6 Large predators and their impact on reindeer husbandry

Birgitta Åhman, Sirpa Rasmus, Camilla Risvoll, Svein Morten Eilertsen and Harri Norberg

Introduction

Several species of large carnivore – wolf, lynx, wolverine, brown bear and golden eagle – are present in the reindeer herding area (RHA) of Fennoscandia. They all prey on reindeer to a varying degree depending on environmental factors like season, density of the carnivore species and overlap with reindeer ranges. The opportunity for reindeer herders to manage the presence of large carnivores depends on national strategies for the management of carnivores and compensation for losses. This chapter describes the situation for Fennoscandian reindeer husbandry in relation to the presence and distribution of large carnivores, estimated losses, other effects, compensation and management systems.

Predator populations

Large carnivore densities in Fennoscandia have fluctuated widely during the time that reindeer husbandry has been conducted. Once almost eradicated by humans, the populations have increased substantially in northern Europe during the last 50 years (Chapron et al. 2014), mainly as an effect of a gradual introduction of legal protection. Increasing numbers of wolf, Eurasian lynx, wolverine, brown bear and golden eagle have resulted in increased predation on reindeer and growing disturbances to reindeer husbandry (described below).

In Finland, the densities of brown bear, wolverine and lynx have increased and populations have grown, although most predators are found outside the RHA. The estimated numbers of lynx within the RHA are currently a little below 100 individuals, while the number of wolverines is slightly higher (Table 6.1). The estimated number of brown bears within the RHA is around 300. A permanent breeding population of wolves exists close to the southern border of the RHA. This, and the proximity of the Russian border, leads to varying numbers of non-resident immigrant wolves annually in the RHA. However, wolf packs and pairs are also frequently observed near the border. Approximately 90% of the golden eagle territories in Finland are located within the RHA, and the numbers are slowly increasing, especially in the south-eastern part. Predators, wolverine and bear, in particular, also cross the borders from Sweden and Norway to Finland.

DOI: 10.4324/9781003118565-9

Table 6.1 Approximate numbers of large carnivores (individual animals, except for golden eagle) within the reindeer herding area (RHA) of Finland, Sweden and Norway during recent years (2016–2020)

	Finland	*Sweden*	*Norway*	*Notes*
Wolf	10–20	10–50	sporadic	Large variations between years
Lynx	100	700	200	
Wolverine	100–150	700	250	
Brown bear	300	2,000	at least 100	Norway: minimum number
Golden eagle	400	350	500	Nesting pairs

Sources: Estimates based on the following sources: Heikkinen et al. 2021, Norberg 2021, pers. comm. (wolf, Finland), Holmala et al. 2020 (lynx, Finland), Kojola et al. 2020 (wolverine, Finland), Heikkinen et al. 2020 (bear, Finland), Metsähallitus/National Board of Forestry 2021 (golden eagle, Finland, www.metsa.fi/maakotka, August 2021), www.sametinget.se/statistik/rovdjur (wolf, lynx and wolverine, Sweden), Mattisson & Frank 2020 (lynx, Scandinavia); Mattisson et al. 2020a (wolverine, Scandinavia); Kindberg & Swenson 2018 (bear, Sweden); Fløystad et al. 2020 (bear Norway); Wallén et al. 2019 (eagle Sweden); Mattisson et al. 2020b (eagle Norway).

Notes: Estimates of lynx and wolverine are based on annual inventories of family groups and dens, respectively (each representing about six individuals). In Finland, the estimate of wolverine population is based on a combination of different methods (wildlife triangles, areal counts and DNA). Number of bears is based on analysis of DNA (yearly inventories in Norway, single years in Sweden), in Sweden in combination with reports of direct observations of bear, and in Finland based on observations only. The number of nesting pairs of golden eagles is based on observations of occupied nests.

Populations of large carnivores are partly shared between Norway and Sweden and have shown stable or increasing trends during recent decades, except for lynx, which has declined somewhat from a maximum in around 2010 (Mattisson & Frank 2020). The total wolf population has reached about 450 individuals, although most are present outside the RHA (Figure 6.1). Lynx were already present in relatively high numbers in Sweden and Norway when systematic inventories started in the late 1990s, and the total population within the RHA is currently around 900 individuals (Table 6.1). Wolverines are almost exclusively present within the RHA (Figure 6.1), and numbers have almost doubled during the last two decades (Mattisson et al. 2020a). The latest estimates show nearly 700 animals in Sweden and about 250 in Norway (Table 6.1). The brown bear population in Norway seems to be rather stable, and around 150 individuals were identified by DNA analysis in 2020, when the highest number of female bears since 2009 was also recorded (rovdata.no 2021). In Sweden, there are at least 2000 bears within the RHA (Table 6.1). The population of golden eagles seems to be fairly stable, with around 350 and 500 nesting pairs, respectively, within the RHAs of Sweden and Norway (Table 6.1).

