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Lynx behaviour around reindeer carcasses

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Abstract: The main prey for lynx in northern Sweden is semi-domestic reindeer. Lynx often utilise their large prey for several days and therefore a special behaviour can be observed around a kill site. The aim of this study was to investigate behavioural characteristics of lynx around killed reindeer and examine factors that might affect the behaviour. Data was collected in 2008 during two 6-weeks periods (winter and summer) from 4 lynx equipped with GPS-collars. In total 77 kill sites were analysed. Lynx spent on average 40 hours (SD=40) around a kill site but only about 10 hours (SD=11) within 50 meters of the carcass. Lynx revisited the carcasses on average 4 times (SD=3.5) and rested on average 898 meters (SD=1311) away from the carcass. I found that higher complexity in the environment such as steep slope and dense vegetation increased time spent around kill sites and shortened distance to resting sites, presumably because this is where lynx can feel safe. My results can be helpful in future predation studies, where it can aid interpretation of GPS-data and distinguish kill sites of reindeer from other clustered positions.

Introduction

The Eurasian Lynx (*Lynx lynx*) is the largest cat in the lynx family. There are two species in North America, the Bobcat (*Lynx rufus*) with a more southern distribution within North America than its smaller cousin, the Canadian lynx (*Lynx canadensis*). The most threatened member of the lynx family is the Iberian Lynx (*Lynx pardina*) living in the southwest of Spain The Eurasian lynx has a distribution ranging from Scandinavia, parts of central Europe, the Baltic States and throughout to the most eastern parts of Siberia (Alderton 2002). Lynx prey varies from birds and small mammals like rodents and hares to larger ungulates such as roe deer (*Capreolus capreolus*), reindeer (*Rangifer tarandus)* and chamois (*Rupicapra rupicapra*). The Swedish lynx population is about 1500-2000 individuals and approximately 50 % of the lynx are found in the reindeer husbandry area (Liberg and Andrén 2006).

An animal tries to maximize its fitness within the frames that the environment offers. The behaviour can be divided in two classes, innate and learned behaviour. Both behaviours have a genetic and environmental foundation. Innate behaviour depends on the production of a nervous system that "recognizes" certain stimuli and "orders" specific response to them. Learned behaviour depends upon the development of a nervous system that is capable of storing selected kinds of information in the environment and using this stored input to modify its behaviours in adaptive ways (Alcock 1975). Thus, individuals behaving in the best way regarding to its environment will have best chance of being successful.

Lynx behaviour around kill sites has been previously studied. Lynx usually utilize their kill for several days and between feeding sessions they take rest sites and engage in other activities (Jedrzejewski et al.1993, Okarma et al. 1997, Pedersen et. al 1999, Jobin et al. 2000). Various environmental parameters such as complex habitat structures for hunting and low visibility for resting have been found to influence lynx behaviour (Podgórski 2008). These earlier studies were performed using radio-collars with VHF-technique. This conventional telemetry involves great working efforts for every position with a number of complicating factors such as light, weather conditions, and inaccessible terrain. All these factors complicate more fine-scale studies but due to new Global Positioning System (GPS) technology it is possible to study the ecology and behaviour of the animals in a much finer scale (Moen 1996, Schofield et al. 2007, Girard et al. 2002).

By using new GPS-technology, I have examined lynx behaviour around reindeer kill sites. The main prey for lynx in northern Sweden is the semi-domestic reindeer, which creates a conflict between reindeer owners and the lynx. The reindeer owners are given compensation for their losses but it is an ongoing discussion whether it is a "fair" compensation system. The compensation system is based on the number of lynx reproductions within a reindeer management unit, i.e. for the risk of having predators, and not on documented losses. A model for estimating the number of killed reindeers by lynx would be a good tool to improve the compensation system. To compute models based on GPS-locations and movement patterns between GPS-locations to find kill sites without costly field confirmation has been the objective in several studies. Webb et al. (2008) found a model that could detect 100 % of large-bodied animal killed by wolf. Zimmerman et al. (2007) found that a low proportions of afternoon positions, many positions and visits being indicators of a cluster being a moose kill made by wolves. Anderson and Lindzey (2003) found a strong relationship between number of nights a cougar spent at a cluster and the probability of that being a kill.
The aim of this study was to describe variables affecting lynx behaviour around reindeer carcass. This study is a smaller part of a greater study on lynx predation of reindeer and lynx interaction with wolverine (*Gulo gulo*) around carcasses.

