The feeding behavior of free ranging semi-domestic reindeer (*Rangifer tarandus tarandus*) in relation to a wind park

Beiteadferd blant tamrein (*Rangifer tarandus tarandus*) i forhold til en vindpark

Hilde Rønning

Norwegian University of Life Sciences
Department of ecology and natural resource management
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Preface

This thesis represents the last semester for the master degree in Natural Resource Management at the University of Life Sciences, Ås. This study was conducted in conjecture with the Wind Rein project. I would like to thank all the collaborating partners in the project for making this study possible through economic support, and for giving me the opportunity to participate on the 15th Nordic Conference on Reindeer Research in Luleå, Sverige.

A special thank go to my supervisor Jonathan E. Colman for all his help during fieldwork, for sharing all his knowledge on the topic and for comments on earlier drafts. I have never met a person with a greater ability to motivate a student. I would also like to give a special thanks to Sindre Eftestøl for all his help during fieldwork, and for always being open for questions and discussing topics related to the thesis. For good teamwork during the weeks in the field, I must also thank Brit-Agnes Buvarp.

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I would also like to thank my parents for supporting my choices through the study progress and for always believing in me. For my best friend Kristine, and the rest of my fellow students, thanks for all the memories we have shared during years of studies, both in Trondheim and at Ås.

A special thanks to Øyvind.

I hope that this thesis can contribute to increasing the level of knowledge relating to potential effects on free ranging reindeer from wind park development.

Hilde Rønning
15. May 2009

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1. Abstract

Feeding behavior of free ranging semi-domestic reindeer (*Rangifer tarandus tarandus*) was observed during summer grazing on Nordkinnhalvøya (the Nordkinn peninsula), Finnmark, Northern Norway in connection with the Kjøllefjord Wind Park. The wind park was opened in 2006, and fieldwork was carried out from 2005 to 2008. The main object of this study was to investigate whether the wind park affected the feeding behavior of individual reindeer. To examine this, focal observation were conducted on randomly selected reindeer. Feeding behavior was tested in relation to data gathered during and after the wind park was built. Other variables that might affect the reindeers' feeding behavior, for example weather and elevation that directly influences pasture distribution, were included in the analyses. Due to the lack of pre-data, and to control for the other variables independent of the wind park, the data gathered in the area with a wind park was also compared with similar data gathered in a control area without wind power development. Reindeer grazing near the wind park did not exhibit a more restless feeding behavior compared to those farther away. There was a significantly higher mean value of number of steps for animals grazing more than 1000 meter from the park compared to animals grazing 0-500 meter from the park (p-value=0.0049). On the other hand, differences were found between the test and control area. In 2006, when the wind park opened, significantly higher mean values for number of steps were found in the area with wind park development compared to the control area (p-value=0.030). Findings from a survey carried out with local people in the area indicated that the area around the wind park and its adjacent road was used more after the park was built. Nine percent answered that they used the entire study area more, while thirty two percent answered that they used the area adjacent to the wind park more after it was built. Other variables, independent of the wind park, were also found to have an affect on the reindeers' feeding behavior making it difficult to relate the findings solely to the wind park. Overall, the results showing lower mean values for animals in close vicinity to the wind park and the fact that both peninsulas constitutes large areas rich in grazing opportunities, lead me to conclude that the wind park in itself is not a serious disturbing factor that reduced the animals ability to utilize their summer pasture. Despite this, the park may constitute an indirect threat through increased use by humans of the area that originally was relatively inaccessible.

Key words: *Rangifer tarandus tarandus*, optimal grazing, disturbance, reindeer husbandry, Northern Norway, wind farm, human activity.

2. Sammendrag

Beiteadferd blant frittbeitende tamrein (*Rangifer tarandus tarandus*) ble observert under sommerbeite på Nordkinnhalvøya i Finnmark, Norge. Feltarbeidet ble gjennomført fra 2005 til 2008 i tilknytning til Kjøllefjord vindpark som åpnet i 2006. Hovedformålet med studiet var å undersøke hvorvidt vindparken påvirket beiteadferden til reinsdyrene. For å undersøke dette, ble metoden *fokale observasjoner* utført på tilfeldig valgte simler med og uten kalv. Antall skritt tatt under beiting ble registrert og benyttet som et mål på beiteadferd. Disse dataene ble så testet i relasjon til data samlet inn under og etter utbyggingen av vindparken. På grunn av mangel på før-data, og for å isolere potensielle andre faktorer, ble dataene også sammenliknet med tilsvarende data samlet inn i et kontrollområde uten vindparkutbygging. Reinsdyrene som beitet nær parken viste ingen tegn til mer urolig beiteadferd sammenlignet med dyr som beitet lenger bort fra vindparken. Signifikant høyere gjennomsnittsverdier ble funnet for dyrene som beitet mer enn 1000 meter fra vindparken sammenlignet med dyrene som beitet 0-500 meter fra vindparken (p-verdi=0,0049). Forskjeller ble også funnet mellom test- og kontrollområdet, med signifikant høyere snittverdier for testområdet i 2006 da vindparken ble åpnet (p-verdi=0,030). I tillegg til data samlet inn for beiteadferd, ble det utført en spørreundersøkelse som rettet seg mot innbyggerne i Kjøllefjord og deres bruk av området i forhold til vindparken. Resultater fra spørreundersøkelsen viste at området rundt parken og dets tilhørende vei ble benyttet mer til turformål etter at parken var bygget sammenlignet med før utbyggingen. Av de spurte svarte ni prosent at de i større grad benyttet hele området, mens trettito prosent svarte det samme for området rundt vindparken. Andre faktorer, uavhengig av vindparken, viste seg å ha en effekt på variasjoner knyttet til beiteadferd. Variasjoner i antall skritt kan derfor ikke alene tilskrives vindparken. Lavere antall skritt for dyrene som beitet nær parken kontra lenger bort, samt det faktum at begge halvøyene innehar gode beitemuligheter, gir grunn til å konkludere med at vindparken i seg selv ikke utgjør en reell trussel mot dyrenes mulighet til å utnytte det viktige sommerbeitet. På den annen side kan vindparken inneha en indirekte negativ effekt for reinsdyrene i form av økt menneskelig ferdsel i området.

Nøkkelord: *Rangifer tarandus tarandus,* optimal beitebruk, forstyrrelse, reindriftsnæring, Nord-Norge, menneskelig aktivitet.

3. Introduction

This study is part of the Wind-Rein project, a multidisciplinary project begun in 2005 (Colman et al. 2007; Colman et al. 2008). The project aims to investigate potential biological and socio-economic consequences of wind park development in semi-domestic reindeer pasture-land. Because of their requirements for large areas with potentially limited pasture, reindeer are vulnerable towards development that might reduce pasture availability or quality, disturb the animals and reduce optimal grazing, or that constitute a hindrance for their natural movements within a region (Flydal et al. 2004; Reindriftsforvaltningen 2008).

Several new wind parks are planed in Norway (Flydal et al. 2004; Reindriftsforvaltningen 2008). Many of these proposed wind parks are located along the coast of Nordland, Troms and Finnmark counties where semi-domestic reindeer have their summer pastures (Flydal et al. 2004; Reindriftsforvaltningen 2008). Optimal utilization of summer pasture is crucial for reindeer fitness (Colman & Pedersen 2000). Because of the very scarce resources available during the winter, reindeer are dependent on the availability of high quality grazing areas in the summer (Holand 2003; Skjenneberg & Slagsvold 1968). Survival and success is dependent on the animals' ability to utilize the short but nutrient-rich summer (Blix et al. 1998; Holand 2003). A good summer grazing will increase their ability to reproduce, and give earlier birth to heavier calves with higher chance of survival (Blix et al. 1998; Holand 2003). A good summer pasture is also important for lactation. If female reindeer lack access to or are unable to utilize nutrient-rich pasture, they might prioritize their own fitness instead of producing high quality milk which can result in calf death (Blix et al. 1998).

Few studies examine feeding behavior of free ranging reindeer or other ungulates in relation to wind power development (Flydal et al. 2004). Flydal et al. (2004) studied potential effects of wind turbines on reindeer held in enclosures. No effects were found on behavior that could increase the animals' energy use. Lack of negative effects on the behavior or distribution of semi-domestic reindeer (*Rangifer tarandus tarandus*) in Scandinavia as a consequence of existing wind parks in Norway, Finland and Sweden, was also reported in Eftestøl et al. (2004).

