Mortality of semi-domestic reindeer Rangifer tarandus in central Norway

Authors: Nybakk, Kai, Kjelvik, Ola, Kvam, Tor, Overskaug, Kristian, and Sunde, Peter

Source: Wildlife Biology, 8(1) : 63-68

Published By: Nordic Board for Wildlife Research

URL: https://doi.org/10.2981/wlb.2002.009

Mortality of semi-domestic reindeer *Rangifer tarandus* in central Norway

Kai Nybakk, Ola Kjelvik, Tor Kvam, Kristian Overskaug & Peter Sunde

Nybakk, K., Kjelvik, O., Kvam, T., Overskaug, K. & Sunde, P. 2002: Mortality of semi-domestic reindeer *Rangifer tarandus* in central Norway. - Wildlife Biology 8: 63-68.

During the last decade, losses of semi-domestic reindeer *Rangifer tarandus* have increased in central Norway. Natural mortality in a semi-domestic reindeer herd was studied by use of mortality sensing transmitters. From 15 April 1995 to 15 April 1996, 135 of 612 animals equipped with radio collars were found dead. Adult females (>2 years old) suffered a mortality of 18.3%, of which 40.5% was due to predation. Yearlings suffered a yearly mortality of 20.2% of which 66.7% was due to predation. Calf mortality from 6 August 1995 to 15 April 1996 was 31.0%, of which 75.3% was due to predation. Predation by Eurasian lynx *Lynx lynx* was the predominant cause of death, with 39.3% of the total mortality. Accidents were the second most important cause of death, with 16.0% of the total mortality. Peaks in mortality were registered in September, November and January.

Key words: Eurasian lynx, golden eagle, mortality, predation, Rangifer tarandus, reindeer

Kai Nybakk, Ola Kjelvik**, Tor Kvam***, Kristian Overskaug[#] & Peter Sunde[¤], Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim, Norway - e-mail addresses: kai.nybakk@engineering.statkraft.no (Kai Nybakk); Ola.Kjelvik@hint.no (Ola Kjelvik); tor.kvam@hint.no (Tor Kvam); kristian.overskaug@chembio.ntnu.no (Kristian Overskaug); Psunde@zi.ku.dk (Peter Sunde)*

Corresponding author: Tor Kvam

Present addresses:
**Bergljots vei 5C, N-0575 Oslo, Norway*
***Finsås kurssenter, N-7760 Snåsa, Norway*
****Nord-Trøndelag University College, P.O.Box 2501, N-7729 Steinkjer, Norway*
[#]NTNU Vitensentret, Postboks 117, N-7400 Trondheim, Norway
[¤]University of Copenhagen, Department of Population Ecology, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark

Received 25 January 1999, accepted 3 April 2001

Associate Editor: Heikki Henttonen

Losses of semi-domestic reindeer *Rangifer tarandus* increased in Norway through the 1980s and early 1990s. Predation is suspected to be the primary cause of mortality in wild reindeer and caribou (Bergerud 1980, Filonov 1980, Miller, Broughton & Gunn 1988, Hearn & Luttich 1989, Bjärvall, Franzén, Nordkvist & Åhman 1990, Mahoney, Abbott, Russell & Porter 1990, Whitten, Garner, Mauer & Harris 1992, Adams, Singer, & Dale 1995). Although reindeer owners have always recognised that carnivores inflict losses on their herds, quantitative studies are lacking (Mysterud & Mysterud 1995). 'Unknown cause' is by far the most used label on carcasses of lost animals in reindeer husbandry. The aim of this study was to identify, date and quantify the causes of mortality in a semi-domestic reindeer herd in an area in central Norway known to hold a high density of large carnivores, especially the Eurasian lynx *Lynx lynx*.

