treeless so that both people and reindeer are visible over many kilometres. Mosses (Bryophyta) and monocotyledons (Norderhaug 1969) dominate herbaceous vegetation. Temperatures throughout the fieldwork period were similar among the five study areas and ranged within 0.5-12.1°C (Gustav Bjørbæk, Norwegian Meteorological institute, unpubl. data).

July is the peek of the tourist season on Svalbard (Kaltenborn 1991). Summer tourism consists mostly of guided tours to the active and abandoned coal mines, Russian settlements, and trapper's cabins, in addition to nature walks (safaris), backpacking and boating (Kaltenborn 1991). During the rest of the year, tourism and human activity on foot is minimal in all the areas except ADVE, where the remaining winter residents (1,500) and a few tourists rely on snowmobiles or skis when travelling outside of a 20-km^2 radius of Longyearbyen (Kaltenborn 1991).

Reindeer in SASS and SERE had been hunted since 1983, whereas those in COLE were hunted in 1983 and 1984 and then again since 1988 (Governor of Svalbard, yearly hunting reports 1983-1993, unpubl. data). The hunting season usually includes the last 10 days of August and the first week of September, thereby including three weekends. Hunters access the areas by boat and animals are mostly killed the first day at short distances from the shoreline. A hunting permit is required and quotas for each area are established after population estimates prior to the opening of the season. Most applicants are permanent residents of Svalbard, although anyone could apply. Males and females are hunted in approximately equal numbers (Governor of Svalbard, yearly hunting reports 1983-1993, unpubl. data). Poaching is strictly controlled by the Governor of Svalbard and considered rare in the five study areas (Governor of Svalbard, pers. comm.).

We tested the response of reindeer to provocations by humans on foot in the five areas by ranking them according to their levels of hunting and human activity (Table 1). Intensity of hunting in an area was ranked based on the average number of reindeer harvested per year and calculated over the years in which hunting had

Table 1. Tourist and hunting information for Reinsdyrflya, Sassendalen, Semmel-/Reindalen, Colesdalen and Adventdalen, Svalbard, 1994.

	Reinsdyrflya	Sassendalen	Semmel-/ Reindalen	Colesdalen	Adventdalen
Human activity [a]	1 = Low	2 = Med-Low	3 = Medium	4 = Med-High	5 = High
Total number of people/km^2 [b]	<10	<20	20-70	70-140	>300
Distance to closest settlement by foot/boat [c]	-/165 km	45/40 km	39/- km	30/28 km	0/0 km
Number of cabins [d]	1	3	4	12	>200
Number of hunting seasons since 1983 [e]	0	12	12	9	0
Max./min. animals hunted since 1983 [e]	0/0	33/95	10/35	20/54	0/0
Average # of animals hunted since 1983 [f]	0	63	23	41	0
Hunting rank order [g]	1 = None	4 = High	2 = Low	3 = Medium	1 = None

[a] Rank order categorised according to b, c, d, and the existence of mining or other industries in the area (Kaltenborn 1991, Bjerga 1994, Governor of Svalbard, unpubl. data).

[b] Registered boating, hiking and over-nighting in each area combined for 20 June - 1 September 1989 (Kaltenborn 1991, Bjerga 1994).

[c] Walking and boating distance as measured on a 1:24,000 topographic map by land or boat from Longyearbyen where the most frequented airport and harbour was located. Distances not shown represent routes never taken (Kaltenborn 1991). All distances by boat are from Longyearbyen except for Reinsdyrflya, which is accessed from Ny-Ålesund. Distance from Longyearbyen to Reinsdyrflya by boat is 320 km.

[d] Governor of Svalbard (unpubl. data).

[e] Governor of Svalbard, yearly hunting reports 1983-1993.

[f] Number of reindeer harvested per year combined over the years in which hunting had been allowed in that area divided by the number of hunting seasons (Governor of Svalbard, yearly hunting reports 1983-1993).

[g] Rank order categorised according to the average number of reindeer harvested per year calculated over the combined years hunting had been allowed in that area (Governor of Svalbard, yearly hunting reports 1983-1993).

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been allowed in the area (Governor of Svalbard, yearly hunting reports 1983-1993, unpubl. data). Rankings of human activity levels were based upon: 1) the amount of summer tourism derived from the total number of people/km^2 registered boating, hiking and over-nighting in each area combined for the period 20 June - 1 September 1989 (Kaltenborn 1991, Bjerga 1994); 2) the number of cabins (Governor of Svalbard, unpubl. data); and 3) the walking and boating distance as measured on a 1:24,000 topographic map by land or boat from Longyearbyen where the most frequented airport and harbour were located (for a detailed description of tourism and human activity on Svalbard and the five study areas, see Kaltenborn (1991), Bjerga (1994) and Kaltenborn (1994)). The ranking for human activity from the highest (level 5) to the lowest (level 1) was ADVE = 5, COLE = 4, SERE = 3, SASS = 2, and REIN = 1 (see Table 1). The ranking for hunting from the highest (level 4) to the lowest (1 = no hunting) was SASS = 4, COLE = 3, SERE = 2, and ADVE and REIN = 1 (see Table 1).