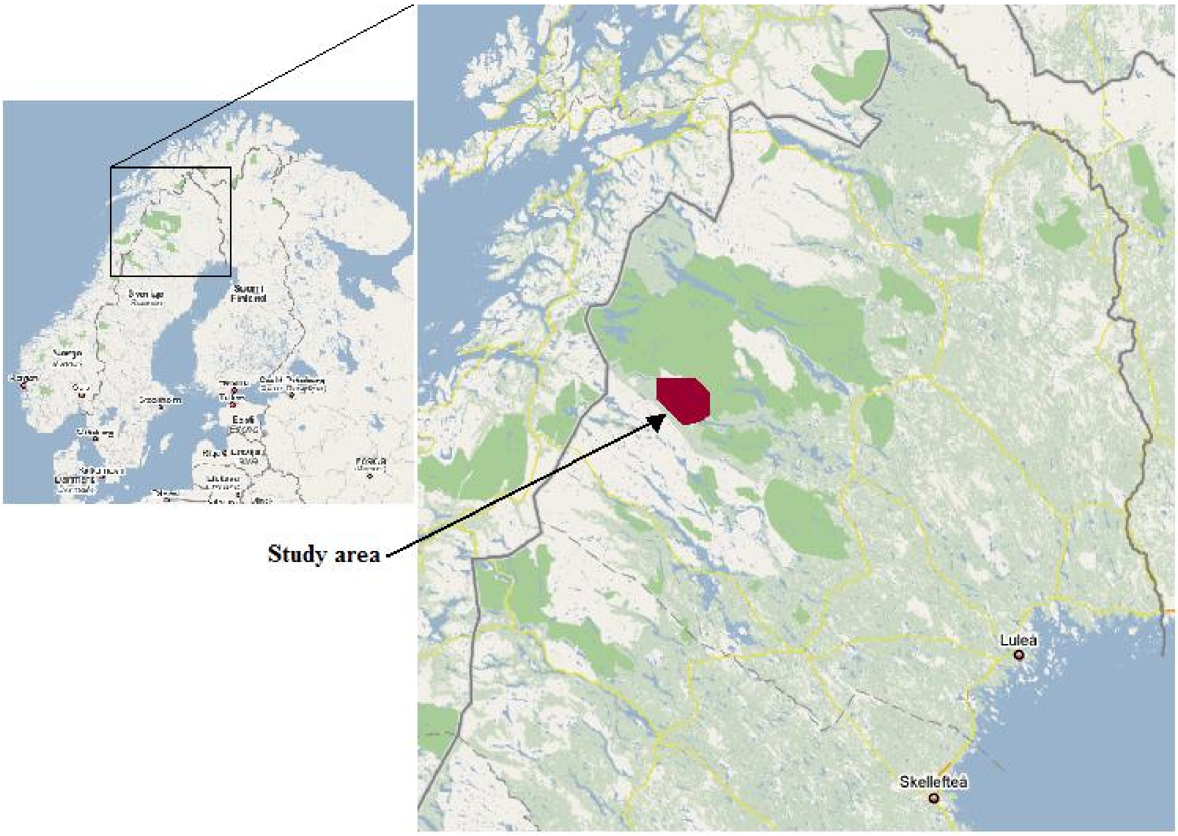

Figure 1. Locality of the study area in northern Sweden.

Study area

The study area covers 2000 km^2 and range from Kvikkjokk in the southeast to the southern borders of Sarek National Park in the north and to the east parts of Padjelanta National Park in the west (Figure 1). The climate is continental with cold winters (-10 to – 13 °C in January) and medium warm summers (13 to 14 °C in July). The area is usually covered with snow from October to May, with a snow depth of over one meter. The study area is dominated by treeless alpine areas (81 % of the study area). The forested area is composed of Norway spruce (*Picea abies*) and Scots Pine (*Pinus sylvestris*) in the lower parts (7 %) and Downy birch (*Betula pubescens Ehrh.)* forest at higher elevation (12 %). The tree line is at 600-700 m a.s.l. and is formed by Downy birch (Grundsten 1997). The topography varies from 300 m a.s.l in the valleys to peaks over 2000 m a.s.l. The Eurasian lynx co-exist in the study area with wolverine and brown bear (*Ursus arstos*). Other important scavengers are red fox (*Vulpes vulpes*), golden eagle (*Aquila chrysaetos*), pine marten (*Martes martes*) and raven (*Corvus corax*). The most important prey for lynx in the study area is semi-domestic reindeer (Pedersen et al. 1999). The reindeer in the study area mainly belongs to Jåkkåkaska and Tuorpon reindeer herding districts with herds of approximately 3900 and 6200 reindeer, respectively (2006). The semi-domestic reindeer migrate 100-150 km between summer ranges in treeless alpine areas in the northwest and winter ranges in the forest in the southeast. The study area is situated roughly in between summer and winter ranges. Lynx in this area do not follow the migrating reindeer (Danell et al. 2006) but reindeer is still the main prey throughout the year. Other important prey species for lynx are rock ptarmigan (*Lagopus muta*), willow grouse (*Lagopus lagopus*), capercaillie (*Tetrao urogallus*) and mountain hare (*Lepus timidus*). Moose (*Alces alces*) are also found in the study area, but are not preyed upon by lynx.

Methods

Capture of lynx and wolverine

In February 2008, four lynx and five wolverines were captured and equipped with GPS-collars (GPS plus mini with VHF-download, Vectronic Aerospace GmbH, Berlin, Germany). The animals were already equipped with intraperitoneally implanted VHF-transmitters and were localised by radio-tracking from helicopter. The animals were immobilized by darting from helicopter. A few additional lynx (3) and wolverines (3) were equipped with GPS-collars in April to June to have more animals with overlapping home ranges. The handling scheme of lynx and wolverine has been examined by the Swedish Animal Welfare Agency and fulfils ethical requirements for animal research.