Study area

The study took place in the northwestern part of the county of Nord-Trøndelag, situated in central Norway between 64°35'-65°00'N and 12°00'-13°00'E. The study area is mountainous with peaks reaching up to 1,100 m a.s.l. The treeline is found at 300-400 m a.s.l. in coastal areas and at 400-500 m a.s.l. inland. Boreal spruce forest, bogs and alpine plants dominate the vegetation. Norway spruce *Picea abies* occurs up to the treeline. In the subalpine area Scots pine *Pinus sylvestris* occur together with ericaceous heather and lichens. In 1969, Lyftingsmo (1974) found that parts of the area had good grazing with favourable snow conditions and lichens growing abundantly among heather and on bogs. The large bogs in the subalpine areas also provided early green grazing. The winter grazing area had a carrying capacity of 6.25 reindeer per km^2 in 1969 (Lyftingsmo 1974). Investigations of reindeer pastures have not been given priority in this area in recent years due to the obvious needs in Finnmark, where overgrazing, in contrast to the situation in central Norway, constitutes a severe problem in reindeer husbandry.

The period of snow cover varies depending upon elevation and distance from the sea. In winter 1995/96 the first snow came on 1 November at 400 m a.s.l., but at the coast it melted away several times in November and December. At altitudes above 800 m the snow came in October and did not melt until May. The snow cover that winter was about 70-90% of the normal snow cover in the area. The normal annual precipitation is 1,137 mm ranging within 934-1,340 mm (Norwegian Meteorological Institute, pers. comm.). The normal temperature in the area ranges from -7.2°C in January to 11.9°C in July (DNMI, pers. comm.).

Lynx, wolverine *Gulo gulo* and golden eagle *Aquila chrysaëtos* are present in the area. Brown bear *Ursus arctos* irregularly roam the area, and a wolf *Canis lupus* was last seen in 1986. Moose *Alces alces* and roe deer *Capreolus capreolus* are common below the treeline.

Central Norway is the southernmost part of the reindeer herding area in Norway. Reindeer husbandry is the basis of the ancient culture of the Saami, who have status as aboriginal citizens in accordance with ILO-convention no 169. The owners guard the semi-domestic reindeer with varying intensity all year round. Three to four times a year the reindeer are fenced up for marking and slaughtering, and on these occasions weighing, radio-collaring and counting can be carried out.

Material and methods

During 15 April 1995 - 15 May 1996, 612 reindeer (including 323 calves and 54 yearlings (of both sexes) and 235 adult females) were fitted with mortality-sensing radio collars (TELEVILT®) operating on the 142 MHz band evenly distributed on six different frequencies. This kind of transmitter remains silent as long as the bearer is active, but emits a signal after the animal has remained motionless for about two hours.

Reindeer were classified by sex and age as calves, both sexes (< 1 year old), yearlings, both sexes (1-2 years old), and adult females (>2 years old), and were weighed and ear-tagged during routine seasonal roundups of the herd. Non-calf reindeer were weighed in box scales, and calves were held and weighed on bathroom scales (weight of person with reindeer calf minus weight of person). Calves were ear-tagged and radio-collared in August only.

Radio-collared reindeer were monitored daily from the ground, and once a week from aircraft. All carcasses were closely examined using standard autopsy methods, and the sites at which carcasses were found were searched for clues as to the cause of death, including signs of predators such as tracks, scats and hair. The cause of death was classified as 1) killed by lynx, 2) killed by other predators (wolverine, golden eagle, or undetermined predator), 3) 'other death causes' (accidents or disease) and 4) 'unknown'.

The ages of dead reindeer were determined by tooth development for calves and yearlings, and by counts of cementum annulations in reindeer older than two years (Reimers & Nordby 1968).

As reindeer were radio-collared on different dates throughout the year, 'the product/limit method' (Kaplan & Meier 1958, Cox & Oakes 1984) modified by Pollock, Winterstein & Conroy (1989) was used to calculate survival rates for radio-collared reindeer from 15 April 1995 to 15 April 1996. Annual survival rates and 'reindeer-days' (one 'reindeer-day' = one radio-collared reindeer out for one day) were calculated using the computer programme 'Kaplan-Meier survivalship analysis ver. 1.0' (Pollock et al. 1989). Mortality rates distributed by cause of deaths were calculated by means of the computer program 'Micromort ver. 1.3' (Heisey & Fuller 1985). Differences between survival rates were tested by use of 'Contrast' (Sauer & Williams 1989). All other statistical tests were carried out by use of SPSS ver. 7.0 for Windows. The data were examined for statistical significance at a critical level of 5%.