Provocation procedure

Responses of reindeer to provocation were recorded in July 1994 during the peak of the tourist season and when Svalbard reindeer were not migratory, but grazed alone or in small sedentary groups in the valley bottoms (Tyler 1991). We used a provocation scheme like that described by Tyler (1991) and Dervo & Muniz (1994). An area was scanned with a (15-60X) spotting scope or binoculars to locate as many reindeer groups as possible. We then established a strategy to conduct a series of provocations such that one provocation of one group did not affect another group. Nevertheless, we did not always avoid disturbing neighbouring reindeer. When animals were inadvertently disturbed, we reassessed the situation and planned a new strategy. We waited at least three hours between provocations of the same group or before sampling a group inadvertently disturbed. We did not provoke the same group more than twice on the same day or more than once after a group had inadvertently been disturbed earlier.

Our sampling units were single adults (>1 year old) and the following group-types: a female with calf, a female with calves from the last and the present year, 2-4 adult males, several adult females with or without calves, several adult females with or without calves joined by one or more adult males, or several adult males joined by one or more adult females. When we provoked groups consisting of more than a single adult reindeer, we initiated recording distances after the first adult reindeer in a group visibly responded, and distance measures were made to the approximate group centre. Most group responses were co-operative after they first sighted us. In order to complete a provocation, the 'provoker' had to be visible to the reindeer from the start of the provocation until the reindeer initiated their flight. If we lost sight of the reindeer before they took flight, that provocation was stopped and a new route was decided upon. In unlevel terrain, the provoker climbed to the same height as the reindeer and approached these along the same topographical contour at which the reindeer were located, thus avoiding provocations where the provoker was either above or below the reindeer at start of the provocation. If there was wind during a provocation, the direction of approach towards the reindeer in relation to wind direction was recorded, but not planned.

Four response distances were recorded by counting paces while striding towards the reindeer: 1) sight distance = the distance between the observer and the reindeer when a reindeer first discovered (by sight or scent) the provoker, indicated by looking, standing, turning their head or pausing from eating in a manner visible to the provoker; 2) fright distance = the distance at which reindeer exhibited alarm, indicated by standing with hind legs spread and the back end lowered, abruptly turning around, urinating or defecating; 3) flight distance = the distance at which a reindeer retreated by walking, trotting, stotting or running; and 4) running distance = the short-term distance covered by the reindeer until they stopped and started activities including lying down, eating or walking, and not necessarily the distance fled, which we consider as a more long-term distance. Following a provocation, we recorded the direction in which reindeer moved relative to the wind direction (with, into, side) and to the terrain (up, down, level).

Six independent variables were recorded prior to each provocation: provocation number (first or second); activity of the reindeer prior to being provoked (lying, foraging, or mixed in cases when reindeer in a group were engaged in different activities); number of reindeer per tested unit (1, 2-3, or ≥4); group composition (adult males only, adult females and calves, adult females only, or adult animals of both sexes with or without calves (mixed)); wind direction from the observer at start of provocation (the reindeer upwind, downwind, sidewind or no wind), and topographic position of the observer relative to the reindeer (level or un-level).

Statistical analyses

A Shapiro-Wilk W test was used to examine if the de-

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Table 2. Spearman rank correlation for the four dependent variables sight, fright, flight and running distance.

	Sight distance		Fright distance		Flight distance	
	r_{Sp}	P	r_{Sp}	P	r_{Sp}	P
Fright distance	0.710	0.000				
Flight distance	0.611	0.000	0.710	0.000		
Running distance	0.192	0.002	0.305	0.000	0.449	0.000

pendent variables met the requirements of a normal distribution (Kleinbaum, Kupper & Muller 1988) and response distances were $\log_{10}$-transformed prior to parametric analyses when they did not meet this assumption. Correlation among dependent variables was tested with original (untransformed) data using a Spearman's rank correlation. To test the human activity and hunting hypotheses, we used a Spearman's rank correlation to test for relationships between the ranks of the areas based on hunting and human activity on the response distances.