Fieldwork

Data for the analyses were collected during two intensive periods: winter (2008-03-17 to 2008-04-28; 26 positions/day) and summer (2008-07-16 to 2008-08-27; 38 positions/day). The aim of this part was to find kills made by GPS-collared lynx and wolverine. We downloaded the data from the GPS-collars with VHF-communication. This was done both from helicopter and from snowmobiles during the winter period. For the summer period we only used helicopter. The GPS locations were plotted using GIS (ArcView 3.2). We selected suspected kill sites by looking at clustered positions. The positions for the suspected kill site were downloaded to a Handheld GPS-unit (Garmin 60 CSx) and visited in the field by use of helicopter, snowmobile, skis or by foot to confirm whether there was a kill or not.

Data collection

I chose to analyse data from 4 lynx individuals where 8 or more carcasses were found during the two periods (table 1). For the winter period the GPS-collars were programmed to take a position every 30 minutes between 17:00 and 05:00 and one position at 11:00, except for one collar (fitted on Kaluno), which was programmed to take a position every 30 minutes for 24 hours. During the summer period the GPS-collars were programmed to take a position every 30 minutes between 14:00 and 08:00 and one position at 11:00. In addition, I used four kill sites from before the start of the intensive period in winter (2 sites with 3 pos/day and 2 with 8 pos/day). The interruption of the 30-minute positioning in the mid-day was a trade-off between saving batteries and to get good enough data to find kill sites. A previous study showed that lynx are less active during mid-day (Mattisson and Andrén, 2007), thus the risk of missing carcasses should be low during this time. The GPS-collars were programmed to take 3 positions a day outside of the intensive periods, i.e. before winter period and between winter and summer periods with exception for Kaluno’s collar which took 8 positions per day outside the intensive periods.

Table 1. Information about lynx included in this study. Data for the study was collected in two periods, summer and winter 2008.

Individual	**Gender**	**Age(**years**)**	**Period**	**Status**
Grim	m	6	winter + summer	single
Kaluno	m	9	winter + summer	single
Bodil	f	8	winter + summer	family group
My	f	3	summer	single

Data handling

We found prey remains of other animals than reindeer, such as hare, capercaillie and ptarmigan. However, I have only looked at kill sites of reindeer in this study. The lynx is known to be in the surroundings of its kill during a couple of days and to visit the carcass to feed (Okarma et al. 1997). To estimate the time a lynx spent at and around a reindeer carcass and number of visits to the carcass, I created 2 buffer zones (50 and 150 m) around the reindeer carcass. I used these two buffer zones for all analyses. I did not include positions that clearly had nothing to do with the carcasses, like positions from weeks after the last other position at the carcass. The first position within the buffer zone was assumed to be the time when the reindeer was killed. As long as the positions were contiguous inside the buffer zone, I consider it as one visit. If one position was outside the buffer I counted the next position inside the buffer as a new visit. I calculated the time for each visit and added 30 minutes. The extra 30 minutes was added because it is possible that the lynx entered the buffer one minute after the last position outside the buffer and stayed inside the buffer 29 minutes after the last consecutive position in the buffer, so 15 minutes before the first position and 15 minutes after the last position is a mean of the possible error. To get the effective time, i.e. the time that the lynx actually spent at the kill site, I added all times from single visits. I calculated total time around the kill site from the first position in the buffer to the last position in the buffer, plus the extra 30 minutes.

I defined maximum distance from the carcass as the distance to the position furthest away from the carcass before the lynx returned to the carcass. The lynx would most often leave and return to the carcass several times so therefore I used the mean from all these maximum distances. I calculated distance to rest sites as the distance from the carcasses to the first rest site in between visits. I defined a rest site as a place where the lynx was situated for at least 30 minutes, i.e. at least two consecutive positions less than 10 m apart. I have seen, by studying positions at confirmed rest sites, that using positions 10 meters or less from each other as rest sites is suitable. I also defined the positions at 11:00 as a rest site. There were cases when the lynx had several rest sites in between visits, but I only used the first one, as at this site the lynx is still bonded to the carcass in its behaviour but is assumed to feel secure enough to take rest. On some occasions the lynx walked away from the kill site and returned without resting. These cases resulted in a new visit but not a new rest site.

The habitat at the kill site was classified into four classes; alpine heath (vegetation above the tree line mostly consist of heath, lakes were also included due to similar visibility and complexity), boulder fields (sparse vegetation with mainly naked rock), mountain birch and conifer forest (mainly spruce and pine). The classes were chosen to represent differences in visibility and sheltering structures but also to secure a meaningful data set from a statistical point of view.

Analyses

I tested for correlation between total time at carcass and effective time at carcass, number of visits and number of rest sites using Pearson correlation. I tested different factors possibly affecting effective time at kill site, total time at kill site, mean maximum distance from kill site and mean distance to rest sites using General Linear Model (GLM). Factors included in the analyses were Individual, Period, Habitat, Slope, Carcass type and Wolverine-factor (Table 2). The factor Individual was a random factor taking into account the differences among the four different lynx. The factor Period was a fixed factor, winter (2008- 03-17 to 2008-04-28) and summer (2008-07-16 to 2008-08-27). Habitat was a fixed factor with 4 classes; boulder fields, alpine heath, mountain birch forest and conifer forest. Slope was a covariate and varied from 0-65°. Carcass type was a fixed-factor with 4 classes; summer calf, winter calf, unknown and adult. The Wolverine was a fixed factor with 3 classes; kill site visited by a wolverine: 1 - before the lynx left the kill, 2 - after the lynx left the kill and 3 - unknown (no collared wolverines had visit the carcass, but it could have been visit by a non-collared wolverine). I used backward elimination to find the best model. Only main factors were included. I used paired t-test to test if there was a selection for steeper slope for rest sites compared to where the reindeer carcass was found. I used contingent table (Chi-2 test) to test the habitat distribution of reindeer carcasses compared with the available habitat in the study area.