Results

Of the 612 radio-collared reindeer, 135 were found dead during 15 April 1995 - 15 April 1996. Predation accounted for 65.2% (N = 88) of the total reindeer mortality. The recorded mortality was not evenly distributed over the year. Predation by lynx peaked in September, November and January and was lowest in October and December. Accidents peaked in January (Table 1). All accidents except two cases of collisions with cars happened during periods with snow cover.

Adult females and yearlings

Adult females (>2 years old) suffered a mortality of 18.3% (see Table 1). For adult females, accidents were the most important cause of death with 45.9% of the total mortality. Predation accounted for 40.5% of the mortality.

Yearlings suffered a yearly mortality of 20.2% of

Table 1. Annual survival rates and monthly survival of radio-collared reindeer in central Norway during 15 April 1995 - 15 April 1996.

			Interval rates				
				Mortality			
Interval	No of days	Reindeer-days	Survival	Lynx (N)	Other predators (N)	Other death cause (N)	Unknown causes (N)
Adult females							
15 April -15 May	31	4001	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 May -15 June	31	3999	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 June -15 July	30	3870	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 July -15 August	31	4123	99.3	0.0 (0)	0.8 (1)	0.0 (0)	0.0 (0)
16 Augaust -15 September	31	4369	97.9	0.7 (1)	0.7 (1)	0.7 (1)	0.0 (0)
16 September -15 October	30	4939	97.6	0.6 (1)	1.2 (2)	0.0 (0)	0.6 (1)
16 October -15 November	31	5258	97.7	0.0 (0)	0.6 (1)	1.8 (3)	0.0 (0)
16 November -15 December	30	5688	97.9	0.0 (0)	0.5 (1)	1.6 (3)	0.0 (0)
16 December -15 January	31	6529	97.2	0.0 (0)	0.0 (0)	2.8 (6)	0.0 (0)
16 January -15 February	31	6220	96.6	0.5 (1)	1.5 (3)	1.0 (2)	0.5 (1)
16 February -15 March	29	5722	98.0	0.0 (0)	1.0 (2)	0.5 (1)	0.5 (1)
16 March -15 April	31	5997	98.0	0.0 (0)	0.5 (1)	0.5 (1)	1.0 (2)
Annual rates			81.7	1.7 (3)	6.2 (12)	8.1 (17)	2.3 (5)
95% conf. limits	Lower		76.5	0.0	2.8	4.4	0.3
	Upper		87.2	3.7	9.7	11.8	4.3
Yearlings							
15 April -15 May	31	1147	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 May -15 June	31	1147	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 June -15 July	30	1085	97.3	2.7 (1)	0.0 (0)	0.0 (0)	0.0 (0)
16 July -15 August	31	1126	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 August -15 September	31	1118	94.6	0.0 (0)	2.7 (1)	0.0 (0)	2.7 (1)
16 September -15 October	30	1141	97.4	0.0 (0)	0.0 (0)	2.6 (1)	0.0 (0)
16 October -15 November	31	1209	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 November -15 December	30	1260	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
16 December -15 January	31	1420	97.8	2.2 (1)	0.0 (0)	0.0 (0)	0.0 (0)
16 January -15 February	31	1334	93.2	4.5 (2)	0.0 (0)	2.2 (1)	0.0 (0)
16 February -15 March	29	1197	97.6	2.4 (1)	0.0 (0)	0.0 (0)	0.0 (0)
16 March -15 April	31	1271	100	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Annual rates			79.8	10.6 (5)	2.6 (1)	4.4 (2)	2.6 (1)
95% conf. limits	Lower		68.9	1.7	0.0	0.0	0.0
	Upper		92.5	19.4	7.7	10.3	7.7
Calves [a]							
6 August -15 August	10	2640	99.2	0.0 (0)	0.0 (0)	0.0 (0)	0.8 (2)
16 Augguest -15 September	31	8412	94.3	2.5 (7)	1.8 (5)	0.4 (1)	1.1 (3)
16 September -15 October	30	7946	94.5	1.5 (4)	1.8 (5)	0.4 (1)	1.8 (5)
16 October -15 November	31	7857	95.7	3.5 (9)	0.4 (1)	0.0 (0)	0.4 (1)
16 November -15 December	30	7167	95.5	3.3 (8)	1.2 (3)	0.0 (0)	0.0 (0)
16 December -15 January	31	7114	93.7	3.4 (8)	0.8 (2)	1.7 (4)	0.4 (1)
16 January -15 February	31	6564	96.3	2.8 (6)	0.5 (1)	0.5 (1)	0.0 (0)
16 February -15 March	29	5947	97.1	0.5 (1)	1.4 (3)	0.5 (1)	0.5 (1)
16 March-15 April	31	6205	97.5	1.0 (2)	1.0 (2)	0.0 (0)	0.5 (1)
Total period			69.0	15.6 (45)	7.7 (22)	2.8 (8)	4.9 (14)
95% conf. limits	Lower		63.9	11.4	4.6	0.9	2.4
	Upper		74.6	19.8	10.8	4.7	7.4