To test for differences between areas and to relate environmental and grouping characteristics to reindeer responses, we used a mixed, stepwise ANOVA for preliminary identification of important variables. As a control, we looked at the influence of each independent variable alone and together with the area factor to test for interactions. We set the P-value to enter at 0.15 and the P-value for rejection at 0.10, and used the closeness of Mallow's Cp to p (number of parameters) + 1 when selecting models (Kleinbaum et al. 1988). We compared the results of this procedure to the results of backward, stepwise regression to confirm our selection of variables. Residuals for each model were tested for normality and homoscedacity (Fry 1993).

Because we were also interested in which environmental and grouping factors were related to responses in general, we pooled data from all five areas and used one-way ANOVA and two tailed t-tests to isolate and test the effects of selected variables. When significant differences occurred, Tukey's Studentized range (HSD) multiple comparison of mean effects was used to determine which variables were different (Kleinbaum et al. 1988). We also used data pooled from the five areas to test for where the reindeer ran in relation to wind direction and terrain using χ^2-test. Considering wind, only provocations performed when there was wind were included. For topography, we only included provocations when the three options were simultaneously available to the reindeer (uphill, downhill or across (flat)). We used a Spearman's Rank correlation to test if there was an effect between wind direction in relation to the provoker at the start of a provocation and the direction in which the reindeer moved in relation to wind or topography.

Results

We provoked 261 independent groups or single reindeer; 31% comprised of a single animal, 52% of 2-3, and 17% of ≥4 animals per group. Because there was no difference in any response distance between the first and second time a group was provoked (for sight t = -1. 798, df = 254, P = 0.073; for fright t = 0.011, df = 250, P = 0.991; for flight t = -0.483, df = 254, P = 0.629; for running t = 1.386, df = 228, P = 0.167), data from first and second time provocations were treated independently and pooled for all analyses. All distances were positively correlated between the areas, with a general decrease in the correlation coefficients from sight to running distance (Table 2).

There were no differences in any response distance relative to group size (for sight t = -0.001, df = 254, P = 0.999; for fright t = -0.379, df = 250, P = 0.705; for flight t = 0.548, df = 254, P = 0.584; for running t = -1.325, df = 228, P = 0.186). There was only a significant effect of group composition on the running distance (for sight F = 0.274, df = 3, 248, P = 0.844; for fright F = 0.883, df = 3, 244, P = 0.451; for flight F = 0.997, df = 3, 248, P = 0.395; for running F = 6,845, df = 3, 223, P < 0.001), with groups of females with calves moving farther than male groups (Tukey's HSD: P < 0.001), female groups (Tukey's HSD: P = 0.002), and mixed groups (Tukey's HSD: P = 0.064). We recorded a total

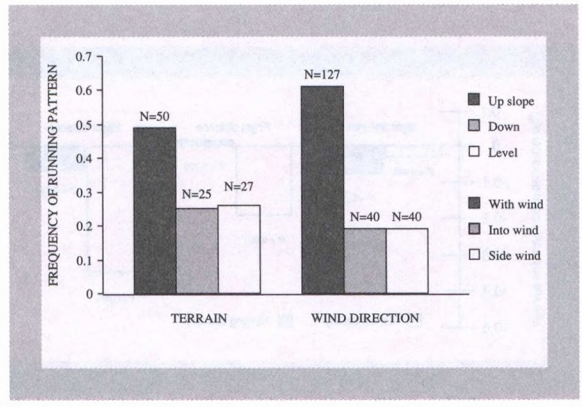


Figure 2. Frequency of running pattern of Svalbard reindeer in relation to terrain and wind direction after being provoked by a human on foot.

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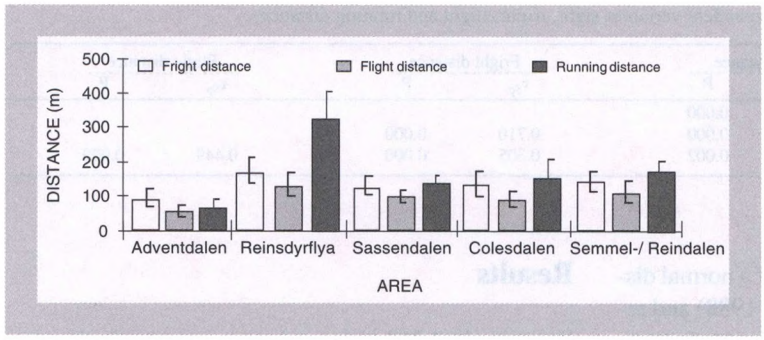