Several studies focusing on the distribution and density of reindeer in areas with infrastructure development, have found that reindeer reduce their use of areas within 5 km of development (Nellemann et al. 2000; Nellemann et al. 2001; Nellemann et al. 2003; Vistnes et al. 2001). Other studies using pasture measurements (Vistnes 1999; Vistnes & Nellemann

2001) have shown that some areas previously used by reindeer possibly declined in use as a consequence of development with a simultaneous increase in use of undisturbed areas. However, there was no test of actual cause and effect, for example, on the reindeer themselves. A logical assumption would be that the reindeers' use or avoidance of an area is associated with their behavior. Following this, I aimed to test the number of steps taken while feeding as a measurement of feeding intensity and uneasiness.

This thesis focused on the direct effects a wind park had on the feeding behavior of semi-domestic reindeer. Based on feedback and traditional knowledge amongst reindeer herdsmen, reindeer move more while feeding if they are stressed and aware of a disturbance, while the opposite is true when they are relaxed (i.e. feeding undisturbed) (Jonathan E. Colman, pers.comm.). Based on this, I hypothesized that (I) animals grazing in the area with wind park development would have a more restless feeding behavior than animals grazing in a control area without such development, and (II) that animals grazing in near vicinity to the park would have a more restless feeding behavior compared to those grazing farther away from the park in the same area. Other important variables that have the potential to affect the animals feeding behavior (e.g. insect stress) were controlled for. Data collected in field were analyzed using a T-test (Barnard et al. 2007), analyzes of variance ((ANOVA; one-way (Barnard et al. 2007), general linear model (Agresti 1990)) and Tukey test (Ryan & Joiner 2001) in Minitab version 15.1.0.0.

If the number of steps taken while feeding increases as a consequence of different disturbance factors, it will be at the expense of essential nutrient uptake during summer (Colman & Pedersen 2000). This can result in negative effects towards the reindeer husbandry, which is based on sale of reindeer meat and the production of calves for future sales. Changes in feeding and lying patterns can therefore have negative effects, resulting in reduced carcass weights, physical condition, survival and production (Colman & Pedersen 2000; Nellemann et al. 2001). Since meat production result in over ninety percent of the income of reindeer herdsmen, the reindeers' ability to optimize summer pasture is crucial (Colman & Pedersen 2000; Holand 2003). This study could therefore contribute to increase the level of knowledge around potential effects a wind park might have on the feeding behavior of reindeer, and hopefully, contribute to important knowledge when new parks are being built. In this way, it might minimize the potential negative effect for reindeer husbandry in the future.

4. Method

4.1 Area description

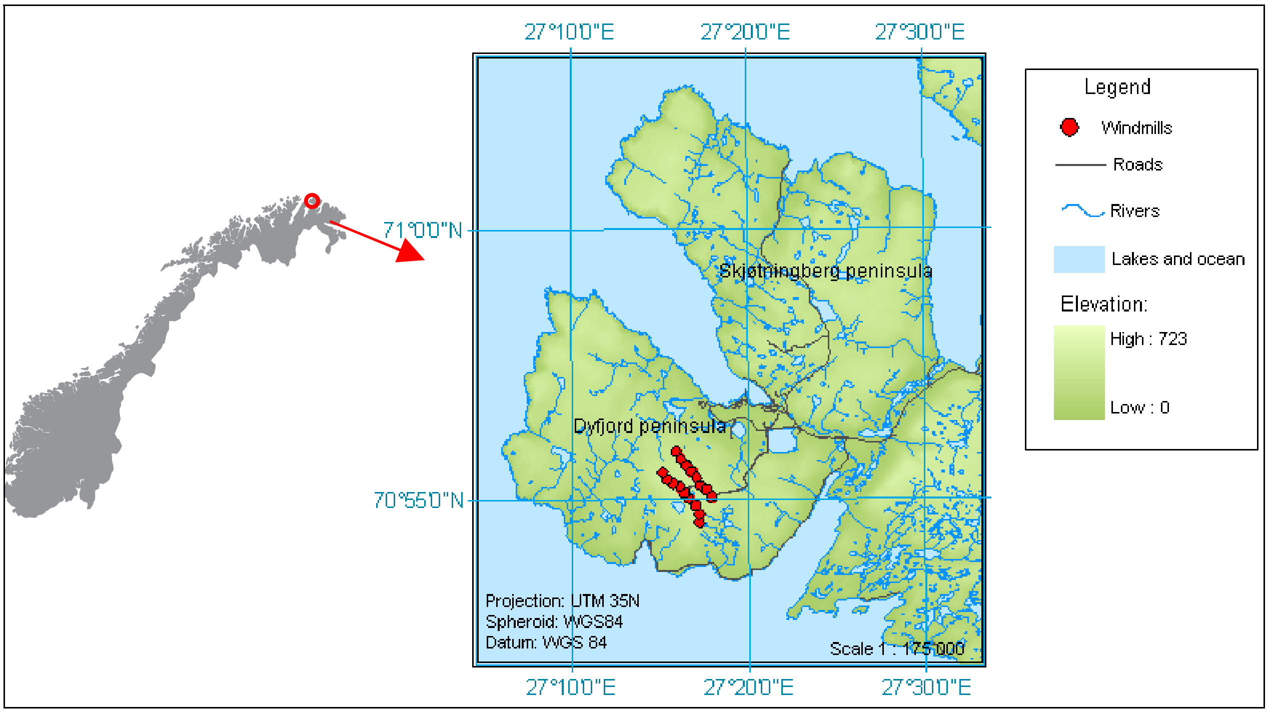

Figure 1. Map over the study area. The study area was located on Nordkinnhalvøya, Finnmark, Norway. Dyfjord peninsula constitutes the test area where the wind park is situated. Skjøtningberg peninsula was used as a control area without wind park development.

Fieldwork was conducted in two areas on Nordkinnhalvøya (the Nordkinn peninsula), Finnmark, Northern Norway, in connection with Kjøllefjord Wind Park (Fig. 1).

Construction work began in September 2005 at the Dyfjord peninsula, and the wind park was opened in October 2006. The wind park consisted of 17 windmills with an estimated yearly production of about 150 Gwh (Statkraft s.a.). The area used for the wind park is approximately 1.6 km^2, and a 6 km access road is built in connection with the wind park (Statkraft s.a.). The wind park was situated within the reindeer herding district number nine's summer pastures, with approximately 5570 animals in their winter herd in 2006/2007 (Reindriftsforvaltningen 2008). The reindeer arrived here from their winter ranges around the onset of calving in early May. They remained in the area until the mid of October when they migrate back to their winter ranges.

The area within the wind park was mainly dominated by impediment with only a few vegetation strips in-between the windmills in a north-south direction (Colman et al. 2002). The rest of the Dyfjord peninsula and much of Skjøtningberg constituted good summer pastures. The vegetation section was slightly oceanic (Moen et al. 1998), and according to

Rapp et al.(Rapp et al. in prep.), five main groups of plants dominate in the area; grassland, heather land, herbs, woody plants, and mosses and lichens. According to their botanical examinations in the area, there was 62.8 km^2 of available pastureland in the test area and 75.2 km^2 in the control area.

The climate in the area was oceanic, characterized by mild winters, low summer temperatures and a yearly precipitation around 500-700 millimeter (Table 1) (Moen et al. 1998).

Table 1. Mean temperatures (Celsius) for all years and months with observations. *Total mean* present the mean temperatures for all years with observation. Measurements were done at Mehamn Lufthavn, Gamvik municipality (Meterologisk institutt 2009).

Year	May	June	July	August	September	October
2005	3.8	9.8	11.9	12.2	8.2	5.5
2006	4.9	8.9	10.1	11.0	6.7	0.9
2007	3.8	8.2	10.7	10.8	7.0	5.3
2008	2.3	6.5	9.8	8.2	6.6	2.6
Total mean	3,7	8.4	10.6	10.6	7.1	3.6
Normal (1961-1990)	3.0	7.6	11.4	10.3	7.1	2.0

4.2 Fieldwork

Fieldwork was conducted during the end of Mai, June, July and September 2008. As mentioned in the introduction, this thesis was part of a larger, ongoing project and data gathered from 2005 until 2007 was also included in the present analyses. Focal observations were used to record the reindeers' behavior as described in Colman & Pedersen (2000). Altmann (1974) describe this method as "*a sampling method where specified action of an individual are recorded during each sampling period"*. In this study, it involved a registration of number of steps taken by the foreleg while feeding. Observations were mostly recorded for animals engaged in grazing. Observations were continued even though the animal stopped grazing and began moving. If an animal disappeared out of sight, the observation was ended and the duration time was registered. An animal was considered grazing if it was standing or walking, and at the same time pointed its head downwards (Mörschel & Klein 1997; Pérez-Barbería & Nores 1996; Toupin et al. 1996). Number of steps taken while feeding was then used as an indicator for behavioral change and stress. Individuals were randomly selected from a herd and observed for 2 minutes each. This was similar to the method described by Colman et al. (2001b), Mårell et al. (2002) and Colman et al. (2003). There was one individual per sample period. If found within a group, individual female reindeer were randomly selected for observation. The first animal was chosen from one side of the herd, and the next observations were done towards the other side of the herd. In this way, the chance of observing the same animal two times was minimized.