Hunting behaviour of large carnivores

Wolves are regarded as the most efficient predator on reindeer, both with regard to how many reindeer they are able to kill and their disturbance of

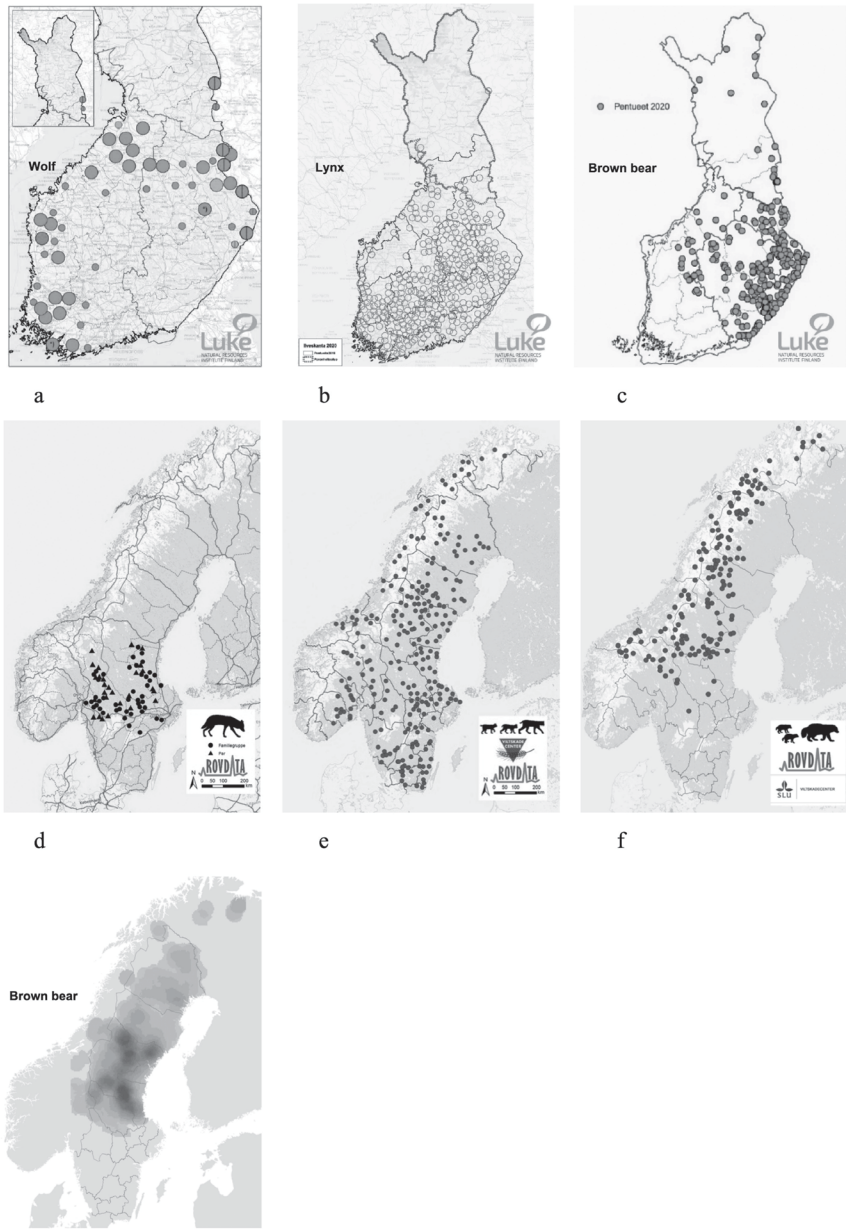

Figure 6.1 Maps for Finland (Luke/Natural Resources Institute Finland, 2021) showing distributions 2019/2020 of (a) wolf (family groups/pairs), (b) lynx (family groups) and (c) bear (family groups). Maps for Sweden and Norway from www.rovdata.no showing distribution of (d) wolf family groups (round dots) and pairs (triangles), (e) lynx family groups, (f) wolverine dens in the winter

caption for Figure 6.1 continued

of 2019–2020. Map (g) showing the density of brown bears (according to inventories 2017), from the Scandinavian Brown Bear Research Project (http://bearproject.info). Each family group of wolf corresponds to about ten individuals, while each reproductive unit (family group or den) of lynx or wolverine corresponds to an average of a little over six individual animals. Published with permission of Luke, Rovdata and the Scandinavian Brown Bear Research Project, respectively.

the reindeer herds (Bjärvall et al. 1990; Ryd 2007; Sikku & Torp 2008). The damage by wolves to Fennoscandian reindeer husbandry is currently limited, since their numbers are strongly regulated within the RHA of all three countries. Nevertheless, wolves have the potential to cause substantial damage where they are present, which is well illustrated by studies on wild reindeer in Finland (Kojola et al. 2004) and caribou in North America (Bergerud & Elliot 1986).