Figure 3. Effect of the five geographical areas (Adventdalen (N = 37), Reinsdyrflya (N = 46) Sassendalen (N = 77) Colesdalen (N = 35), Semmel-/Reindalen (N = 66)) on Svalbard reindeer fright, flight and running distances after provocation by humans on foot. Measurements were recorded from lone reindeer (31%) and groups of 2 - 3 (52%), or ≥4 (17%) reindeer. Distances were measured in metres by pacing. Error bars represent 95% confidence intervals and N = sample size.

of 69, 66, 100 and 16 provocations with the observer being either up wind or down wind, or at side wind or no wind positions at the start of the provocation. There was no correlation between wind direction in relation to the provoker at the start of a provocation and the direction in which the reindeer moved in relation to wind (r_s = -0.081, P = 0.461, N = 207) or topography (r_s = 0.011, P = 0.946, N = 102). Following a disturbance, reindeer most often moved up slope (χ^2 = 11.3, df = 2, P < 0.001, N = 102) and with the wind (χ^2 = 73.2, df = 2, P < 0.001, N = 207; Fig. 2).

Sight distances were similar (F = 2.021, df = 4, 251, P = 0.092), whereas fright (F = 4.825, df = 4, 247, P = 0.001), flight (F = 19.058, df = 4, 251, P < 0.001) and running distances (F = 19.903, df = 4, 225, P < 0.001) were significantly affected by area (Fig. 3). Geographic area was the only independent variable that affected flight and running distance in a multivariable approach. When tested specifically, reindeer in REIN had the longest flight (Tukey's HSD: ADVE and COLE P < 0.001, SASS P = 0.002 and SERE P = 0.009) and running distances (Tukey's HSD: P < 0.001 for all except for COLE P = 0.003; see Fig. 3). Animals in ADVE displayed the shortest fright (Tukey's HSD: REIN P = 0.001, SASS P = 0.003, COLE P = 0.090, SERE P = 0.002), flight (Tukey's HSD: P < 0.001 for all except for COLE P = 0.192), and running distances (Tukey's HSD: REIN and SERE P < 0.001, SASS P = 0.072 and COLE P = 0.001; see Fig. 3). There were no significant differences in fright, flight and running distances among COLE, SERE and SASS. When these three areas were combined, their averaged fright (F = 9.538, df = 2, 249, P < 0.001), flight (F = 32.631, df = 2, 253, P < 0.001) and running distances (F = 35.268, df = 2, 227, P < 0.001) were longer than in ADVE and shorter than in REIN.

Svalbard reindeer's summer fright, flight and running distances were negatively correlated with the rank of human activity in an area (r_s = -0.21, -0.36, -0.42, respectively, P < 0.001) and, with the exception of running distance, not correlated with intensity of hunting (Fig. 4). Running distance was slightly related (r_s = -0.11, P = 0.050) to hunting intensity (see Fig. 4), but this correlation was not as strong as the correlation with human disturbance. Therefore, hunting seems to have only a weak effect if any at all on the four response distances.

Discussion

Before the present work, the long-standing and well-cited hypothesis that animals that are hunted are less likely to habituate to human activities than animals that are not hunted had never been tested. On Svalbard, reindeer that were hunted did not consistently have the longest response distances to direct provocation by humans on foot during the summer. This suggests that fall hunting practices on Svalbard did not impose enough negative stimuli towards humans on foot to carry over to the following summer. Wild and semi-domestic reindeer in southern Norway have shown that response distances towards humans on foot were actually shorter after the hunt-

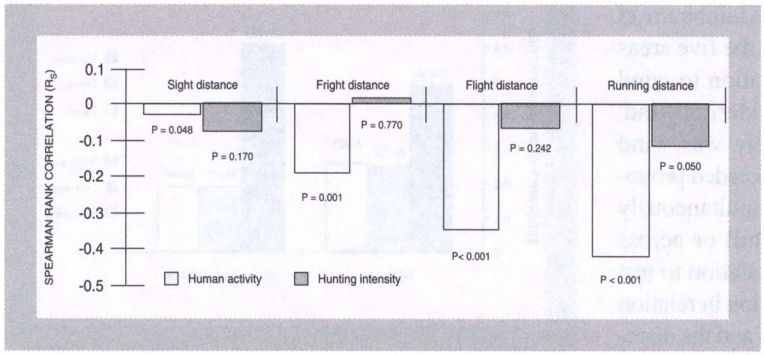


Figure 4. Spearman's rank correlation (r_s) for Svalbard reindeer sight, fright, flight and running distances with human activity and hunting intensity.