The observations were carried out during daytime (circa between 08.00 am and 21.00 pm). The observers' location was marked using GPS (Global Positioning System). In combination with compass direction and distance from the animals, the observations were mapped with accuracy on field maps.

Several studies have found that females and calves are more sensitive towards disturbance than males and yearlings (Maier et al. 1998; Nellemann & Cameron 1998; Nellemann et al. 2000; Nellemann et al. 2001). Data was therefore gathered on females with and without calves. The observations were done from a hidden position with a binocular or a telescope of various types and magnification strengths. On the basis of this and descriptions of these methods found in the literature, I assumed that the animals' behavior was not affected by the observer.

In addition to counting number of steps, a number of variables were registered for every observation (See appendix 1 for field form). This was important in order to control for other variables that potentially affect reindeer feeding behavior independent of the wind park itself. Based on the scope of this paper and to minimize the element of uncertainty related to some of the variables, not all of the variables gathered in the field were included in the analyses (see table 2 for variables included in the analyses).

Since weather condition affects the movement and quantity of insects (Colman & Pedersen 2000; Holand 2003), such data was collected from the wind park and used as a indication for potential insect stress. The weather was assumed to be the same for study and control area (observations were done simultaneous in the two areas). Weather measurements were recorded by the station every 10 minute. Mean temperatures and wind speed was calculated within the time period of the observation. For days where time data was missing, mean values were calculated for the entire day. Since level of insect harassment was not measured directly, observation was as far as possible avoided on days with potentially high levels of insect harassment. This was often the case when it was warm, sunny and calm, and reindeer behaviors consistent with insect harassment as described by Colman & Pedersen (2000) were observed. During mild harassment, it could be difficult to detect such disturbance, and controlling for weather conditions was therefore important.

With exception of service people working on wind park maintenance, the wind park road was closed for all motor traffic. The road was well suited for recreational activities, and it was therefore interesting to test whether the wind park and the access road might have led to a change in local peoples' use of the area. To investigate this, a survey was conducted on the local people living in or near Kjøllefjord. A survey can be defined as a "*standardized questionnaire of a big sample of persons on a given theme*" (Ringdal 2001). The survey aimed at investigating peoples' use of the area (Dyfjord- Skjøtningberg and the rest of the Nordkinn peninsula), whether their use of the area had changed as a consequence of the wind park and also some questions about type of activity they performed and how often they used the areas. For the complete questionnaire see appendix 2 (note; only in Norwegian). It should be noted that results from the same survey are also presented in another master thesis written by Buvarp (in prep.). We carried out the survey together, and the questionnaire and the presentation of results related to this are partially overlapping.

Table 2. All test variables used in the data analyses. Weather parameters are only tested on data for 2007 and 2008. The variable *distance to windmills* is only tested for data gathered in the test area (with the wind park).

Type of Variable	Variable name	Type of variable	Categories
Response variable	Number of steps / sec	Continuous	-
Independent variable	Location	Categorical	1 Dyfjord peninsula 2 Skjøtningberg peninsula
Independent variable	Period	Categorical	1 May/June 2 July/August 3 September/October
Independent variable	Year	Categorical	1 2005 2 2006 3 2007 4 2008
Independent variable	Distance roads	Categorical	1 0-500 m 2 501-1000 3 > 1000 m
Independent variable	Distance windmills	Categorical	1 0-500 m 2 501-1000 3 > 1000 m
Independent variable	Mean altitude above sea level	Categorical	1 0-50 m 2 51-100 m 3 101-150 m 4 151-200 m 5 201-250 m 6 251-300 m 7 > 300 m
Independent variable	Herd composition	Categorical	1 Breeding herd (females / calves) 2 Mixed herd 3 Yearlings 4 Unknown
Independent variable	Herd size	Categorical	1 < 5 2 5-10 3 11-30 4 > 30
Independent variable	Temperature insects	Categorical	1 0-7 degrees 2 7,1-14 degrees 3 > 14 degrees
Independent variable	Wind speed insects	Categorical	1 > 18 m/s 2 12,1-18 m/s 3 6,1-12 m/s 4 0-6 m/s

4.3 Data analyses

4.3.1 Analyses carried out in Geographical Information System (GIS)

The coordinates for each herd were embedded in Arc GIS version 9.3. In this program, distances between the animals, the wind park and roads in the area were estimated. Various distances to the wind park and roads could then be taken into account when analyzing the different number of steps taken while feeding. I calculated the distance from the roads and the wind park separately by using the NEAR command in Arc GIS (DeMers 2009). With this analysis, I determined the nearest distance from each herd position to the nearest road or windmill. For both distances to windmills and roads, I controlled for possible errors by picking out random points and measured the distance manually by using a ruler (in Arc GIS). For all random points, the distance matched the distance from the analysis. About five points were checked. Since there are many roads in the area, I connected all the roads together using a tool called Merge Management in Arc GIS (ESRI s.a.). This made it possible to calculate mean distance from the herd position to any nearest road. Type of road is therefore not taken into account. Since observations were mainly done on either the control area or test area and not along the main road, I decided this was a suitable method.

In addition to calculating the distances to windmills and roads, Arc GIS was also used to calculate mean height above sea level for each herd position. Since the animals were not GPS marked, a buffer zone with a radius of 100 m was created around each position. The mean height above sea level within each buffer zone was then calculated. Temperature is a determining factor for plants, and it has the ability to change the plant composition with increased height above sea level due to decreasing temperatures (Holand 2003). Height above sea level was therefore used as a measure for vegetation. The mean heights were classified after vegetation classes presented in Rapp et al. (in prep.). GIS was also used for presentation of map-figures.

4.3.2 Statistical analyses

For the statistical analyses, Microsoft Excel 2003 and Minitab version 15.1.0.0 was used. Before running statistical tests in Minitab, mean values for each individual animal and each herd was calculated, and descriptive statistics presented. For each observation, the mean number of steps was calculated using formula 1. Each observation was divided on the length of the observation time. Based on the mean values for each animal, a mean value of the entire herd was calculated and these values were used in the analyses. I underlie this choice on the assumption that among gregarious animals, the behavior of single individuals can be influenced by the behavior of the whole herd (de Vos 1960; Thomson 1977).

Formula 1 $$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

The data was checked for normality using an Anderson-Darling test and histogram with fit. The data was not normally distributed, and was therefore log transformed (log(*number of steps /sec* + 1)). I was not able to obtain a perfectly normal distribution. Regardless of this, I used parametric tests. I underlie this on the assumptions that biological data often have a bit skewed distribution (Svein Dale, pers.comm.), and that the number of observations is considerably over the critical number of observations that is needed to assume a normal distribution (Solve Sæbø and Ellen Sandberg, pers.comm.).

A T-test was carried out to test for differences between females with and without calves. Data collected on the test area was then compared with data sampled at the control area. This allowed for a comparison of the feeding behavior of the animals grazing in an area with a wind park versus those observed in an undisturbed area, and to control for other variables that could have an affect on the feeding behavior. Preliminary tests, using one-way ANOVA, where carried out in order to find models that best described the variation in the dataset. All independent variables were tested against the response variable *number of steps / sec.* Variables that got a p-value at 0.20 or lower were included in further analyses. In addition to using results from the preliminary study, I carried out a Best Subset Regression to check that important variables were not omitted in the models. ANOVA GLM (General linear model) was used for the final testing. A significance level of 0.05 was chosen in the final model. If significant differences was found, a Tukey test was carried out to reveal where the differences was situated.

5. Results

5.1 Statistical analyses

330 groups of animals were observed from 2005 until 2008. Descriptive statistics presenting number of observations, total mean values and standard error for each year are presented in Appendix 3.