I used ArcGIS 9.0 to calculate the slope for carcass and rest sites. For all the other GIS calculations I used ArcView 3.2. Pearson correlation tests and GLMs were conducted using SPSS 12.0.1. and Chi-2 and t-test tests using Statview 5.0.1

Results

In most of the analyses, I only present results from the 50 meter buffer size, since the results from the different analyses gave the same results for the 150 meter buffer size. However, when there was a difference i.e. the analysis gave a significant result from one buffer but not the other I present results from both buffer sizes. I found 31 reindeer carcasses during winter period and 46 during summer period. Most reindeer (74 %) were killed during the night, from 19:30-03:00, 12 % of the reindeer were killed from 03:30-16:00 and 14 % of the reindeer were killed from 16:30-19:00 (Figure 2).

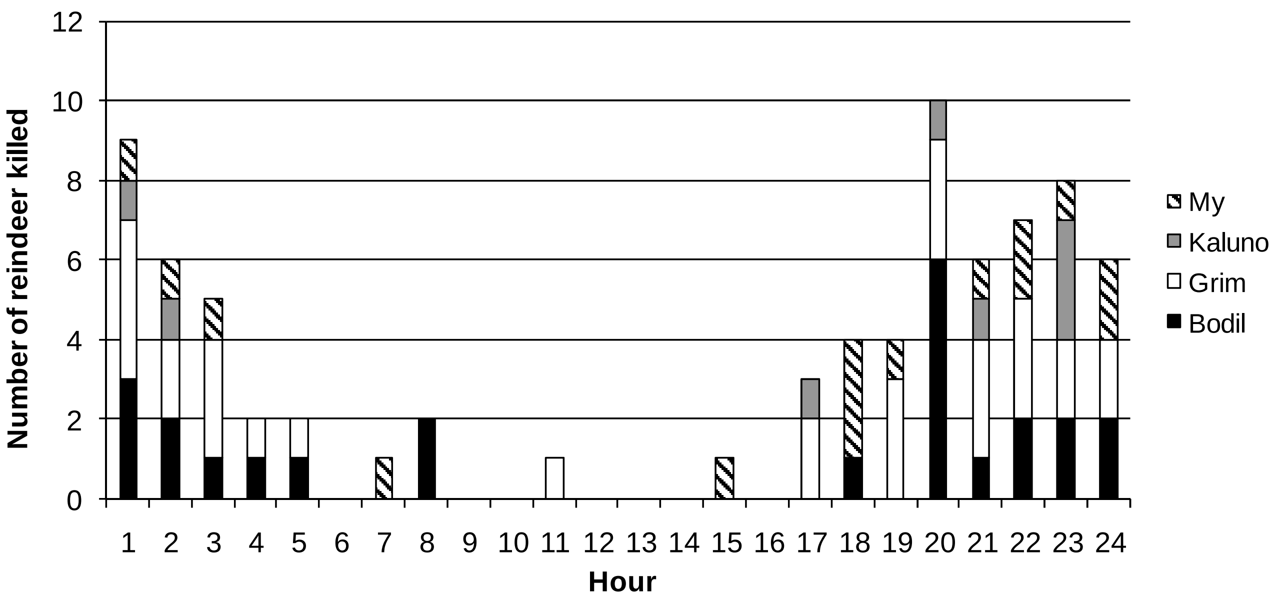

Figure 2. Number of lynx killed reindeer in relation to hour of the day. 1 = 00:01-01:00, 2=01:01-02:00 etc. The time of killing is defined as the time of first lynx position within 50 meters from the carcass. The different sections of the bars represent different lynx individuals. No positions were taken between 08:01 and 10:59, 11:01-13:59, 15:01-16:59. Data are from winter and summer 2008.