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ing season than before (Dervo & Muniz 1994, Kind 1996, Eftestøl 1998). There was an average of 2.5 reindeer/km^2 for our five study areas. We observed mostly solitary individuals and small groups of 2-3 individuals, and distances of 0.5-2 km between individual reindeer or groups in the terrain. This density and dispersed distribution of Svalbard reindeer in the terrain was also reported in Tyler & Øritsland (1989), and may facilitate a non-negative stimuli approach to hunting. Hunters in our study areas most often approach, shoot and dress a reindeer without being noticed by other reindeer (Prestrud 1983, T. Severinsen, pers. comm.). If reindeer that are not shot do not experience negative stimuli from a hunter during the hunt, there are no stimuli for these animals to develop negative response behaviour towards hunters. Behrend & Lubeck (1968) also found that periodic hunting did not reduce summer viewing of white-tailed deer in some New York parks. Likewise, Grau & Grau (1980) and Kufeld et al. (1988) reported no increase in dispersal or home range abandonment by white-tailed and mule deer, respectively, as a consequence of hunting pressure.

Where populations of large game are hunted, the animals' behaviour towards hunters and tourists is especially important to consider simultaneously. This is because the animals' reaction towards a human figure is a result of how the animal perceives a human. Large ungulates' perceptions of humans, including response behaviour towards disturbances, are mostly learned through experience (Geist 1975). Our results indicate that for Svalbard reindeer, hunting probably does not exhibit stronger or much stronger negative stimuli, and thus may not evoke negative response behaviour towards humans on foot in areas with other human activities. However, we do not know how reindeer would react in an area with hunting and no other human activities.

Most likely, it is the cumulative effects of all human activities that determines the behaviour of ungulates towards humans (Jeppesen 1987). Svalbard reindeer were hunted to near extinction when protected in 1925. One may speculate that strong negative response behaviour was established during earlier times, and persisted without the intervention of new stimuli. This could be just the case on REIN, where we recorded the longest distances at which reindeer responded to provocation by humans on foot. In the other four areas, and especially ADVE, where the shortest distances were recorded, the reindeer have experienced positive or non-negative stimuli and may, therefore, have become habituated. Reindeer living in the areas with a high to medium level of human activity, with and without hunting, showed weaker responses than reindeer living in the area rarely frequented by humans and with no hunting. Our prediction that reindeer that were exposed to high levels of human activities were likely to habituate to human presence, was supported.

Similar sight distances for reindeer among the five areas indicated that differences in response distances by reindeer among areas were not a function of environmental factors influencing visibility. Even though a positive correlation among the response variables existed, a correlation with sight distance would not affect the analyses or comparisons among geographical areas because sight distance was almost equal for all provocations. Thus, the respective correlations were also equal for all five areas. Running distance may be the best response variable for testing our hypothesis because it was the response variable least correlated with the other response variables and most negatively correlated with human activity. However, the presence of a calf influenced the running distance. It is possible that when provoked, some females may have waited for their calves, and when joined together, moved collectively. De Vos (1960) reported that cow caribou with young calves also were more alarmed by humans than calfless individuals. The presence of calves is mainly responsible for the increased sensitivity towards human observers among groups of female caribou (de Vos 1960, Jakimchuk 1980). In our results, however, females with calves did not have longer fright or flight distances than other group compositions. Only their running distance was significantly longer. De Vos (1960) and Horejsi (1981) found the same pattern in caribou. When disturbed by humans, caribou change their flight path or hesitate to run in order to remain near other caribou, especially cows waiting for calves (de Vos 1960, Horejsi 1981).

Our position at the start of the provocation was not correlated to where the reindeer ran in relation to wind direction or topography. We avoided provocations where the provoker was either above or below the reindeer at the start of the provocation, and for the analysis of where the reindeer ran in relation to terrain, only provocations in which the reindeer had the choice of moving up, down and across were included. Provocations when there was no wind were not included and when there was wind, the three choices for wind direction were automatically available by nature. Reindeer running up slope was also the most common response recorded for reindeer in Norway (Kind 1996, Eftestøl 1998) and on Svalbard and Wrangle Island (Baskin & Skogland 1995). Above danger, reindeer may be less vulnerable to attack and gain a visual advantage. Moving with the wind may enable olfactory contact with a threat while retreating simultaneously.

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Hunting could have a weak effect on Svalbard reindeer's behaviour towards humans. However, we suggest that in areas with summer tourism, Svalbard reindeer may become habituated to human activity even when hunted in autumn. An increase in human activity in areas where hunting is allowed may not have a negative impact on reindeer survival, as long as hunting practices do not change considerably from the present. If a reindeer population is hunted and subjected to a low level of human activity, hunting could have a negative effect on the reindeer's response behaviour towards humans. Nevertheless, the present work indicates that Svalbard reindeer could habituate to human activity and that hunting has only a weak effect.

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