A T-test revealed no significant difference between females with versus without calves ($t = 1.28$, df (N_1+N_2-2) = 300, $P = 0.202$). Groups consistent of both females with and without calves therefore constituted the basis for further analyses.

On the basis of single tests using one-way ANOVA, the variables location, period, year, herd composition, and mean height above sea level were included in the further analyses (Table 3).

Table 3. Results from preliminary tests, one-way ANOVA. Each variable was tested against the response variable *number of steps / sec*. Data that obtained a p-value at or below 0.20 was included in further analyses.

Factor	DF	F-value	P-value
Location	1	1.72	0.191
Period	2	20.70	0.000
Year	3	11.54	0.000
Herd composition	3	1.81	0.146
Herd category	3	0.37	0.777
Mean height above sea level	6	2.13	0.050
Distance windmills	2	4.46	0.012
Distance roads	2	0.79	0.454

The model that best explained the variation in the dataset was location, year and the interaction between these two variables (Table 4).

Table 4. Based on preliminary studies and a best subset regression, location, year and the interaction between these variables best explained the variation in number of steps per second during two minute intervals taken by females while feeding, ANOVA GLM.

Variable	DF	F-value	P-value
Location	1	5.24	0.023
Year	3	10.20	0.000
Location*Year	3	3.46	0.017
R-Sq = 12.64 %			

The results from the model indicated that there was a difference between location and year. When locations were tested against each other within each year, a significant difference was found between the two areas in 2006 (one-way ANOVA; d.f=1, F=4.93, p-value=0.030). A pair wise comparison between both location and year, using a Tukey test, revealed a significant difference between year 2 and 4 (p-value=0.000), and year 3 and 4 (p-value=0.0036) for the test area. There was a significant difference for year 2 in the test area compared to year 4 in the control area (p-value=0.000). In addition, year 3 for the test area was significantly different from year 4 in the control area (p-value=0.0427). When years were tested separately for the two areas, a significant difference between year 1 and 4 in the test area was found (Tukey; p-value=0.0350) (Fig. 2). No significantly differences were found between years within the control area.

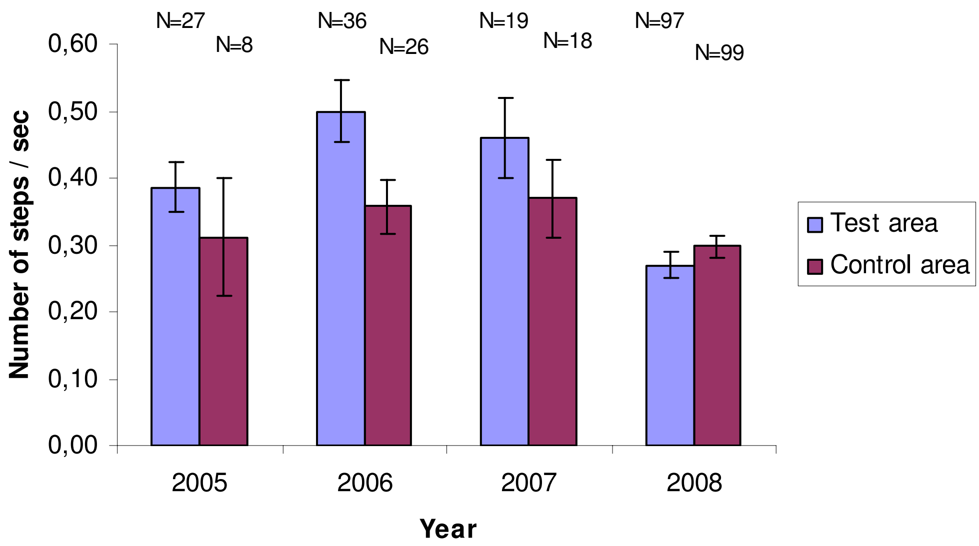

Figure 2. Total mean number of steps (+/-standard error) per second during two minute intervals for female reindeer while grazing for each year and for the test area (Dyfjord peninsula) with wind park development and a control area (Skjøtningberg peninsula) without a wind park in Finnmark, northern Norway.

Tests were also carried out for the two areas separately. For the test area, it was important to analyze whether the difference in number of steps taken could be related to distances to the wind park. The analyses gave a significantly result for year, distance to windmills and period (Table 5).

Table 5. Model for the test area with wind park development, ANOVA GLM. The model is based on variables that obtained a p-value less than 0.20 in preliminary analyses (one-way ANOVA).

Variable	DF	F-value	P-value
Year	3	11.72	0.000
Distance windmills (categorical)	2	4.37	0.032
Period	2	11.80	0.000
R-Sq = 30,99%			

Total number of steps taken while feeding showed an increasing trend as the distance to a windmill increased (Fig. 3). A Tukey test revealed that there was a significantly higher mean value for the animals situated farthest away from the wind park (>1000 m) compared to animals in closest vicinity of the wind park (0-500 m) (p-value= 0.0049).

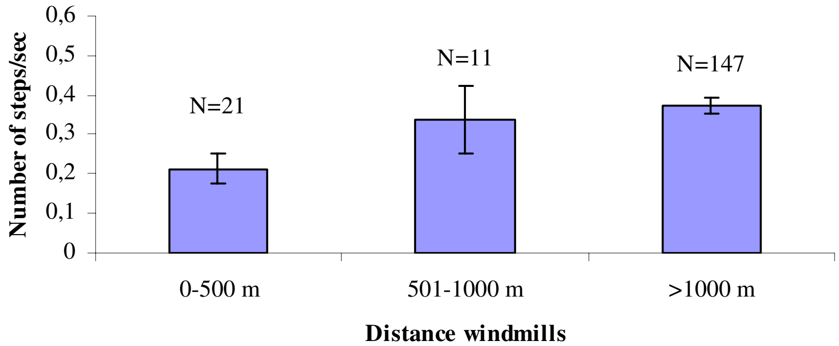

Figure 3. Total mean numbers of steps (+/- standard error) per second during two minute intervals for female reindeer while grazing related to distance to the Kjøllefjord wind park, northern Norway during the summer seasons of 2005-2008.

A Tukey test revealed that all periods were significant different from each other within the test area. Differences were found between May/June and July/August (p-value=0.000). Both May/June and July/August also differed from September/October (p-value=0.0314; p-value=0.0020, respectively). This corresponds with the trend illustrated in figure 4, showing highest mean value for July/August.

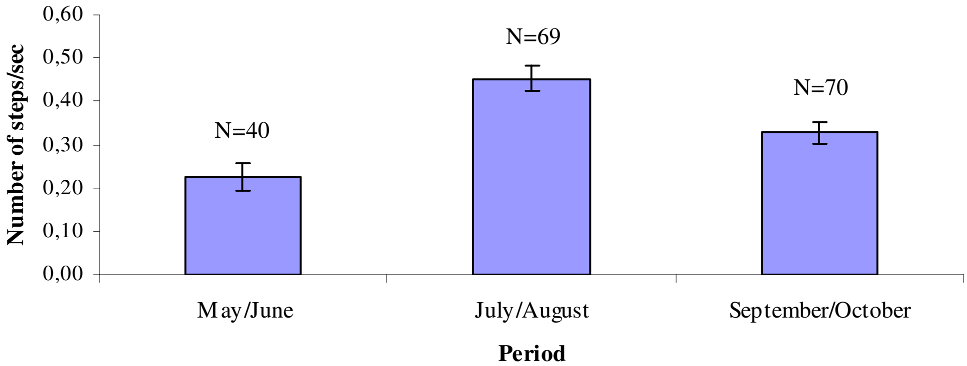

Figure 4. Total mean number of steps (+/- standard error) per second during two minute intervals for female reindeer while grazing in the test area (Dyfjord peninsula) classified by period. Note; the bars represent total mean values for all years (2005-2008) with observations.

When tests were carried out on the control area, only period was significant (one-way ANOVA; d.f=2, F-value=7.43, p-value=0.001). The trend was mainly the same as for the test area, with significant differences between May/June and July/August (Tukey; p-value=0.0256) and July/August and September/October (Tukey; p-vale=0.0009). Since period was the only variable shown to have an affect, no further analyzes were carried out on the control area alone.

Due to the lack of weather data in 2005 and 2006, only data from 2007 and 2008 were tested against different weather parameters (two last variables in table 2). In 2007 and 2008, data were first analyzed against all the independent weather variables using one-way

ANOVA. Wind speed, categorized for insect harassment, was the only variable that achieved a p-value lower than 0.20 (one-way ANOVA; d.f=2, F-value=2.23, p-value=0.109). Since none of the weather variables were significant at a p-level of 0.05 or lower, no further analyses were carried out.