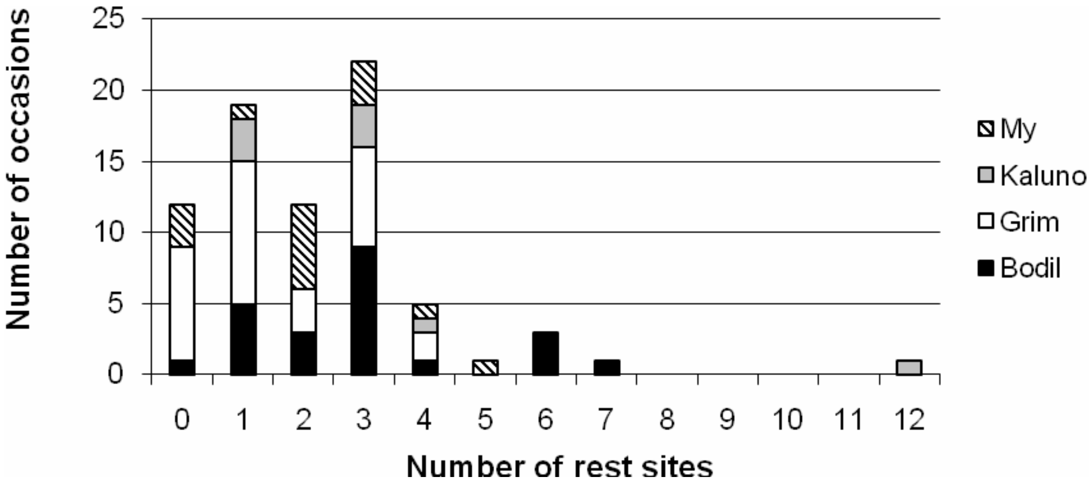

Figure 3. Mean value of the total time lynx spent at killed reindeer (77 kill sites) for 4 lynx in different types of vegetation. There were 8 kill sites in boulder fields, 53 in alpine heath, 12 in mountain birch and 4 in conifer forest. Error bars show 95% confidence interval. Data are from winter and summer 2008.

Lynx spent on average 40 hours around a kill site but only about 10 hours within 50 meters of the carcass. Lynx revisited carcasses on average 4 times and left for up to 7554 meters from the carcass to take rest (Table 2). On some occasions lynx left a carcass and returned without taking rest site, but most often when they left the carcasses they took at least one rest site. At a majority of the kills (93%) lynx left the kill ≤ 4 times (figure 4) to take rest sites. Both number of visits and number of rest sites increased with increased total time (Pearson correlation, $r = 0.716$ and $r = 0.764$ respectively).

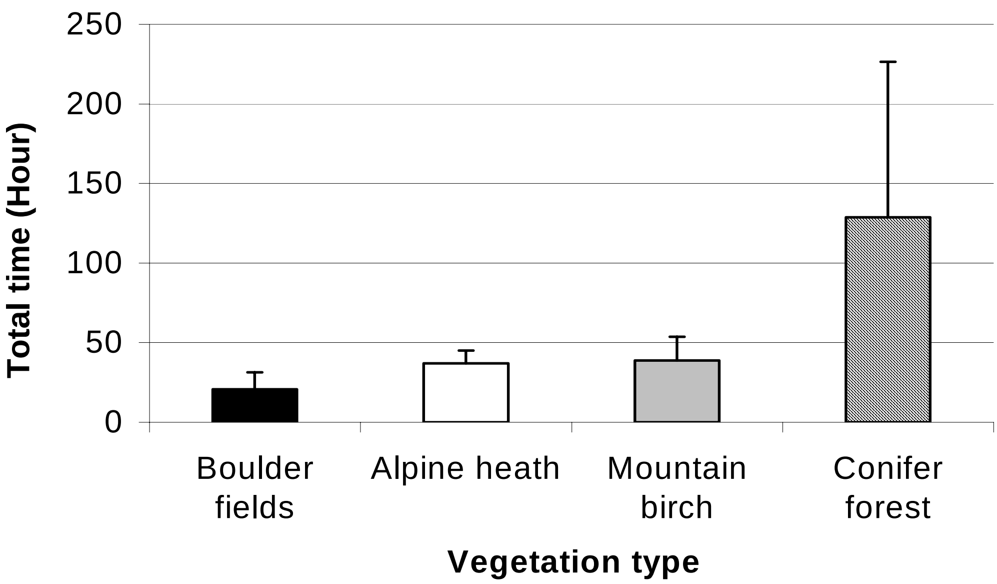

Figure 4. Number of times lynx walked further than 50 meters from its killed reindeer to rest and later return to the killed reindeer. The different sections of the bars represent different lynx individuals.

Number of visits to the kill site was not significantly different when wolverines had visited the kill site ($\bar{x}$ = 4.9) or not ($\bar{x}$ = 3.8; t-test, t = 1.24, F = 0.99 df = 25, p = 0.33). Both effective and total time lynx spent at kill sites varied significantly between individuals (Table 3). For total time, males (Kaluno and Grim) spent the shortest time and family group (Bodil) the longest. Lynx spent more time, both total and effective, at kill sites in conifer forest than in alpine heath (only effective time) and boulder fields (total time only 150 m buffer) (figure 3). The effective time at a kill site increased significantly with increased slope at the kill site (figure 5). The effective time increased with increasing total time at the kill site (Pearson correlation, r = 0.635). It was also a difference between winter and summer with longer total time spent at the kill in winter, but this difference was only seen in the 150 m buffer (p = 0.002).

There was an individual difference in both the distance to first rest site (only 150 m buffer) and the maximum distance walked from a kill site (only 50 m buffer) between visits. Lynx walked shorter distances both to the first rest site (only 50 m buffer) and maximum distances away from a kill site in steep slopes compared to less steep slopes. They also walked longer distance from kill sites in winter than in summer. Lynx selected rest sites at places with significantly steeper slope ($\bar{x}$ = 20° ± 6° SD) than the at the kill sites ($\bar{x}$ = 13° ± 6° SD; paired t-test; t = 5.14, df = 64, p<0.0001).