Lynx are present in large parts of the RHA (Figure 6.1), where reindeer are usually their main prey (Mattisson et al. 2011b), although to a lesser extent in areas with high abundance of roe deer (Sunde et al. 2000). An investigation in the Sarek area in Northern Sweden revealed that reindeer constituted 90% of the prey killed by females with kittens (Pedersen et al. 1999), corresponding to six reindeer killed per month. Kill rates, however, vary depending on the time of year, abundance of reindeer and age and sex of the lynx. Lynx generally seem to prefer reindeer calves rather than adults (Mattisson et al. 2014).

Wolverines within the RHA usually utilize reindeer as their main food (Mattisson et al. 2016). They are not such efficient hunters as wolf and lynx and often scavenge on leftovers from other predators (Mattisson et al. 2011a). They can, however, hunt effectively when the snow is dense enough to support the wolverine (due to their large feet), but not the reindeer (Haglund 1966), and in these circumstances, they may kill many reindeer on a single occasion. Kill rates range from 0 to 15 (average 1–2) reindeer per month (Mattisson et al. 2016), with lower rates in areas with high presence of lynx, where wolverines can feed on leftovers from lynx (Mattisson et al. 2011a).

Bears cause damage to reindeer husbandry mostly during the calving period. Recent research in two forest reindeer herding districts (RHDs) in Northern Sweden (Sivertsen 2017) showed an annual average kill rate of 11 reindeer calves per bear present within the calving area. Predation ceased shortly after the last calves were born. Similar results have been obtained from Finland (Norberg & Nieminen 2007). Bears may also kill adult reindeer before or during the calving period, as well as later in the autumn before hibernation.

Golden eagles can be the main predator on young calves in areas where other predators are less common (Norberg et al. 2006). Light calves are at higher risk of being killed by eagles than heavier ones (Nybakk et al. 1999; Norberg et al. 2006). The age and condition of female reindeer may play a role, as young and light females tend to give birth to light calves (Rönnegård et al. 2002), and young females are also less experienced in protecting their calves from eagles (*personal observation*, Norberg).

Losses of reindeer due to predation

Losses of reindeer due to predation are estimated differently in the three countries. In Finland and Norway estimates are based on dead reindeer that have been found and assumed to have been killed by predators. In Sweden, with a different compensation system (see below), assessments are largely based on the presence of predators and their estimated kill rates.

The number of reindeer lost to predators for which compensation is paid in each RHD in Finland is published annually in the journal *Poromies* (by the Reindeer Herders' Association) and was relatively low until 1990. Damage has increased significantly since then, with a maximum level being reached in 2020 (in total, 5,965 predator-killed reindeer were found and for which compensation was paid). As damage statistics in Finland are based on the number of found and reported reindeer carcasses for which compensation has been approved, the numbers are to be considered the minimum loss due to predation. Searching for dead reindeer has become more efficient recently, and data from early decades are therefore not entirely comparable with more recent data. Damage varies between regions and is most apparent in the south-eastern corner of the RHA in Finland (Rasmus et al. 2020). Losses are also high along the eastern border and in northern RHDs. In some hotspots, the damage has recently amounted to more than 10% of the reindeer stock.

As there is no systematic documentation of predated reindeer in Sweden, indirect measurements have to be used. A governmental inquiry (SOU 2012), based on predator numbers and kill rates, estimates the total annual predation of reindeer in Sweden to be between 19,500 and 72,500, mostly by lynx (10,000–50,000 reindeer) and wolverine (6,000–15,000 reindeer). Correlations between the number of predators and harvest rates for different RHDs and years suggest that each reproduction (lynx family group or occupied wolverine den, corresponding to about six individuals) of lynx or wolverine, reduce the harvest of reindeer by about 100 animals (Hobbs et al. 2012). According to a model based on the comparison between expected and observed reindeer survival and reproduction rate (Åhman 2017), the annual loss of reindeer due to predation corresponds to 10–20% of the winter stock for many RHDs.

In Norway, compensation was paid for about 19,000 reindeer killed annually by predators from 2015/16 until 2019/20 (www.rovbase.no). The majority of these (76%) were calves. High calf losses have been reported in most of the RHA in Norway during the last two decades. Compensation for around 63,000 reindeer has been applied for annually but paid for only about 30% of these. Of the compensation payments in 2019/2020, lynx were responsible for 27%, wolverine 32%, golden eagle 34%, brown bear 2%, wolf 1% and unspecified predators 4%.