[a] Calves were not radio-collared until 6 August 1995.

which 66.7% was due to predation (see Table 1). Annual survival rates for the two age classes (yearlings and adult females) of reindeer ≥1 year old were not significantly different ($\chi^2 = 1.433$, df = 2, P = 0.488), and pooling these groups together as 'reindeer ≥1 year old' resulted in an annual survival rate of 82.3%. Predation was the cause of 48.2% of the total mortality in this group. Of 10 documented cases of predation on reindeer by golden eagle, three were adult females 5, 7 and 9 years of age. The 5- and 7-year-old reindeer weighed 65 and 71 kg, respectively. The mean weight in December of adult females in the herd was 66.5 kg (mean = 66.5 kg, SD = 7.5, N = 484).

Calves

Of 323 radio-collared reindeer calves, collared after 6 August 1995, 89 died during the research period. Calf mortality from 6 August 1995 to 15 April 1996 was 31.0%, of which 75.3% was due to predation (see Table 1). The data on calves were tested for sex-specific predation risk, but no indication was found that predators showed any preference for a particular sex ($\chi^2 = 0.009$, df = 1, P = 0.923). In the period 16 August 1995 - 15 April 1996 survival rates of calves and adults were significantly different ($\chi^2 = 11.521$, df = 1, $P < 0.001$). In the same period lynx killed more calves (15.6%) and yearlings (7.9%) than adult females (1.7%).

For a considerable proportion of the autopsied carcasses the cause of death could not be determined ('unknown cause of death'). There is no reason to believe that these cases should be distributed differently on real causes of death than those with known causes of death. The distribution of causes of death should accordingly be based on the number of cases with known causes of death, and not on the total number of radio-collared carcasses.

Predation

Of the total mortality in calves, 89.3% of the cases with known causes of death was due to predation, and predation by lynx was the dominant cause of death reported in our study. Only for adult females did 'other causes' account for more deaths than lynx predation. Lynx accounted for at least 53 of 135 lost reindeer, which is 42.4% of cases in which the cause of death was known, and the wolverine accounted for 6.9% of the total mortality in our study.

Discussion

The main cause for the high reindeer mortality recorded in our study was an inflated lynx population in North-Trøndelag. Based on hunting statistics the population size more than doubled from 1990 to 1996, when 5.3 lynx per 1,000 km^2 was estimated (Kvam 1997). Recent studies report reindeer to constitute 28.1% of the lynx diet in the area, while roe deer constitutes 31% (Sunde & Kvam 1997). Telemetry studies indicate that lynx in the study area tend to kill one medium sized ungulate (reindeer or roe deer plus sheep in summer) every 4-6 days (Kvam, Sunde & Overskaug 1998, Sunde, Kvam, Bolstad & Bronndal 2000).