Except for the results presented in the models, height above sea level got a significant result during the preliminary tests (one-way ANOVA; d.f=6, F-value=2.13, p-value=0.050). Reindeer grazing within 101-150 meters above sea level (m.a.s.l.) had significantly higher mean values compared to those grazing 201-250 m.a.s.l. (Tukey; p-value=0.0214). Presentation of mean values for each height class is given in appendix 4. Due to the importance of isolating other factors that might affect the number of steps besides those from the wind park, a presentation is also provided for number of steps within each height class in relation to different distances to the park (Appendix 4).

5.2 Survey

Approximately 100 surveys were handed out, and 98 were returned completed. Since several answers contain several check-offs, number of answers may differ from total replies. In the following section, perceptual distributions will be presented. Only questions that I found relevant for this study will be presented here. For the complete questionnaire, see Appendix 2 (note; only in Norwegian).

One of the questions asked was how often the test area (all of Dyfjord peninsula) and the control area (all of Skjøtningberg peninsula) were used as a hiking area the last two years, i.e. after the wind park was built. The majority of the respondents replied that they use these areas once or seldom per month. Beyond that, there was a relatively even distribution among the reply categories for both areas (Fig. 5).

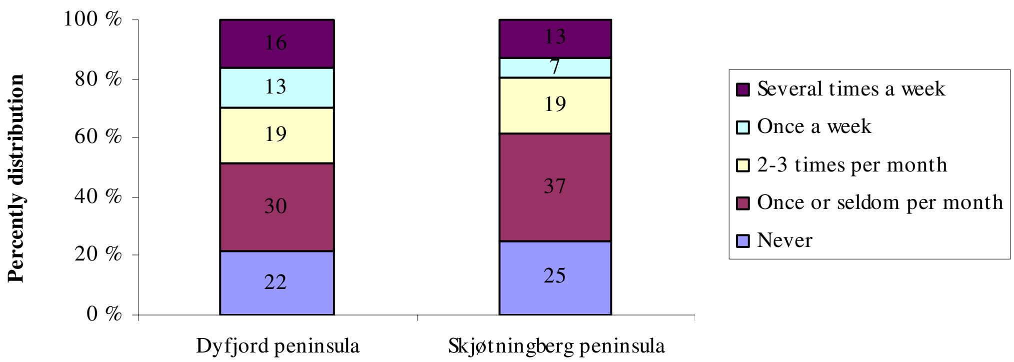

Figure 5. Percent distribution of how often Dyfjord (test area) and Skjøtningberg (control area) peninsula was used as a hiking area after the wind park was built in 2006 (i.e. for 2007 and 2008) on the Dyfjord peninsula. 190 and 189 people crossed for Dyfjord and Skjøtningberg respectively.

A clear majority answered that the wind park did not lead to a change in their use of the test area, control area or the rest of Nordkinn, respectively. For the test area, one can see that considerably more people have increased their use compared to the control area and the rest of Nordkinn (Fig. 6).

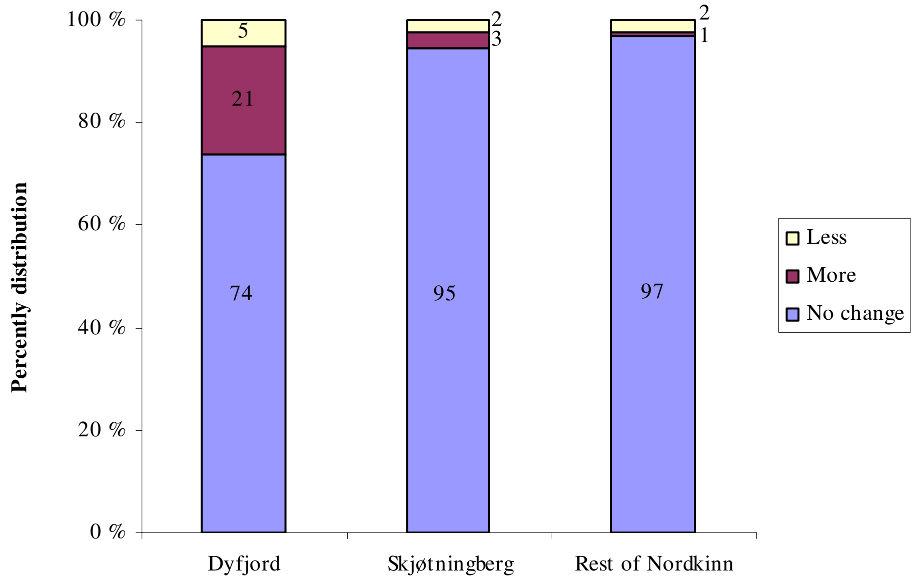

Figure 6. Peoples change in their use of Dyfjord, Skjøtningberg and the rest of Nordkinn peninsula as a hiking area in 2007 and 2008 after the Kjøllefjord wind park was opened on Dyfjord in autumn 2006. A total of 96, 92 and 92 people crossed for Dyfjord, Skjøtningberg and the rest of Nordkinn, respectively.

When the same question, including use of specific areas, was asked for the test area only, a relatively high percent answered that they used the area around Gartefjell (where the park is situated) more after the park was built. The result also indicated that the respondents had increased their use of the entire area. In accordance with the findings from the question above, the majority of the respondents replied that they had not change their use of the area after the park was built (Fig. 7).

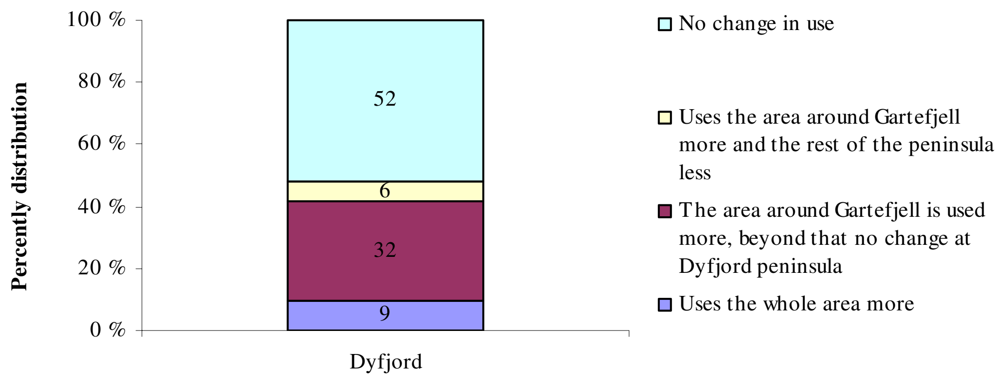

Figure 7. Question about whether the development of the Kjøllefjord wind park in 2006 lead to a change in the use of Dyfjord peninsula (where the wind park is situated) as a hiking area in 2007 and 2008. 127 people in total answered this part of the survey.

The respondents were also asked if they used both the road and the terrain or only one of them. A total of 64 % in the test area and 70 % in the control area answered that both the road and the terrain were used. When asked how far from the road they walked, 22 % answered that they only used the road in the test area compared to 13 % for the control area. 36 % answered that they walked more than 3 km from the road in the test area, while 52 % crossed for the same alternative in the control area.

6. Evaluation of the material

6.1 Evaluation of field method

The method used is easily measured. This reduces the possible differences between observers in the field. The short observation period (2 minutes) also makes it possible to gather many observations, as long as one avoids pseudo replication if observing the same reindeer repetitively. Furthermore, Reimers & Colman (2006) have claimed that such a method is a good indicator for potential behavioral responses. However, they emphasize that it is time consuming and that it sets limitations for the size of the study area under observation.

A possible danger with this method is that the animals that graze more peacefully are chosen rather than animals that are moving more while feeding, since it may be more difficult to count the number of steps for a more restless animal. If this is the case, calmer animals are overrepresented and potential effects of more restless and in worst case sensitive animals are removed. Nevertheless, this potential effect of observer bias would be the same in both the test and control areas, and therefore not affect their comparisons.

Many observers reduce subjectivity, but variables may be considered differently, for example vegetation composition and cover. Variables where this has been a danger were obtained in other more objective ways. For example, vegetation data was measured from both height above sea level and gathered from botanical investigations done in the area. Potential effects of insects are based on weather data and animal behavior, and not on the observers own measurements of actual insects in the field.