It has been discussed to which extent predation is compensatory to other causes of mortality, that is, when an animal killed by a predator should have died anyway, e.g., due to disease or starvation (Tveraa et al. 2003). Calf mortality due to other reasons than predation may be high after a winter with exceptionally

hard grazing conditions or if the summer is late (Tveraa et al. 2013), if females are generally in poor condition (Rönnergård et al. 2002), or in the case of very adverse weather during the calving period. Otherwise, most research conducted previously, when there were fewer predators (when other causes of mortality were not hidden by high predation), revealed low mortality rates for reasons other than predation. Bjärvall et al. (1990) reported calf mortality due to disease, accidents and so on between 2% and 4% from calf marking in July until autumn gathering in November–December. Skjenneberg and Slagsvold (1968) reported 3–10% annual loss of reindeer in parts of Norway, with predation as a minor cause (1.5%), during the period 1948–1956.

Indirect and long-term effects of predators

According to herders' perceptions, the presence of predators has several detrimental effects on reindeer husbandry (Turunen et al. 2017, Rasmus et al. 2020; Risvoll & Kaarhus 2020). Herds break up, reindeer foraging is disturbed, the best pastures may be impossible to use, reindeer condition declines and calving is disturbed. Predators also affect herding, causing difficulties in keeping herds under control and gathering and moving the herds to round-up sites.

Predation has negative effects on herd productivity by changing the age structure of the breeding population, thus reducing calf production, and the opportunities for genetic selection. In the long run, this can compromise the economic sustainability of the livelihood (Pekkarinen et al. 2020). The unpredictability of the work has increased, and the feeling of autonomy has decreased. Recurring finds of reindeer killed by predators cause physical and mental burdens, and the situation affects families and the overall social life of herders (Pohjola & Valkonen 2012).

If losses of reindeer become too large, reindeer husbandry may reach a tipping point (see Chapter 14) when the number of calves that survive to adulthood is too few to replace adult reindeer that die or become too old to reproduce. This will eventually lead to herd collapse, which was the case in one Swedish RHD when a *siida* group lost not only calves but also 18% of adult female reindeer each year, greatly exceeding the threshold for herd collapse (Åhman et al. 2014). This scenario is also increasingly emerging in Norway due to large losses to predators over time (Risvoll et al. 2022).

All through history, herders have aimed to minimize losses to predators. A variety of strategies have been developed based on practitioners' knowledge related to the behaviour of predators and different means of protecting reindeer (Ryd 2007; Sikku & Torp 2008; Sara 2009). The knowledge is active in reindeer herding cultures throughout Fennoscandia. Before the hunting restrictions, there was active hunting of predators, which gave the herders more control over predator–reindeer interactions. Nonetheless, great efforts are still made to protect reindeer from predators.

Present coping strategies include fencing and feeding of reindeer or constantly tending the reindeer by circling the herd with snowmobiles or skis. Areas

with many predators are avoided, leaving potential pasture resources unused. Effective protection of reindeer is almost impossible during snow-free seasons and may also be difficult in winter as predation often takes place at night. Herders increasingly use modern techniques, such as GPS collars on reindeer, drones or wildlife cameras, which can provide more control over predator–reindeer interactions and aid in finding reindeer carcasses (Risvoll et al. 2022).

Economic compensation

The compensation systems in all countries aim at minimizing the financial damage caused to reindeer herders, while maintaining viable predator populations (Strand et al. 2016; Zabel & Holm-Müller 2008; Pekkarinen et al. 2020) but differ considerably between countries.

In Finland, the scheme compensating for damage caused by game animals (including large carnivores, but not golden eagle) is regulated in the "Riistavahinkolaki" (game damage law: www.finlex.fi/fi/laki/ajantasa/2009/20090105). According to this scheme, predator-killed reindeer carcasses that have been found should be reported to the municipality official responsible for rural livelihoods. The compensation is provided either to the reindeer owner or to the RHD. From 5% to 10% of reported cases are inspected in the field by the municipality official, often accompanied by representatives of the RHD and local game management association. The sum paid is 1.5 times the defined value of the lost reindeer to compensate for losses that are not documented. In addition, the RHDs are provided with specific calculated compensation for calves lost, but not found, between birth and 30 November. Nevertheless, herders experience that they do not get full and accurate monetary compensation for indirect costs and extra work caused by the predators. Herders also find the uncertainty and slowness of compensation payments, as well as the allocation of payments among herders, problematic.

Since 1998, reindeer damage in Finland caused by golden eagles has been compensated for based on occupied territories and successful reproduction, and herders have been generally satisfied with the scheme. However, they are generally reluctant to switch to a territory or presence-based compensation scheme for damage caused by other large carnivores. The total annual sum paid in compensation has increased during the 2000s and has amounted to over 6 million euros (M€) since 2012. In 2016 and 2017, cuts in compensation per lost animal took place since the maximum allowed compensation level for Finnish reindeer husbandry (10 M€ on annual basis) set by the EU was exceeded, and (in 2017) also due to limitations in the state budget.