The wolverine is often dependent on favourable snow conditions to be able to kill reindeer (Haglund 1966). Four of 10 reindeer documented to have been killed by a wolverine were adults. The biggest adult female reindeer killed by a wolverine weighed 73 kg in December 1995. As the lynx tends to leave a larger part of its prey uneaten, it is probable that the numerous lynx population has made it possible for the wolverine to benefit from scavenging lynx prey.

The design of the present study was similar to that of the four-year programme monitoring reindeer calf mortality in Sweden in the 1980s (Bjärvall et al. 1990). The total mortality recorded in our study was higher (31.0%) than the total mortality (14.3%) recorded in Umbyn, Sweden. Predation accounted for a higher part of the total mortality recorded in our study (75.3%) than in the study in Sweden (65%). Caribou herds exposed to predation may lose 50% of the annual calf crop before calves reach 6 months of age (Bergerud 1980), and predation has been reported to constitute up to 93% of the total annual mortality in calves (Mahoney et al. 1990). The annual mortality recorded in our study is, nevertheless, higher than earlier reported from Scandinavia, and supports the hypothesis that predation is a key element in the mortality regime of semi-domestic reindeer in central Norway.

Other causes of death

Besides predation, accidents were the most important cause of death in our study, and were the primary cause of death for adult reindeer. Most accidental deaths were due to falls off cliffs, avalanches, or getting trapped in scree. It is currently discussed to what extent reindeer falling off cliffs were chased by predators. If this were the case one might expect the dead reindeer to be eaten by the predator. In most accident cases, however, the carcasses were 'intact' when found. Thus nothing in our study seems to indicate that predators affected the number of accidents happening. We often observed that reindeer which were later lost in accidents were foraging on foliose lichens in the scree or near the rock crack where they later got stuck. With no chance of getting up again they starved to death there before they were located by radio telemetry. The reindeer tended to forage in steep areas in periods with deep snow, as the snow cover is not so deep there and it is easier to find food. In our investigation, accidents and disease constituted 8.1% annual mortality in adult female reindeer. Losses of this size could be expected in a hypothetic situation with no predation. The recorded mortality rate for calves (31.0%) obviously underestimates annual mortality because some calves must have died before radio-collaring was carried out. Calves were collared on 6 August, and normal parturition of reindeer in the study area is in May (Ozaga & Clute 1988, Whitten et al. 1992).

Survival patterns

Month

The mortality peaked in September, November and January. Herd structure and habitat use of the reindeer vary throughout the year. During the calving season in May and through the summer season reindeer go up to higher parts of their range, normally above the treeline. In the calving season the reason may be to avoid predators, such as the lynx, which is the predominant predator species in central Norway. The lynx prefers forest areas in lower altitudes rather than open alpine areas (Moa, Negård & Kvam 1998). In autumn reindeer spread out and migrate to lower elevations to search for mushrooms. This means that habitat use by lynx and reindeer overlaps in autumn more than in summer, thus causing increased predation.

As many as 52% of the accidents and 34% of the lynx kills were recorded during 16 December - 15 February, which is the period with the deepest snow cover in the area. Many of the accidents were the result of reindeer falling off precipices, getting trapped in screes, or being taken by avalanches. The deep snow may also partly explain the high losses due to lynx predation in January, since the deep snow may have led to favourable hunting conditions for the lynx.

Age and sex

Although adult female reindeer weighing up to 74 kg, which is more than three times the body weight of the lynx, were recorded to have been killed by lynx, calves seem to be the lynx's favourite prey. Lynx, wolverine and golden eagle are relatively small predators, and it seems reasonable for them to prefer calves to adults.