There was no significant effect of the presence of wolverine at a lynx killed reindeer on lynx behaviour (table 3). Wolverine factor was among the first factors removed using backwards elimination (p = 0.22 and p = 0.58 for the 50 m and 150 m buffer, respectively). Excluding all cases with the unknown level in the wolverine factor (i.e. when it was not known if a wolverine had been at the carcass) did not change the results. The wolverine factor was still among the first factors to be removed (p = 0.48 and p = 0.34 for 50 and 150 meter buffer, respectively).

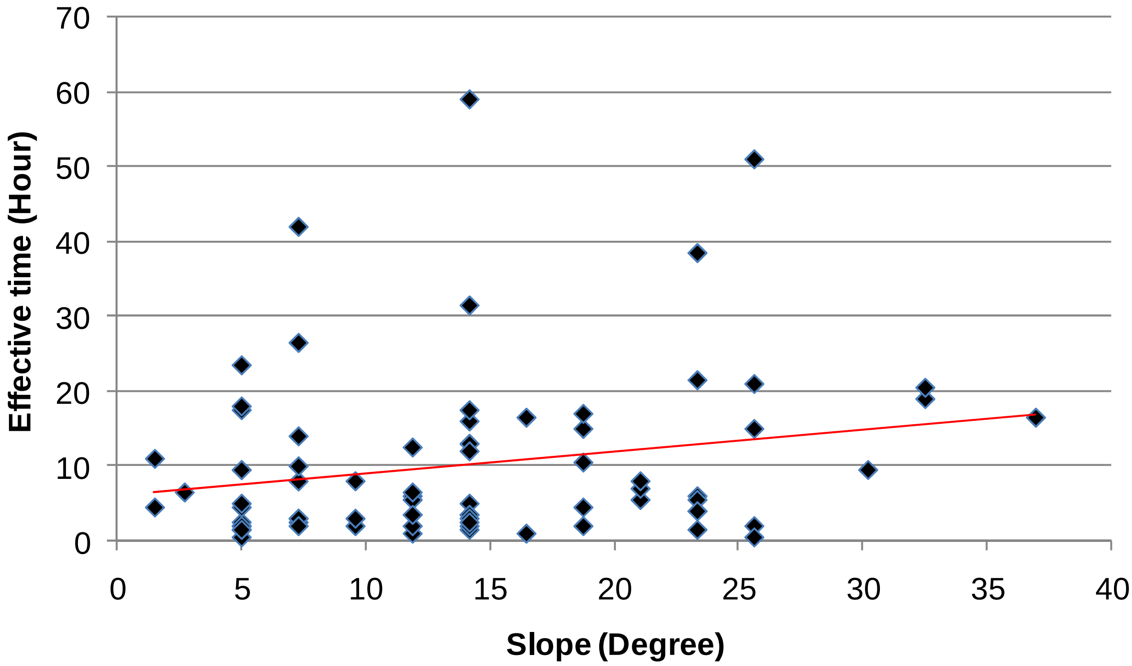

Figure 5. The actual time (effective time) lynx spent within a 50 meter radius to its killed reindeer in relation to slope at the kill site. The data are from 77 kill sites produced by 4 lynx from two study periods, summer and winter 2008.

Table 2. Summary statistics of GPS collected data for 4 lynx that produced 77 reindeer kill sites. Data are from two study periods, winter and summer in northern Sweden 2008. 6 variables are shown for two distances (Buffers) from the killed reindeer.

Variables	Buffer	Mean	SD	Min	Max
Number of visits	50	3.9	3.5	1	16
	150	3.7	3.3	1	12
Number of rest sites	50	2.3	1.9	0	12
	150	2.1	1.8	0	10
Effective time at prey (hour)	50	10.1	11.4	0.5	59
	150	13.8	14.2	1	71
Total time at prey (hour)	50	40.3	40.0	0.5	251
	150	50.8	46.7	1.5	251
Max Distance from prey (m)	50	1254	1980	51	11615
	150	1810	2370	151	11615
Distance to rest sites (m)	50	898	1311	51	7554
	150	1278	1503	151	7554

Table 3. Results from General Linear Model. Lynx behaviour as dependent variables in 50 and 150 meters (buffers) from its killed reindeer and the effect of six independent variables, given as p-values. Bold values indicate p < 0.05, italic values indicate 0.05 < p < 0.20 and "-" indicate p > 0.20.

