



## 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?

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### ABSTRACT

Semi-domestic reindeer (*Rangifer tarandus*) are the main prey for lynx (*Lynx lynx*) in northern Scandinavia. This causes large, but poorly documented, losses of reindeer. Although the compensation schemes differ between Norway and Sweden, there is a legal requirement in both Scandinavian countries that losses of semi-domestic reindeer to large carnivores should be fully compensated. The current level of compensation payment is based on limited data on lynx kill rates on reindeer. The main goal of this study was to quantify lynx kill rates on reindeer across a range of ecological conditions in northern Scandinavia. A total of 35 lynx were monitored during 3667 days. All lynx individuals killed reindeer. However, we observed a high variation in individual kill rates. Kill rates were strongly affected by sex and social status (i.e. females with and without kittens), as well as season and reindeer availability. The highest kill rates were observed in summer for male lynx, and the lowest were observed during winter for solitary lynx at low reindeer density. In summer, several female lynx switched completely to small prey species even at high densities of reindeer. The present political goals for lynx conservation in Scandinavia require that lynx occur in the reindeer husbandry area where reindeer are the only suitable ungulate prey available. Accordingly, it is therefore impossible to have the total prevention of depredation as a management goal. Rather depredation levels must be limited such that they are considered acceptable, and fair compensation payments should be paid. Our study is the first empirical quantification of the magnitude of lynx depredation on semi-domestic reindeer. This is an important step necessary to enable the setting of fair compensation levels and will hopefully lead to a reduction in conflict level concerning the potential impacts that lynx have on reindeer.

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### 1. Introduction

Livestock depredation by large carnivores is one of the most common causes of human-wildlife conflicts (Thirgood et al., 2005). Livestock depredation is often unevenly distributed in space and time and can have a significant socio-economic impact on individual farmers or herders where it occurs (Thirgood et al., 2005; Zimmermann et al., 2010). Many large carnivore species are now recovering and expanding into new areas (Landa et al., 2000; Linnell et al., 2009), resulting in a growing concern from livestock owners. In Scandinavia (Sweden and Norway), the Eurasian lynx (*Lynx lynx*) population increased rapidly in the mid 1990s resulting

in increased depredation and conflicts with semi-domestic reindeer (*Rangifer tarandus*) and sheep (*Ovis aries*) herders (Swenson and Andrén, 2005; Linnell et al., 2010). In Scandinavia, reindeer are managed almost exclusively by indigenous Sámi people and husbandry is typically extensive. Norway has signed the International Labour Organization (ILO) convention on Indigenous and Tribal Peoples in Independent Countries, and both Sweden and Norway have signed the UN's International Covenant on Civil and Political Rights and are thereby committed to sustain the Sámi culture in which reindeer management is an important part. Likewise both countries are signatories of the Council of Europe's Bern Convention on the Conservation of European Wildlife and Natural Habitats, and Sweden is bound by the European Union's Habitats Directive (Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora). Consequently, management needs to find compromises between the conservation of carnivores and the sustainability of reindeer husbandry (Nilsson Dahlström, 2003). The reindeer husbandry area covers ~50% of

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Sweden and ~40% of Norway, where 250,000 and 230,000 reindeer, respectively, graze freely, mainly unattended (Anonymous, 2010, 2011). The natural seasonal migration of reindeer between winter and summer pastures is largely maintained, but is increasingly governed by the owners and land use restrictions. Both countries experience extensive depredation on semi-domestic reindeer mainly by lynx and wolverine (*Gulo gulo*), but also by brown bear (*Ursus arctos*), golden eagle (*Aquila chrysaetos*) and to some degree grey wolf (*Canis lupus*; Bjärvall et al., 1990; Nybakk et al., 1999; Sikku and Torp, 2004; Swenson and Andrén, 2005).

In Scandinavia, there is a legal requirement that depredation losses of semi-domestic reindeer should be fully compensated, and the subsequent cost of compensation for large carnivores in 2010 was US\$ 8.5 million and US\$ 10.4 million in Sweden and Norway, respectively, where lynx were held responsible for ~40% of the total compensation (Swedish Environmental Protection Agency, The Norwegian Directorate for Nature Management). However, the compensation schemes differ between the countries. In Norway, ex post facto compensation (Schwerdtner and Gruber, 2007) is based on an estimation of losses and is paid directly to the owners. However, the detection rate of carnivore-killed reindeer is very low (9% in winter and 2% in summer; Odden, J., Personal communication) so there is a high degree of uncertainty concerning the real magnitude of depredation. In Sweden, the compensation scheme is based on the presence and density of carnivores and a risk-based compensation (or compensation in advance according to Schwerdtner and Gruber, 2007) is paid to each of the 51 reindeer grazing cooperatives (Zabel and Holm-Müller, 2008). When compensation is based on the presence of carnivores rather than actual losses, reliable estimates of carnivore density (Andrén et al., 2002; Linnell et al., 2007) and individual kill rates are essential. Still, the current level of compensation is based on uncertain and limited information concerning kill rates. The lynx-reindeer conflict is unique in the sense that semi-domestic reindeer are the only suitable ungulate prey species available for the lynx throughout most of the reindeer husbandry area (Andersen et al., 1998 and chapters therein) and consequently, as lynx are largely specialized on medium-sized ungulates (Pedersen et al., 1999; Odden et al., 2006; Molinari-Jobin et al., 2007), reindeer are the main prey.