Biased sex ratios in adult reindeer have been reported from a number of studies (Bergerud 1980, Reimers 1977, Parker 1972), and are assumed to be a result of predation and intraspecific strife. Male calves are supposed to attract more attention from predators than females due to their more independent and 'careless' behaviour. However, no selection for male calves was found in our study.

Research and management implications

Although some risks are connected with generalising the results of this one-year investigation, our results are in agreement with those of earlier comparable studies. The economic consequences for reindeer husbandry in an area with predation rates as high as those recorded in our study makes it questionable to what extent reindeer husbandry in its present form can be combined with legislation and international treaties which demand that large carnivores be maintained in viable populations.

By ratification of the Bern Convention, Norway became responsible for survival of large carnivore species in viable populations. In 1990 the ratification of ILO-Convention no 169 made Norway responsible for enforcing aboriginal citizens' right to their own culture. The Saami people have status as aboriginal citizens, and have based their culture on reindeer husbandry for centuries. This leads to a conflict between the two conventions. The protected large carnivores threaten Saami reindeer husbandry, which constitutes the framework of an aboriginal culture. It is therefore a management challenge to find large carnivore population sizes that keep the predation rate of semi-domestic reindeer at an acceptable level, and at the same time maintain viable populations of the large carnivore species.

Studies of carnivores and predation on reindeer have mostly been descriptive, without examining more closely the factors that may explain the results obtained. Hence, the results of such studies are of limited value for practical management because they merely deal with a single situation, at a specific time without saying anything about the general causes of losses. Important aspects may be the intensity of herding, scatteredness, grazing conditions, weather conditions in different seasons of the year, and interspecific factors like habitat overlap between predators and prey species. Future research should focus on interspecific interactions and apply models of population dynamics based on the interplay between species and their biology. This will improve the general basis for management and enable us to manage the natural heritage with a more long-term perspective.

Acknowledgements - this project was supported by grants from the Norwegian Research Council, the Norwegian Research Council of Semi-domestic Reindeer Husbandry (Reindriftens forskningsråd), the Directorate for Nature Management, and the Norwegian Institute for Nature Research. We thank Karl Brøndbo, Torsten Ingerslev, Charlotte Moshøy, Stig Lasse Rosendal and Kai Magne Rosendal for field assistance and Nicholas Tyler for his helpful review on an early version of the manuscript.

References

Adams, L.G., Singer, F.J. & Dale, B.W. 1995: Caribou calf mortality in Denali National Park Alaska. - Journal of Wildlife Management 59(3): 584-594.

Bergerud, A.T. 1980: A review of the population dynamics of caribou and wild reindeer in North America. - In: Reimers, E., Gaare, E. & Skjenneberg, S. (Eds.); Second international reindeer/caribou symposium. Direktoratet for vilt og Ferskvannsfisk, Trondheim, Norway, pp. 556-581.

Bjärvall, A., Franzén, R., Nordkvist, M. & Åhman, G. 1990: Renar och rovdjur. -Naturvårdsverket forlag, Solna, Sweden, 296 pp. (In Swedish).

Cox, D.R. & Oakes, D. 1984: Analysis of survival data. - Chapman & Hall, New York, N.Y., 201 pp.

Filonov, K.P. 1980: Predator-prey problems in nature reserves of the European part of the RSFSR. - Journal of Wildlife Management 44(2): 389-396.

Haglund, B. 1966: De stora rovdjurens vintervanor I. (In Norwegian with English summary: Winter habits of the Lynx Lynx lynx L. and Wolverine Gulo gulo L. as Revealed by Tracking in the Snow). - Viltrevy 4(3): 1-299.

Hearn, B.J. & Luttich, S.N. 1989: Survival of radio-collared caribou (Rangifer tarandus) from Georg River Herd. - Canadian Journal of Zoology 68: 276-283.

Heisey, D.M. & Fuller, T.K. 1985: Evaluation of survival and cause specific mortality rates using telemetry data. - Journal of Wildlife Management 49(3): 668-674.

Kaplan, E.L. & Meier, P. 1958: Nonparametric estimation from incomplete observations. - Journal of the American Statistical Association 53: 457-481.