In Sweden, compensating for damage is based on the presence of predators within each of the RHDs (Zabel & Holm-Müller 2008). This system was introduced in 1996. Until then, compensation was paid based on predated reindeer carcasses found (similar to Finland). The compensation is regulated by "Viltskadeförordning" ("Wildlife Damage Ordinance", www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/_sfs-2001-724) and

administered by the Sami Parliament. The money is paid to the RHD, who distribute it internally, or use it for collective costs. At present each reproduction of lynx or wolverine is compensated with 200,000 SEK (20,000 Euro), while a wolf reproduction is compensated with 500,000 SEK. Permanent or occasional presence of these three predators results in lower sums being paid in compensation. Compensation for losses due to brown bear or golden eagle is based solely on the area of the RHD. High levels of documented damage (many dead reindeer) on a single occasion may result in additional payment directly to the affected reindeer owner. During recent years, the annual compensation has been around 50 million SEK (≈5 M€) (www.sametinget.se/statistik/rovdjur), of which approximately 90% was for damage caused by lynx or wolverine. The total sum is limited by the government and has not been raised since 2002.

In Norway, compensation for losses due to protected carnivores is regulated by the Government Regulation: "Forskrift om erstatning for tap og følgekostnader når tamrein blir drept eller skadet av rovvilt" (https://lovdata.no/dokument/SF/forskrift/2001-05-04-468). Compensation is paid via the County Governor for reindeer that are found dead and confirmed as having been killed by a predator (wolf, bear, lynx, wolverine or golden eagle) by someone from, or authorized by, the Norwegian Environmental Protection Agency. Compensation is paid directly to the individual herder, who may also get compensation for costs, inconvenience or losses that are related to loss of the animal. In addition, compensation can be paid for lost but not found reindeer, provided that they are lost in an area and at a time with documented finds of predator-killed reindeer and presence of predators. In this case, there is a deduction from the compensation relative to the expected mortality due to causes other than predation. The annual sum for compensation during the last five years has been, on average, 77.6 million NOK (≈8 M€). There is, however, great frustration among herders about the method used for making judgements and what counts as evidence that reindeer are killed by predators (Risvoll & Kaarhus 2020).

Management policy

In historical times, large carnivores were targeted, and populations were kept low using any means available. After almost total eradication of carnivore populations by the early to mid-1900s, national protection laws and restrictions on hunting were gradually developed. The obligations of the CITES Convention (1976), Bern Convention (1979) and later the Convention on Biological Diversity (1994), as well as the EU Habitats Directive (1992) and Birds Directive (1979), had to be taken into account when considering suitable levels of protection.

In Finland, large predators were gradually protected from 1962 until 1984. There are, however, permits for damage prevention or sport hunting, although based on strict criteria. Management plans are important tools in Finnish predator management policy. The policies for the RHA differ from those to the

rest of the country. Damage-based hunting permits for wolves, lynx and brown bear in the RHA can be issued without quotas, and for wolverines based on an annual quota, when the conditions set in the Habitats Directive and Finnish hunting law have been thoroughly considered. The brown bear population in the RHA is mainly regulated by quota-based hunting. Some management-based licenses are also issued to hunt lynx in the RHA, although lynx are mostly hunted outside the RHA.

In Sweden, golden eagle, bear and lynx were protected as early as the 1920s. Wolves were protected in 1966 and wolverines in 1969. Like Finland, Sweden has management plans for all the large carnivores. There is quota-based hunting for bear, lynx and recently also wolverine in the RHA, but under strict regulations. Quotas are decided by the Swedish Environmental Agency. In addition, the RHDs can apply for damage-based hunting. Hunting permits are, however, often appealed against by nature conservation organizations, and in many cases revoked. In 2013, the Swedish Parliament decided that 10% should be the maximum loss to predators for any single RHD in Sweden and that actions should be taken if this level was exceeded. So far, this decision has had limited power. A model for estimating loss (Åhman 2017) is used in appeals for protective hunting, but supporting information verifying predation is generally required in order to obtain permission for damage-based hunting.

In Norway, national conservation policies started with protecting bears during the 1960s, followed by wolverine in southern Norway in 1971, and northern Norway in 1982. Norway ratified the Bern Convention in 1986, implying a commitment to safeguard sustainable populations of all large carnivores. In 2011, the Parliament settled on a "Carnivore Agreement" (Stortinget 2011), and management authority was then delegated from the central government to regional large carnivore committees (RLCC). These have a mandate to take decisions regarding hunting as long as the population goals are reached. The RLCCs are responsible for management plans, which should reduce spatial overlap between large carnivores and grazing domestic livestock (so-called "clear zoning"). There are, nevertheless, large overlaps between areas for reindeer and areas prioritized for carnivores (Strand et al. 2016). There has been ongoing controversy about the size of these areas and the instruments in place to document large carnivores in Norway (Risvoll & Kaarhus 2020). Reindeer herders and sheep farmers point out the difficulty of maintaining zones due, e.g., to topography that affects animal movement and behaviour; in addition, basing lynx registration solely on snow tracks is perceived as too rigid, not considering local context or the great variability in snow conditions (ibid).