Some of the test variables may be difficult to conclude from and should be viewed with caution. For example, observation of animals was in principle not gathered on days with severe insect harassment. This was merely because the animals were impossible to follow and such data would not be representative for testing interactions with other variables, such as the wind park. This is simply because the animals are over-occupied with trying to relieve themselves from the insects harassing them (Colman & Pedersen 2000). In addition, all weather recordings were done at 10 meter height. Weather parameters are therefore mainly used as a control for potential impact of insects on the number of steps, and not as a measure of the level of insect harassment on the animals.

6.2 Evaluation of statistical analyses

The problem related to normal distribution could perhaps have been solved by removing "extreme values". On the other hand, if observations with very low or high mean values had been removed there would have been a risk of removing the most or least sensitive animals. If nothing indicated that the animals were disturbed by e.g. the observer, hikers, other animals in the herd, predation risk or insects, the observation was included in the analyses regardless of whether is was an outlier.

There are a total of 330 observations. Number of observations is almost equal for both areas and could be said to make a good representative selection between the test and control areas. On the other hand, it should be noted that there was variation in the number of observations amongst years. Because the fieldwork began in September 2005, there were fewer total observations in 2005 than the other years. There was also a difference in number of observations between the areas in 2005, with twenty seven observations for test area and only eight for the control area. Comparisons between these two areas in 2005 should therefore be viewed with caution. The highest number of observations was recorded in 2008. With the exception of 2005, there is a relatively equal sample size for the previous years ranging from approximately 20 to 40 observations per area per year (note; groups of animals).

General higher uncertainties are connected to analyses done for period versus analyses done for an entire year. The sample will be further reduced when divided between periods (note; not for 2005 where year and period will constitute the same data basis). In the period

May/June, there is a lack of observations for two years (2005 and 2007). Few observations and skewed distribution of number of observations among periods may result in lack of or misleading trends. Comparison between periods could have been tested for just year 2006 and 2008, which are the only years that I had data for all three periods. For the total summary of number of observation between years, period and area see appendix 5.

7. Discussion

An interesting trend in the results indicated that the animals were more restless when grazing in the test area with the wind park compared to the control area. Feeding behavior was also different for different years. Except for 2008, a higher number of steps were found for the first three years in the test area compared to the control area, and the difference was significant between the two locations in 2006. Differences found between years for the test area, but not within the control area, indicate that the variation could be a result of the wind park. The park opened in October 2006. An assumption could therefore be that the commissioning of the park lead to increased human activity in the area around the park in 2006, which again might have caused a more stressful behavior for the animals grazing there compared to those grazing in the control area.

This result indicates that the wind park could have affected the animals, at least during and shortly after the construction phase and opening in autumn 2006. However, tests carried out within the test area point in the other direction. When looking at the mean values in relation to distance to the wind park, I found that animals near the park (0-500 m) were significantly less restless when grazing compared to animals further away (>1000 m). These results support the findings from Flydal et al. (2004). Even though their study was not on free ranging reindeer, it showed that the windmills themselves did not affect the feeding behavior of the reindeer grazing in an enclosure in close vicinity (0-350 m) to the wind park in their study.

Effects of the wind park could be difficult to detect due to individual differences between animals and the possibility of habituation. As mentioned under area description, the park is situated in an area with scarce pasture availability consisting mainly of rocks. This was also the case for Flydal et al. (2004). They claimed that the effect of a wind turbine could have been different if it was situated in an area with rich grazing pasture. A danger could be that potential effect is difficult to detect since the animals are free to graze wherever they prefer in my study area. Both Gill et al. (2001) and Holand (2003) claimed that if there is access to good grazing areas away from a disturbance, animals would choose such sites rather than areas where they are affected by a disturbance. Both the test and control area have good summer pastures, and animals have no problem finding new pastures if they get disturbed (Rapp et al. in prep.). Furthermore, animals grazing farther away from the park could be more sensitive to disturbances, and therefore show higher mean values in number of steps, for example if they sense hikers or the observer through the sense of smell (Kåre Rapp, pers.comm.). According to Ujvári et al. (1998), animals in closest vicinity to a disturbance will be the ones with most experience towards it. If this is the case for the animals grazing in the test area, a possibility could be that it is the least sensitive or the most habituated animals that graze near the wind park, which again might result in the low mean values of steps while grazing for these animals.

It is also important to remember that other factors have certainly affected the feeding behavior of the reindeers. This was confirmed in this study, and relating all the variation found in the feeding behavior to the park only would be misleading. On the other hand, it might also make it difficult to detect potential connections between the feeding behavior and the wind park. For example, a closer look at different height classes revealed that animal grazing 200-300 meters above sea level had the lowest mean values compared to the other height classes. The animals grazing closest to the wind park were distributed within this height. Height was used as an indicator for vegetation, which again has the potential to affect how reindeer graze (Tyler 1991). Within the height classes, vegetation varies both in composition and cover (Rapp et al. in prep.). Differences related to distances to the wind park may therefore be a result of variation in vegetation composition and cover within the different distances rather than a consequence of the wind park itself. However, these findings should be further examined for the control area as well. If a similar trend is also found for the control area, it is likely that the variation in number of steps in relation to distance to the wind park is related to variation in vegetation.

Another explanation on the differences in the number of steps related to distance to the wind park, could be that on days with severe insect harassment reindeer searched for refuge at or near the wind park. If they find relief from insects they graze more calmly (Colman & Pedersen 2000), and this could be near or within the wind park (Sindre Eftestøl, pers.comm.). It should be noted that even though the wind park is placed on a windy location, there are many hilltops farther away from the park where animals could seek relief from insects harassment (Colman et al. 2002; Rapp et al. in prep.). Low mean values for the same height were also found for the animals grazing farther away from the park (Appendix 4).

The potential for insect harassment could also be an explanation for the differences found between the years. There were considerably fewer number of steps in 2008 than the previous years. A closer look at the mean temperature for the years in question revealed that 2008 had lower monthly mean temperatures compared to the previous years (except October 2006, Table 1). Annual variation in weather condition has the potential of affecting the quantity and movement of insects (Colman & Pedersen 2000; Holand 2003), which again will be a major disturbance to reindeer (Blix et al. 1998; Colman & Pedersen 2000; Colman et al. 2003; Murphy & Curatolo 1987). This might therefore explain the variation between different years. On the other hand, 2005 had highest monthly mean temperatures (except for May, Table 1) compared to all years with observations, and at the same time mean values for number of steps did not stand out as very high seen in relation to the other years with observations (Fig. 2). This, and the fact that weather variables have been shown to have no effect when insects are not present (Hagemoen & Reimers 2002), indicates that the insect harassment was probably not a major disturbing factor on the mean values of steps in this study.

Also period was shown to have an effect on the feeding behavior (for both areas). A significantly higher number of steps were found for July/August compared to the other two periods. These are also the months with the highest normal mean temperatures (Table 1). The potential for insect harassment may therefore be greatest for this period. Due to the lack of significant effect for the weather variables, a shift in feeding behavior between months could also be a result of change in vegetation composition and availability, for example in relation to searching strategy as was found by Mårell et al. (2001).

Even though the wind park itself might not constitute a direct threat to the animals, increased activity in the area can be a negative effect of the park. The survey indicated a trend towards increased use of Dyfjord peninsula as a hiking area. When wind parks are built, adjoining roads are constructed in connection with it. The road in connection with Kjøllefjord Wind Park forms a nice walking path. Trombulak & Frissel (2000) claimed that all types of roads can lead to an increased alteration and use by humans. They further claimed that in some cases, such increased activity could influence animal behavior in the area, for instance through escape behavior, movement pattern and reproduction. The survey showed a relatively even distribution among the different classes when asked how often the two areas were used for hiking. Twenty one percent said that their use of Dyfjord as a hiking goal had increased after the park was built. For the control area the activity seemed to be more stable, with only three percent saying that their use of the area increased after the park was built. For Dyfjord, the increased use was mainly found around Gartefjellet where the park is situated. Thirty two percent answered that their use of this area had increased, while nine percent answered that they used the whole area more. This trend might be explained by the fact that the area around the park became more accessible as a result of the road. Another explanation could be related to the park itself as an attraction. When talking to the locals in relation to the survey, several pointed out that when friends and family were visiting they asked for a hiking tour to the park. If this is the case, increased activity could also be expected from tourism. The variable distance to road gave no effect on the feeding behavior of the animals for both the test- and the control area. Also in this case, the least sensitive animals might be those grazing close to the road.