Kvam, T. 1997: Bestandsestimat for gaupe 1995-1996 og 1996-1997. (In Norwegian with English summary: Population estimate for Eurasian lynx in Norway 1995-96 and 1996-97). - Rapport til DN, 54 pp.

Kvam, T, Sunde , P. & Overskaug, K. 1998: Matvaner hos gaupa i Nord- Trøndelag. - In: Kvam, T. & Jonsson, B. (Eds.); NINAs strategiske instituttprogrammer 91-96: Store rovdyrs økologi i Norge. Sluttrapport, NINA temahefte 8: 94-104. (In Norwegian).

Lyftingsmo, E. 1974: Norske fjellbeite. Tillegg til bind I, VI, XI og XII. Oversyn over granska reinbeite in Oppland, Hedmark, Sør- og Nord-Trøndelag. - Det Kongelige Selskap for Norges Vel, Oslo, 116 pp. (In Norwegian).

Mahoney, S.P., Abbott, L.H., Russell, H. & Porter, B.R. 1990: Woodland caribou calf mortality in insular Newfoundland. - In: Myrberget, S. (Ed.); Transactions of the XIXth congress of International Union of Game Biologists, Trondheim, Norway, Vol. I, Wildlife Management: 592-599.

Miller, F.L., Broughton, E. & Gunn, A. 1988: Mortality of migratory barren-ground caribou on the calving grounds of the Beverly herd, Northwest Territories, 1981-1983. Canadian Wildlife Service Occasional Paper 66, 26 pp.

Moa, P.F., Negård, A. & Kvam, T. 1998: Arealbruk hos gaupe i forhold til habitattilbud, med spesielt henblikk på sau og rein på beite. (In Norwegian with English summary: Area use in Lynx in relation to available habitat, with special reference to domestic sheep and reindeer). - Fauna 51: 24-42.

Mysterud, I. & Mysterud, I. 1995: Tamreindriften. - In: Mysterud, I. & Mysterud, I. (Eds.); Perspektiver på rovdyr, ressurser og utmarksnæringer i dagens- og framtidens Norge: En konsekvensutredning av rovviltforvaltningens betydning for småfenæring, reindrift og viltinteresser. Sluttrapport, KUR-prosjektet, Oslo, Norway, pp. 41-72. (In Norwegian).

Ozaga, J.J. & Clute, R.K. 1988: Mortality rates of marked and unmarked fawns. - Journal of Wildlife Management 52(3): 549-551.

Parker, G.R. 1972: Biology of the Kaminuriak Population of barren-ground caribou. Part 1: Total numbers, mortality, recruitment, and seasonal distribution. - Canadian Wildlife Service Report No. 20, 95 pp.

Pollock, K.H., Winterstein, S.R. & Conroy, M.J. 1989: Estimation and analysis of survival distributions for radio tagged animals. - Biometrics 45: 99-109.

Reimers, E. & Nordby, Ø. 1968: Relationship between age and tooth cementum layers in Norwegian reindeer. - Journal of Wildlife Management 32(4): 957-961.

Reimers, E. 1977: Population dynamics in two subpopulations of reindeer in Svalbard. - Arctic and Alpine Research 9(4): 369-381.

Sauer, J.R. & Williams, B.K. 1989: Generalized procedures for testing hypotheses about survival or recovery rates. - Journal of Wildlife Management 53(1): 137-142.

Sunde, P., Kvam T., Bolstad, J.P. & Bronndal, M. 2000: Foraging of lynxes in a human-exploited boreal alpine environment. - Ecography 23(3): 291-298.

Sunde, P. & Kvam, T. 1997: Diet patterns of Eurasian lynx (Lynx lynx): what causes sexually determined prey size segregation? - Acta Theriologica 42(2): 189-201.

Whitten, K.R., Garner, G.W., Mauer, F.J. & Harris, R.B. 1992: Productivity and early calf survival in the porcupine caribou herd. - Journal of Wildlife Management 56(2): 201-212.