The fact that lynx prey on reindeer is well documented (Haglund, 1966; Bjärvall et al., 1990; Nybakk et al., 2002) but the only existing data on individual kill rates on reindeer are limited to a few studies of family groups in a few winters (Pedersen et al., 1999; Sunde et al., 2000). In contrast, lynx kill rates on roe deer (*Capreolus capreolus*) and domestic sheep have been extensively studied throughout Europe, and are known to vary depending on sex and demographic status, individual preferences, prey density, prey composition and areas (Sunde and Kvam, 1997; Okarma et al., 1997; Sunde et al., 2000; Molinari-Jobin et al., 2002; Odden et al., 2002, 2006; Nilsen et al., 2009). An understanding of ecological factors causing variation in kill rates will be essential in order to reach a fair compensation scheme. The aim of this study was to fill this gap by quantifying lynx kill rates on reindeer across a range of ecological conditions, focusing in particular on the effects of lynx sex or social status, season, and reindeer availability. These results will then be interpreted in the context of the knowledge needs that exist for Scandinavian compensation schemes to be fair.

## 2. Study areas

The study was conducted in northern Scandinavia, over a series of areas scattered across the northern parts of Norway and Sweden (Fig. 1). The most intensive studied areas were in Troms (69°00'N, 19°90'E), western Finnmark (70°00'N, 23°30'E), and eastern Finn-

mark (70°10'N, 25°00'E) in Norway, and Sarek (67°00'N, 17°40'E) in Sweden. Northern Norway is characterized by a coastal alpine climate. Alpine tundra dominates the area followed by mountain birch forest (*Betula pubescens*) and small patches of pine forest (*Pinus sylvestris*) along the coast and in some of the valleys (Oksanen and Virtanen, 1995). Sarek is characterized by a continental climate and the main vegetation is alpine tundra at higher elevations, sparse mountain birch forest in valleys and hillsides, and mixed conifer forest (*P. sylvestris*, *Picea abies*) at lower elevation. In addition, we monitored some lynx outside the main study areas, hereafter called Swedish forest sites: Tornedalen (66°30'N, 22°80'E), Arvidsjaur (66°20'N, 18°00'E) and Vilhelmina (64°30'N, 16°60'E). These areas are dominated by mixed conifer forest interspersed with bogs and wetlands. All areas are usually snow-covered from November to May.

The ungulate community is dominated by semi-domestic reindeer in all areas. Reindeer are not evenly spread over the grazing areas, are normally seasonally migratory, and are highly mobile within seasons, resulting in large spatial and temporal variations in densities. However, when averaging densities (total counts of reindeer in winter herds per grazing cooperative in 2008/2009) across the administrative areas used by radio-collared lynx, reindeer densities were in the region of 1–16/km<sup>2</sup> inside our study areas (based on official statistics from the Reindeer Husbandry Administration in Norway: <http://www.reindrift.no/?id=948&subid=0>, and the Sámi Parliament in Sweden). In Norway, free ranging sheep are present in most areas during summer. Moose (*Alces alces*) are the only wild ungulate occurring in significant numbers throughout

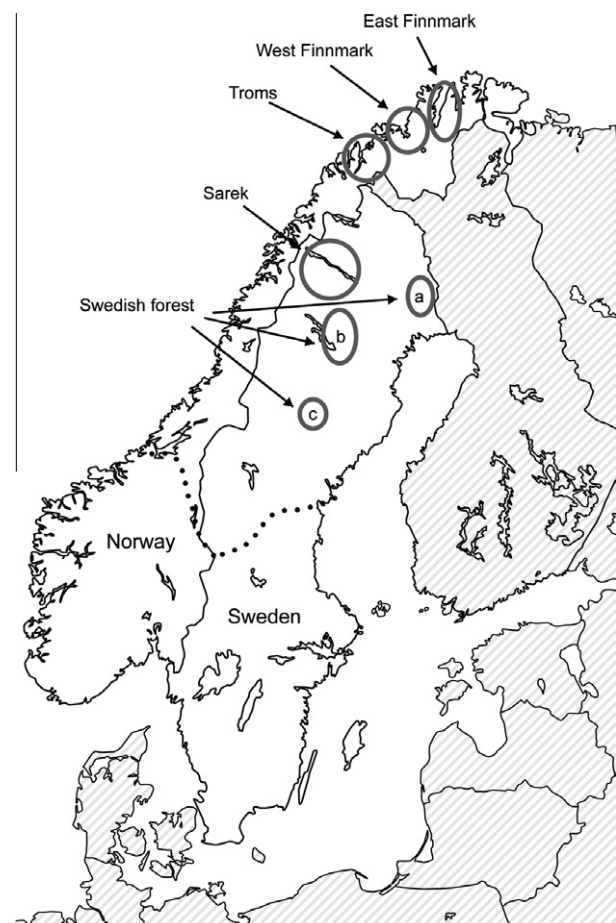


Fig. 1. Map of Scandinavia (Sweden and Norway) showing the areas of data collection on lynx (*Lynx lynx*) predation on reindeer. The dotted line indicates the southern border of the reindeer husbandry area in Norway and Sweden. Swedish forest is represented by Tornedalen (a), Arvidsjaur (b) and Vilhelmina (c).

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