The survey also revealed that a relatively high percent used both the road and the terrain in the test area (64 %). Thirty six percent answered that they walked more than three kilometer from the road and into the terrain in this area. This, together with the potential trend in increased use outlined above, might constitute a bigger threat than the physical structures of the wind park itself. According to Morrison et al. (1995), animals will be more likely to habituate towards fixed installation than to human activities. Human activities are more unforeseen and might therefore constitute a bigger disturbance factor than the windmills themselves. Geist (1971) claimed that a disturbance is most harmful when it is unforeseen, since it reduces the animals` ability to avoid the disturbance. However, how animals react towards humans can be colored by the animals experiences with meeting humans (Colman et al. 2001a; Geist 1971). Geist (1971) claimed that if people keep sufficient distance to the animals and not approaches them, the animals can learn to ignore humans in an area. If this is not the case, increased human disturbance might lead to reduced ability to utilize the important summer pasture and increase their energy use (Colman et al. 2001a; Flydal et al. 2004; Skarin et al. 2004). Another negative effect could be overuse of grazing pastures further away from the area around the wind park and its adjacent road (Reimers et al. 2006; Walter et al. 2006). Undeveloped areas have been found to be used significantly more than expected from their availability (Vistnes et al. 2001). This threat will probably be most evident if availability of alternative grazing areas are limited and the density of animals are high (Reimers et al. 2006). However, reindeer may be able to habituate toward humans, even though the activity levels are high (Colman et al. 2001a). If not, the negative effect may be reduced if the human activity is kept on a low level and is predictable (Colman et al. 2002; Geist 1971).

8. Conclusion

No significant results towards a more restless feeding behavior for animals in closest vicinity to the Kjøllefjord Wind Park were found. The reindeer near the park were actually calmer while grazing compared to animals farther away. This indicates that the wind park did not lead to a more restless feeding behavior, at least for the animals grazing close to the park. Since other factors were shown to have an impact on the number of steps taking while feeding, it is difficult to relate these findings solely to the wind park. Furthermore, the reindeer were free to move between the two peninsulas and should therefore have no problem in finding new grazing areas where they are unaffected by the wind park. In other areas, where animals lack alternative grazing areas, or where development would lead to a loss of good grazing areas, a wind park may have a greater potential for negative effects. Differences between the two locations, showing significantly higher mean values the year the park opened, indicated that the park and the construction phase could have had an affect on the reindeers' feeding behavior, at least in the form of increased human activity. The results from the survey indicated that the human use of the area had increased after the park was built. As far as I can see, and in agreements with concerns outlined in earlier studies, this will constitute the biggest negative effect in this area since such activities are less predictable and expand over a larger area than the fixed wind mill structures themselves.

9. Future research

The differences between the two locations in 2006 should be examined further. No documentation concerning activity during the construction phase was available. If this could be found, it might help explain the high mean values for the test area in 2006. Mean values in relation to height above sea level should also be further examined to see whether lowest mean values are found near the wind park in 2006, and also in the control area.

Other variables, not relating to the park, were shown to have an affect on the number of steps. These variables should be further investigated in order to measure to what extent they have an affect regardless of our use of a control area and comparisons amongst the years. For example, height above sea level was used as a measure for vegetation composition and cover. This variable is discussed on a general level. Further investigation should be carried out in the control area as well and on each vegetation class in order to reveal potential connections between number of steps taken and the amount and type of vegetation available. A significant result was also found for year and period. These findings should be further analyzed in relation to annual variation in weather condition since this affects both insect level and the pasture quality/quantity. In this way, one can closer investigate whether the differences were for instance due to annual differences in insect level rather than a potential habituation towards the park.

The distribution of animals in the study area and in relation to the wind park is not covered in this thesis. For a better understanding of the total effect of the wind park, grazing behavior should be viewed in relation to area use. In this way, one will get a better overall picture of the potential effects of the wind park on the animals in this study area.

The result from this study may not be directly transferable for other reindeer husbandry areas. Due to the lack of scientific work on this field, further studies should be carried out in several areas with different conditions where wind parks are being planed. This will make it easier to see general trends and obtain a better picture of the effects wind parks may have on free ranging reindeer.

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11. Appendix

Appendix 1.
Presentation of the variables that were recorded during fieldwork in connection with the Kjøllefjord Wind Park on Dyfjord peninsula, Finnmark. Similar data was also gathered in a control area without a wind park (Skjøtningberg peninsula). Note; only in Norwegian.

Atferdsregistrering: Antall ganger forbeina beveger seg.

Dato: Område: Vindstyrke: Vindretning: vær: insekter:

Tid	Type dyr m/u kalv	Flokk-sm.setn.	Flokk-størrelse	Antall kalv	Adferd flokk % beit/ligg	GPS-koord.	Veg.-type	Veg dekn dyr	Veg dekn flokk	Skifter Habitat	Ant. sek.	Ant. skritt.

Appendix 2.
Presentation of the questionary that was conducted on the local people living in or near Kjøllefjord centre. The aim of the survey was to look into peoples use of the area and whether their use had changed as a consequence of the wind park that has been built on the Dyfjord peninsula.

Spørreundersøkelse i forbindelse med bruk av turområdene rundt Kjøllefjord vindpark og Skjøtningberg før og etter vindparkutbyggingen.

Formål med undersøkelsen:
I forbindelse med byggingen av Kjøllefjord vindpark ønsker vi å undersøke om bruken av turområdene på Dyfjordhalvøya (ikke boligområder) og Skjøtningberghalvøya har forandret seg etter vindkraftutbyggingen.

Spm. i forbindelse med undersøkelsen rettes til:
Hilde Rønning 95 85 28 43 (masterstudent)
Brit-Agnes Buvarp 48 20 49 08 (masterstudent)

1. Bakgrunnsinformasjon:
Ant. pers i husstanden:………………………………………..
Kjønn:…………………………………………………………
Alder (Undersøkelsen skal fylles ut av personer over 16 år):……
Bosted:………………………………………………………
Hvor blir undersøkelsen utført: ………………………………..
Hvor ofte går du på tur?………………………………………

2. Hvor ofte bruker du Dyfjordhalvøya (ikke langs riksveien) som turmål (de siste 2 årene, dvs. etter vindparkutbyggingen)?

	Sommer (15.mai -15.august)	Høst (16 august-15. oktober)
Aldri	☐	☐
1 gang eller sjeldnere per mnd	☐	☐
2-3 ganger per mnd	☐	☐
1 gang i uka	☐	☐
Flere ganger i uka	☐	☐

3. Hvor ofte bruker du Skjøtningberg som turmål (de siste 2 årene, dvs. etter vindparkutbyggingen)?

	Sommer (15.mai -15.august)	Høst (16 august-15. oktober)
Aldri	☐	☐
1 gang eller sjeldnere per mnd	☐	☐
2-3 ganger per mnd	☐	☐
1 gang i uka	☐	☐
Flere ganger i uka	☐	☐

4. Hvor ofte bruker du andre deler av Nordkynhalvøya som turmål (de siste 2 årene etter vindparkutbyggingen)?

	Sommer (15.mai -15.august)	Høst (16 august-15. oktober)
Aldri	☐	☐
1 gang eller sjeldnere per mnd	☐	☐
2-3 ganger per mnd	☐	☐
1 gang i uka	☐	☐
Flere ganger i uka	☐	☐

5. Når du bruker Dyfjordhalvøya, hvordan kommer du deg til området (hhv. sommer og høst)? *Hvis flere kryss, ranger fra 1 til 4, hvor 1 er mest.*

	Sommer	Høst
Kjører med bil til parkering ved bom og går derfra	☐	☐
Går langs vei fra Kjøllefjord og opp mot vindparken	☐	☐
Sykler fra Kjøllefjord og opp mot vindparken	☐	☐
Går direkte fra Kjøllefjord inn i terrenget	☐	☐

6. Hvis du bruker veien opp mot vindparken, bruker du bare veien eller også terrenget?
Hvis flere kryss, ranger fra 1 til 2, hvor 1 er mest.

	Sommer	Høst
Bare veien	☐	☐
Veien og terrenget	☐	☐

7. Når du bruker terrenget på Dyfjordhalvøya (både direkte fra Kjøllefjord og fra veien i vindparken), hvor langt vekk fra veien/bebyggelse beveger du deg vanligvis?
Hvis flere kryss, ranger fra 1 til 5, hvor 1 er mest.