Concluding remarks

Reindeer husbandry is greatly affected by the presence of large carnivores. At the same time, reindeer are an essential food source for carnivores. Herders are continuously coping with the presence of predators and trying to minimize reindeer losses, for which their traditional and experience-based knowledge

is vital. Nevertheless, this knowledge seems to be insufficient in the rapidly changing operational environment, where institutional, societal and climatic constraints are reducing the space for adaptation.

Compensation schemes aim at easing the co-existence of reindeer husbandry and predators. Herders generally acknowledge that predators belong to the northern natural and cultural heritage and accept their presence provided that losses are bearable and damages are fairly compensated (Sippola et al. 2005, Nykänen & Valkeapää 2016). Compensation schemes differ between countries, but none of them is seen as ideal, and each scheme has benefits and drawbacks. A general criticism is that compensation is too low, because not all predator-killed reindeer are acknowledged, the value of a killed reindeer is set too low, indirect costs are not included, or the numbers of predators are underestimated. There is also frustration among herders who find that their voices are not heard, and their knowledge not recognized when it comes to predator management.

There is friction between predator conservation and local livelihoods globally. The Fennoscandian RHA provides an interesting case; predator populations share the landscape with more or less free-ranging semi-domesticated animals (Chapron et al. 2014) and the people who try to make a living from taking care of them. It may well be that compromises made so far have not sufficiently served either the predators or the livelihood of reindeer herders. What is clear is that conservation goals need to be balanced with livelihood needs and human welfare (Groom & Harris 2008; Sjölander-Lindqvist et al. 2015). Striving towards ecological sustainability and biodiversity targets (both reindeer and predators having a significant role in that) requires that economic and social sustainability of local communities are not being overridden (Sjölander et al. 2020).

References

Åhman, B. (2017). *Beräkning av rovdjursförluster i rennäringen baserat på produktion*. www.sametinget.se/61994

Åhman, B., Svensson, K. & Rönnegård, L. (2014). High female mortality resulting in herd collapse in free-ranging domesticated reindeer (*Rangifer tarandus tarandus*) in Sweden. *PLoS ONE*. 9(10), e111509.

Bergerud, A.T. & Elliot, J.P. (1986). Dynamics of caribou and wolves in Northern British Columbia. *Canadian Journal of Zoology*. 64(7), 1515–1529.

Bjärvall, A., Franzén, R., Nordkvist, M. & Åhman, G. (1990). *Renar och rovdjur. Rovdjurens effekter på rennäringen*. Solna: Naturvårdsverket förlag.

Chapron, G., Kaczensky, P., Linnell, J.D.C., von Arx, M., Huber, D., Andrén, H., López-Bao, J.V. et al. (2014). Recovery of large carnivores in Europe's modern human-dominated landscapes. *Science*. 346(6216), 1517–1519.

Fløystad, I., Brøseth, H., Bakke, B.B., Eiken, H.G. & Hagen, S.B. (2020). *Populasjonsovervåking av brunbjørn. DNA-analyse av prøver innsamlet i Norge i 2019*. (NINA Rapport 1808). Norsk institutt for naturforskning.

Groom, R. & Harris, S. (2008). Conservation on community lands: the importance of equitable revenue sharing. *Environmental Conservation*. 35(3), 242–251.

Haglund, B. (1966). Winter habits of the lynx (*Lynx lynx* L.) and wolverine (*Gulo gulo* L.) as revealed by tracking in the snow. De stora rovdjurens vintervanor. *Viltrevy.* 4, 81–229. Heikkinen, S., Kojola, I., Mäntyniemi, S. (2020). Karhukanta Suomessa 2019. *Luonnonvara- ja biotalouden tutkimus* 26/2020. Luonnonvarakeskus. Helsinki.

Heikkinen, S., Valtonen, M., Härkälä, A., Helle, I., Mäntyniemi, S. & Kojola, I. (2021). Susikanta Suomessa maaliskuussa 2021. *Luonnonvara- ja biotalouden tutkimus*. 39/2021 Luonnonvarakeskus. Helsinki.

Hobbs, N.T., Andrén, H., Persson, J., Aronsson, M. & Chapron, G. (2012). Native predators reduce harvest of reindeer by Sámi pastoralists. *Ecological Applications*. 22(5), 1640–1654.