		Independent variables					
Dependent variable	Buffer	Individual	Period	Habitat	Slope	Carcass type	Wolverine
Effective time at prey	50	**0.031**	-	*0.155*	**0.012**	-	-
	150	**0.031**	-	**0.032**	**0.006**	-	-
Total time at prey	50	**0.016**	*0.164*	**0.001**	-	-	-
	150	**0.023**	**0.002**	**0.001**	-	-	-
Max distance from prey	50	**0.05**	**0.033**	-	**0.03**	-	-
	150	*0.061*	**0.019**	-	-	-	-
Distance to rest sites	50	*0.104*	-	-	**0.008**	*0.119*	-
	150	**0.017**	-	-	*0.116*	*0.085*	-

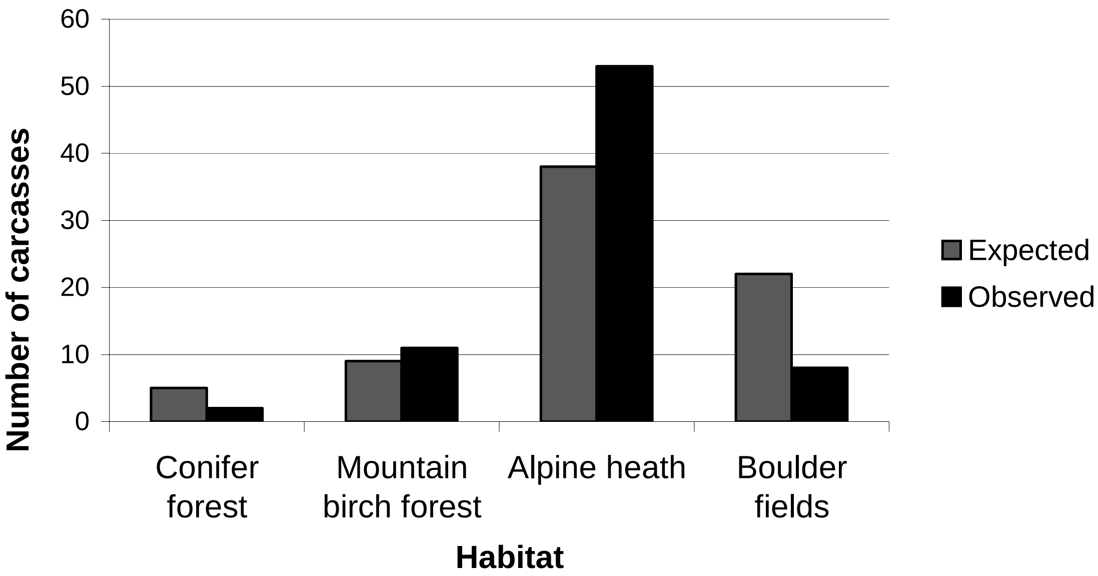

Figure 6. The number of lynx killed reindeer found in different habitat (black bars) compared with expected kill site distribution if reindeer was killed in each habitat proportional to available habitat in the study area (grey bars).

There was no significant difference in habitat at kill sites between winter and summer carcasses (χ^2 = 5.74, df = 3, p = 0.12). Therefore the data was pooled for further analyses. There was a significant difference between the habitat at kill sites and habitat distribution of the study area (χ^2 = 10.49, df = 3, p = 0.015). Reindeer was killed more than expected in alpine heath and less than expected in boulder fields (Figure 6).

Discussion

This study supports the idea that lynx have a precautionary behaviour; they are nocturnal hunters, who stay longer at carcasses in dense habitat than in open areas. They take rest sites in steeper slope than their kill sites and steeper slope at the kill site shorten the distance between daybed and carcass. The lynx usually stayed around the reindeer carcass for 40 hours (± 40 SD), which is similar to other studies (Pedersen et. al 1999, Jedrzejewski et al. 1993, Jobin et al. 2000, Okarma et al. 1997). The lynx moved forth and back between the carcass and rest sites, usually within 1 km from the carcass, a movement pattern also described by Okarma et al. (1997).

A lynx cannot consume an entire animal as large as a reindeer (mean slaughter weight of a female in winter is 29 kg), even if the lynx uses it for several days. The daily food requirement for lynx is around 2 kg (Haglund 1966) and Jobin et al. (2000) estimated that a lynx consumed about 2 kg (± 0.9 SD) per night. Thus, large parts of ungulate kills are left by the lynx (Okarma et al. 1997, Pedersen et al. 1999) available for scavengers like wolverines, ravens and golden eagles. The effective time ($\bar{x}$ = 10 hours) was only approximately one-fourth of the total time. The effective time is a better measurement of lynx carcass use than total time. As expected, most of the kills occurred during night, when lynx are more active (Mattisson and Andrén 2007) and the lynx was mainly at the kill site during the night. These behaviours leaves lot of opportunities for scavengers to forage on the carcass even though the lynx is in the surroundings, especially for day active species like ravens and golden eagles.

There were large individual differences in time and space use around the kill sites, which makes it hard to draw any general conclusions of the lynx behaviour as few individuals were used in the analyses. However, parts of the differences among individuals might be due to that they represent different categories (male, family group and young female without kittens). One of the males (Kaluno) spent the longest effective time by the kill sites, probably because many of his kills (4 out of 8) were in coniferous forest. In the coniferous forest lynx may feel more protected and therefore do not have to walk far to seek shelter while resting. Bodil and her kitten spent more total time at the kills than the others. It might be more important for her to stay and consume most of the food source. In contrast, Okarma et al. (1997) found that family groups spent the shortest total time at kill sites. In their study, roe deer was the main prey of lynx, which is a much smaller prey than the reindeer. Breitenmoser and Heinrich (1993) showed that family groups tend to utilize more of their prey. In addition, Pedersen et al (1999) showed that lynx family groups in our study area only consumed 60 % of killed reindeer so even though family groups stay long at a kill, they may still not have consumed it fully. Bodil and her kitten often returned to rest in a favourite spot (a large boulder field) after killing a reindeer (18 of 24 kills) even though the kill site was far away. This favourite spot results in Bodil having the longest distances from the prey to the rest site, which may add on to increase total time but not the effective time at the kill.