	Sommer	Høst
Benytter kun veien	☐	☐
0-500 m	☐	☐
500 m – 1 km	☐	☐
1-3 km	☐	☐
> 3 km	☐	☐

8. Når du bruker Skjøtningberghalvøya, hvordan kommer du deg til området (hhv. sommer og høst)? *Hvis flere kryss, ranger fra 1 til 4, hvor 1 er mest.*

	Sommer	Høst
Kjører med bil inn mot Skjøtningberg	☐	☐
Går langs vei fra Kjøllefjord og innover	☐	☐
Sykler fra Kjøllefjord og innover	☐	☐
Går direkte fra Kjøllefjord inn i terrenget	☐	☐

9. Hvis du bruker veien innover mot Skjøtningberg, bruker du bare veien eller også terrenget? *Hvis flere kryss, ranger fra 1 til 2, hvor 1 er mest.*

	Sommer	Høst
Bare veien	☐	☐
Veien og terrenget	☐	☐

10. Hvis du bruker Skjøtningberghalvøya, hvor langt vekk fra veien/bebyggelse beveger du deg? *Hvis flere kryss, ranger fra 1 til 5, hvor 1 er mest.*

	Sommer	Høst
Benytter kun veien	☐	☐
0-500 m	☐	☐
500 m – 1 km	☐	☐
1-3 km	☐	☐
> 3 km	☐	☐

11. Hvilket formål har du med turene?
Hvis flere kryss, ranger fra 1 til 4, hvor 1 er mest.

	Dyfjordhalvøya	Skjøtningberghalvøya
Mosjon/turgåing	☐	☐
Bærplukking	☐	☐
Jakt	☐	☐
Fiske	☐	☐

12. Hvor lenge varer turene vanligvis?

	Dyfjordhalvøya		Skjøtningberghalvøya	
	Sommer	Høst	Sommer	Høst
0-3t	☐	☐	☐	☐
3,1-6	☐	☐	☐	☐
Mer enn 6t	☐	☐	☐	☐
Overnatting	☐	☐	☐	☐

13. Har du med hund på tur?
Ja ☐
Nei ☐

14. Hvis ja, går hunden i bånd?
Ja ☐
Nei ☐

15. Har vindparken ført til en endring i bruken av noen av disse områdene?

Dyfjordhalvøya		*Skjøtningberghalvøya*		*Resten av Nordkynhalvøya*	
Ingen endring	☐	Ingen endring	☐	Ingen endring	☐
Mer	☐	Mer	☐	Mer	☐
Mindre	☐	Mindre	☐	Mindre	☐

Hva er grunnen til en eventuell endring? ....
Hvis endringer på spørsmål 15, gå til spørsmål 16, hvis ingen endring gå direkte til spørsmål 19

16. På hvilken måte har vindparken ført til en forandring av din bruk av Dyfjordhalvøya?

	Sommer	Høst
1. Bruker hele området mer……………………………………………….	☐	☐
2. Bruker området rundt Gartefjellet (vindparken med tilhørende veier) mer, men ingen forandring ellers på Dyfjordhalvøya……………………………	☐	☐
3. Bruker området rundt Gartefjellet mer og resten av Dyfjordhalvøya mindre	☐	☐
4. Ingen endring…………………………………………………………	☐	☐

5. Annet………………………………………………………………………………
………………………………………………………………………………………..

17. På hvilken måte har vindparken ført til en forandring av din bruk av Skjøtningberghalvøya?

	Sommer	Høst
1. Bruker hele området mer …………………………………..	☐	☐
2. Bruker veien inn mot Skjøtningberg mer, men ingen forandring av bruken av resten av terrenget………	☐	☐
3. Bruker området mindre…………………………………….	☐	☐
4. Ingen endring………………………………………………	☐	☐

5. Annet………………………………………………………………………………
………………………………………………………………………………………..

18. Hvor mye har bruken av disse områdene økt/minket?

	Dyfjordhalvøya		Skjøtningberghalvøya	
	Sommer	Høst	Sommer	Høst
0-50%	☐	☐	☐	☐
51-100%	☐	☐	☐	☐
101-300%	☐	☐	☐	☐
>301 %	☐	☐	☐	☐

Eventuelt beskriv hvordan du brukte områdene før:

____

____

19. Eventuelle kommentarer eller andre synspunkter?

____

____

Appendix 3.
Descriptive statistics for the response variable number of steps per second during two minute intervals for female reindeer while grazing. These mean values are presented for a test area with wind park development (location 1) and a control area (location 2) without wind park development, for all years with observation.

Location	Year	N	Mean	SE Mean
1	2005	27	0.39	0.0374
2	2005	8	0.31	0.0880
1	2006	36	0.50	0.0463
2	2006	26	0.36	0.0403
1	2007	19	0.46	0.0604
2	2007	18	0.37	0.0594
1	2008	97	0.27	0.0195
2	2008	99	0.30	0.0157

Appendix 4.

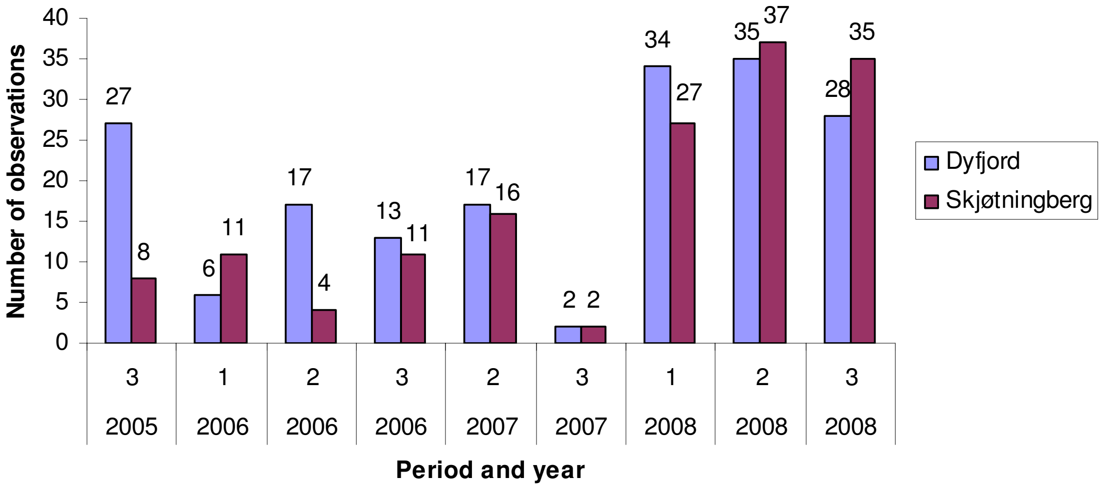
Descriptive statistics for number of steps per second during two minute intervals for female reindeer while grazing in relation to height above sea level. Location is not taken into account. Height above sea level was used as an indicator for vegetation cover and composition.

Height class	N	Mean
0-50 m	12	0.3795
51-100 m	21	0.3832
101-150 m	43	0.4217
151-200 m	83	0.3393
201-250 m	132	0.2970
251-300 m	37	0.3297
> 300 m	2	0.3754

Descriptive statistics for number of steps per second during two minute intervals for female reindeer while grazing in the test area (Dyfjord peninsula) in relation to different distances to the wind park and for different height above sea level.

Distance to wind mills	Height class	N	Mean
0-500 m	201-250 m	11	0.1355
	251-300 m	10	0.2996
500-1000 m	151-200 m	3	0.2895
	201-250 m	8	0.3540
> 1000 m	0-50 m	5	0.3295
	51-100 m	16	0.4458
	101-150 m	26	0.4624
	151-200 m	49	0.3418
	201-250 m	46	0.3435
	251-300 m	5	0.3305

Appendix 5.
Number of observations for each period (May/June (1), July/August (2), September/October (3)) and year between the test area (Dyfjord peninsula) with wind park development and the control area (Skjøtningberg peninsula) without wind park development. Observations were carried out on female reindeer while grazing. All observation carried out on single animals within the same group were given a total mean value and presented as one observation. Number of observations therefore represents number of herds.



Appendix 6.
Pictures from Kjøllefjord Wind Park, Dyfjord peninsula, Finnmark.

Kjøllefjord Wind Park, located on Gartefjellet. The wind park consists of 17 wind mills (Photo; Buvarp/Rønning).

Reindeers walking towards Kjøllefjord Wind Park (Photo; Buvarp/Rønning).

A single reindeer resting in the shadow from one of the wind mills (Photo; Statkraft).

A happy student (me) in the study area (Photo; Buvarp).