Holmala, K., Heikkinen, S. & Mäntyniemi, S. (2020). Ilveskanta Suomessa 2020. *Luonnonvara- ja biotalouden tutkimus* 48/2020. Luonnonvarakeskus. Helsinki.

Kindberg, J. & Swenson, J.E. (2018). Björnstammens storlek i Sverige 2017. Skandinaviska björnprojektet, Rapport 2018:3.

Kojola, I., Huitu, O., Toppinen, K., Heikura, K., Heikkinen, S. & Ronkainen, S. (2004). Predation on European wild forest reindeer (*Rangifer tarandus*) by wolves (Canis lupus) in Finland. *Journal of Zoology*. 263(3), 229–235.

Kojola, I., Heikkinen, S., Mäntyniemi, S. & Ollila, T. (2020). Ahmakannan kehitys ja ahmakanta Suomessa 2020. *Luonnonvara- ja biotalouden tutkimus* 68/2020. Luonnonvarakeskus. Helsinki.

Luke/Natural Resources Institute Finland. (2021). *Reports for the population estimates of large carnivores*. http://riistahavainnot.fi/suurpedot/kannanarviointi/lausunnot

Mattisson. J., Andrén, H., Persson, J. & Segerström, P. (2011a). Influence of intraguild interactions on resource use by wolverines and Eurasian lynx. *Journal of Mammalogy*. 92(6), 1321–1330.

Mattisson, J., Odden, J., Nilsen, E.B., Linnell, J.D.C., Persson, J. & Andrén, H. (2011b). Factors affecting Eurasian lynx kill rates on semi-domestic reindeer in northern Scandinavia: Can ecological research contribute to the development of a fair compensation system? *Biological Conservation*. 144(12), 3009–3017.

Mattisson, J., Arntsen, G.B., Nilsen, E.B., Loe, L.E., Linnell, J.D.C., Odden, J., Persson, J. & Andrén, H. (2014). Lynx predation on semi-domestic reindeer: do age and sex matter? *Journal of Zoology*. 292(1), 56–63.

Mattisson, J. & Frank, J. (2020). Bestandsovervåking av gaupe i 2020. *Bestandsstatus for store rovdyr i Skandinavia*. 2–2020.

Mattisson, J., Höglund, L. & Brøseth, H. (2020a). Bestandsovervåking av jerv i 2020. *Bestandsstatus for store rovdyr i Skandinavia*. 3–2020.

Mattisson, J., Nilsen, E.B. & Brøseth, H. (2020b). *Estimering av antall hekkende par kongeørn basert på kjent forekomst i Norge for perioden 2015–2019*. (NINA Rapport 1858). Norsk Institutt for Naturforskning.

Mattisson, J., Rauset, G.R., Odden, J., Andrén, H., Linnell, J.D.C. & Persson, J. (2016). Predation or scavenging? Prey body condition influences decision-making in a facultative predator, the wolverine. *Ecosphere*. 7(8), e01407.

Metsähallitus/National Board of Forestry. (2021). *Reports for the population estimates of Golden eagle*. www.metsa.fi/maakotka

Norberg, H. & Nieminen, M. (2007). Suurpetojen vaikutus poronvasojen kuolleisuuteen Kallioluoman paliskunnassa vuosina 2005–06. *Kala- ja riistaraportteja*. 415.

Norberg, H., Kojola, I., Aikio, P. & Nylund, M. (2006). Predation by golden eagle *Aquila chrysaetos* on semi-domesticated reindeer *Rangifer tarandus* calves in northeastern Finnish Lapland. *Wildlife Biology*. 12(4), 393–402.

Nybakk, K., Kjelvik, O. & Kvam, T. (1999). Golden eagle predation on semidomestic reindeer. *Wildlife Society Bulletin*. 27, 1038–1042.

Nykänen, T. & Valkeapää, L. (eds.) (2016). *Kilpisjärven poliittinen luonto. SKS:n toimituksia 1422*. Helsinki: Suomalaisen Kirjallisuuden Seura

Pedersen, V.A., Linnell, J.D.C., Andersen, R., Andrén, H., Lindén, M. & Segerström, P. (1999). Winter lynx *Lynx lynx* predation on semi-domestic reindeer *Rangifer tarandus* in northern Sweden. *Wildlife Biology*. 5(1), 203–211.

Pekkarinen, A.-J., Kumpula, J. & Tahvonen, O. (2020). Predation costs and compensations in reindeer husbandry. *Wildlife Biology*. 2020(3), 1–14.

Pohjola, A. & Valkonen, J. (2012). *Poronhoitajien hyvinvoinnin uhat ja avun tarpeet*. Rovaniemi: Lapland University Press.