Several times, the lynx killed a new reindeer before leaving the previous kill. This shows that the lynx can switch to hunting mode even if it has a food source available. This scouting behaviour (the lynx tries to find potential prey while still using its latest kill) could be an adaptation to a migratory prey with large variation in density.

Most of the prey in summer was reindeer calves which explain the shorter total time at a kill site in the summer, as smaller prey are consumed faster (Breitenmoser and Heinrich 1993). However, the effective time does not differ between summer and winter. One may expect that a larger animal (as an adult reindeer in winter) will take longer time to consume, but the lynx do not consume the entire kill (Pedersen et al 1999). The actual feeding behaviour (effective time) did not seem to differs between summer and winter so other factors must play a roll in increasing total time around the kill site in winter. Schmidt (2008) found that lynx moved over greater distances when prey density was low. The maximum distance between visits was longer in winter and can be a result of lower reindeer densities in winter. With longer distances moved between visits to the carcass in winter and the longer time away from the carcass the total time would increase even if the effective time at the carcass was the same. Another idea is that total time in winter may be longer because lynx do not have to hurry to finish the food before it goes bad since meat stays fresh longer in the winter.

The lynx stayed longer at the kill site in denser habitat and steeper slopes and in steeper slopes they walked shorter distances from the carcasses to rest sites, perhaps because this habitat features offer better protection for the lynx. The need for safety can be of two origin; safety against enemies (humans, bears, wolverines and scavengers) or safety against unfavourable weather. Podgórski et al. (2008) suggested that lynx rest sites were chosen regarding shelter against bad weather. Furthermore, in open habitat lynx can easier spot new prey which could encourage a shorter time by the previous prey compared to denser vegetation types. Selva (2006) found that common ravens and white-tailed eagles found carcasses faster in open terrain. This might explain the shorter time at prey in alpine heath and boulder fields. The carcass will be consumed faster if scavengers also utilize it.

An earlier study from the same area (Pedersen et al. 1999) estimated mean distance to kill sites and rest sites to be 250 m, which is considerably shorter than this study. Pedersen et al. (1999) used a different method (snow tracking) to find the rest sites and they included also rest site also those closer than 50 m from the carcass, whereas I used GPS-positions and defined a rest site as two or more positions together further than 50 m away from the carcass. Thus, including also rest sites closer than 50 m from the carcass will lower the mean value as compared to my definition of a rest site.

I did not find any significant effect of presence of wolverines on lynx behaviour around a reindeer carcass. Thus, the hypothesis that the total time lynx spent at its prey would decrease if it had to share it with wolverines or the effective time increase to protect their kill was not supported. However, if a large portion of lynx killed ungulates is not used by the lynx (Okarma 1997, Liberg and Andrén 2006), wolverines' use of the carcasses may not affect the time lynx spend at the kill. Furthermore, the lynx might not find it worth the risk to defend its prey considering the risk of injuries. Maybe there is a mutual avoidance of lynx and wolverine at the kill site. The wolverine use the lynx killed reindeer when the lynx has left. This can actually be an indication of commensalisms, i.e. one organism benefiting from the interaction and the other being unaffected (Stilling 2002). The lynx are not affected by the wolverine but wolverine profiting from utilizing lynx kills.

More reindeer carcasses were found in alpine heath as compared with the habitat composition of the study area. This is not surprising, because this is also the habitat mainly used by reindeer (Skarin 2008). However, I could not estimate the relative risk of predation in different habitats, as I had no data on reindeer habitat selection from my study area. Boulder field terrain, where only 8 of 77 carcasses were found, is probably not used much by reindeer because this habitat do not provide much grazing opportunities and this could explain why few reindeer carcasses were found in this habitat.

There are other factors not measured in this study that might influence lynx behaviour around kill sites. Moonlight influenced hunting success for lions with higher success during darker periods (Funston et al. 2001). Weather might also influence the lynx behaviour around kill sites. Storms and precipitation may result in rest sites in more protected areas and an overall lower activity.

Some decades ago wolf inhabited the study area and might have caused a threat to the lynx but today, with few natural enemies, one might question lynx precautious behaviour as a result of avoidance of natural enemies. Instead one driving factor for a precautious behaviour in this area could be human activity. Lynx being persecuted and killed by humans (Andrén et al. 2006) may have an impact on its behaviour with the ones with a precautious behaviour having the greatest chance of survival.

Kyle et al. (2009) were successful in conducting accurate predation models of cougars' predation on prey > 8 kg using GPS-data. Many variables used in their model were similar to the ones I investigated such as duration of cluster, number of points at the cluster and fidelity to the cluster site. Many of these parameters should be applicable to a lynx predation model on reindeer since both the lynx and the cougar are solitary hunters who utilize large kills for up to several days. Ecological models are always simplifications of the reality but as mentioned in the introduction, these results can hopefully be helpful showing which variables that is useful in conducting good lynx predation rate models on reindeer from GPS data.

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