Rasmus, S., Turunen, M., Norberg, H., Kojola, I, Kumpula, J. & Ollila, T. (2020). Mission impossible? Pursuing the co-existence of viable predator populations and sustainable reindeer husbandry in Finland. *Journal of Rural Studies*. 80, 135–148.

Risvoll, C., Hovelsrud, G.K. & Riseth, J.Å. (2022). Falling between the cracks of the governing systems: Risk and uncertainty in pastoralism in northern Norway. *Weather, Climate and Society (WCAS)*. 14, 191–204.

Risvoll, C. & Kaarhus, R. (2020). Struggling with 'clear zoning': Dilemmas of predator-pastoral coexistence in Nordland, northern Norway. In: Breidlid, A. & R. Krøvel, R. (eds.) *Indigenous Knowledges and the Sustainable Development Agenda*. London and New York: Routledge.

Rönnegård, L., Forslund, P. & Danell, Ö. (2002). Lifetime patterns in adult female mass, reproduction and offspring mass in semidomestic reindeer (*Rangifer tarandus tarandus*). *Canadian Journal of Zoology*. 80(12), 2047–2055.

Ryd, Y. (2007). Ren och varg. Samer berättar. Stockholm: Natur & kultur.

Sara, M.N. (2009). Siida and traditional Sámi reindeer herding knowledge. *The Northern Review.* 30, 153–178.

Sikku, O.J. & Torp E. (2008). *Vargen är värst. Traditionell samisk kunskap om rovdjur*. Östersund: Jamtli förlag Jämtlands läns museum.

Sippola, A.-L., Norberg, H., Renko, M., Suopajärvi, K. & Sutinen, T. (2005). *Petovahinkojen sosioekonominen merkitys porotaloudelle Suomessa*. Arktisen keskuksen tiedonantoja 44. Rovaniemi: Gummerus Kirjapaino Oy.

Sivertsen, T.R. (2017). *Risk of brown bear predation on semi-domesticated reindeer calves. Predation patterns, brown bear – reindeer interactions and landscape heterogeneity*. PhD. Diss. Uppsala: Swedish University of Agricultural Sciences.

Sjölander-Lindqvist, A., Johansson, M. & Sandström, C. (2015). Individual and collective responses to large carnivore management: the roles trust, representation, knowledge spheres, communication and leadership. *Wildlife Biology*. 21(3), 175–185.

Sjölander-Lindqvist, A., Risvoll, C., Kaarhus, R., Lundberg, A. K. & Sandström, C. (2020). Knowledge claims and struggles in decentralized large carnivore governance: insights from Norway and Sweden. *Frontiers in Ecology and Evolution*. 8, 120.

Skjenneberg, S. & Slagsvold L. (1968). *Reindriftens og dens naturgrunnlag*. Oslo/Bergen/Tromsø: Universitetsforlaget.

SOU (2012). Mål för rovdjuren. Slutbetänkande av rovdjrusutredningen. *Statens offentliga utredningar*. SOU 2012:22.

Stortinget (2011). Parliament's Document Nr. 8:163 S. (2010–2011) *Representantforslag 163 S*. Available online at: www.stortinget.no/no/Saker-og-publikasjoner/Publikasjoner/Representantforslag/2010-2011/dok8-201011-163/

Strand, G.H., Rekdal, Y., Stornes, O.K., Hansen, I., Rødven, R., Bjørn, T-A., Eilertsen, S.M., Haugen, F-A., Hovstad, K.A., Johansen, L., Mathiesen, H.F., Rustad, L.J., Svalheim, E. & When, S. (2016). Rovviltets betydning for landbruk og matproduksjon basert på norske ressurser. (NIBIO Rapport 2(63)).

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

Turunen, M., Rasmus, S., Norberg, H. Kumpula, J, Kojola, I. & Ollila, T. (2017). Porot ja pedot – kuinka poronhoidon sopeutuminen petoihin on muuttunut 90 vuodessa? *Suomen Riista*. 63, 19–42.

Tveraa, T., Fauchald, P., Henaug, C. & Yoccoz, N.G. (2003). An examination of a compensatory relationship between food limitation and predation in semi-domestic reindeer. *Oecologia*. 137(3), 370–376.

Tveraa, T., Stien, A., Bårdsen, B.-J. & Fauchald, P. (2013). Population densities, vegetation green-up, and plant productivity: impacts on reproductive success and juvenile body mass in Reindeer. *PLoS ONE*. 8(2), e56450.

Wallén, J., Nilsson, L. & Hellström, P. (2019). *Resultat från inventeringar av kungsörn i Sverige 2019*. Naturhistoriska riksmuseets småskriftserie. 2019:1.

Zabel, A. & Holm-Müller, K. (2008). Conservation performance payments for carnivore conservation in Sweden. *Conservation Biology*. 22(2), 247–251.