DOES RECREATIONAL HUNTING OF LYNX REDUCE DEPREDATION LOSSES OF DOMESTIC SHEEP?

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Abstract: Eurasian lynx (*Lynx lynx*) are responsible for significant depredation on domestic lambs in Norway. Recreational hunting of lynx is widely used to limit lynx population growth and to attempt to remove problem individuals. We analyzed the relationship between annual changes in lamb losses and lynx hunting on 2 scales. On the county scale, lamb losses were related to the size of the lynx population that was reduced through the harvest of 294 lynx by hunters during our study, 1995–2001. At the level of individual grazing areas, we documented a significant local effect of lynx harvest ($n = 321$ lynx); however, the magnitude of this benefit was so small (13 lambs per male lynx, or 2 lambs per female lynx) as to be of little practical benefit. The data indicate that lynx hunting only reduces depredation when it reduces the size of the population.

JOURNAL OF WILDLIFE MANAGEMENT 69(3):1034–1042; 2005

Key words: Eurasian lynx, livestock, depredation, control, recreational hunting.

Depredation on domestic livestock by large carnivores is an international problem (Oli et al. 1994, Mishra 1997, Ciucci and Boitani 1998, Conner et al. 1998, Mizutani 1999, Polisar et al. 2003). Even in countries where depredation is fully compensated, it is often a major conflict that limits human tolerance of carnivore conservation (Vittersø et al. 1999, Treves et al. 2002, Linnell et al. 2005) and consumes a large proportion of available conservation funding. In other countries where compensation is not paid, it can cause significant impacts on local livelihoods and provoke revenge killings and poaching. There are many methods of mitigating carnivore depredation on livestock, ranging from the traditional systems of shepherds, dogs, and night-time enclosures, to modern systems with electric fences, and a wide range of acoustic and visual deterrents (Linnell et al. 1996; Smith et al. 2000*a*,*b*; Breitenmoser et al. 2005). However, all of these involve increased costs to the livestock producer, and there may be practical difficulties in adapting some forms of husbandry.

As a result, lethal control is still often used as a mitigation measure to reduce carnivore population density (Wagner and Conover 1999) or to try and selectively remove "problem individuals" (sensu Linnell et al. 1999) or certain categories of animals that are responsible for a disproportionate share of the depredation cases (Till and Knowlton 1983, Blejwas et al. 2002). There is a broad consensus among many carnivore conservationists that lethal control in some form will always be required to minimize conflicts as large carnivores expand out of their "wilderness" refuges into multi-use landscapes where people have lost their adaptation to carnivore presence (Mech 1995). However, lethal control is almost always controversial for a variety of reasons, including ethics, cost-effectiveness, efficacy, and compatibility with conservation objectives (Gipson 1975, Harris and Saunder 1993, Bekoff 2001, Johnson et al. 2001). Therefore, it is essential that lethal control be evaluated when implemented as a management strategy.

Following the introduction of a series of harvest restrictions, the last 2 decades have seen a dramatic expansion of the Eurasian lynx population in Norway. By the mid to late 1990s, lynx had spread throughout most of the country with the exception of the west coast. Associated with this expansion was an increase in their depredation on domestic sheep that graze with little supervision (i.e., no fencing, no shepherds, no guarding dogs) in forests and alpine habitats throughout Norway. Studies of depredation using radiotelemetry on lynx (Odden et al. 2002) and sheep (Warren and Mysterud 1990) have confirmed the extent of this depredation. By 2000, each year compensation was being paid nationally for over 10,000 sheep (mainly lambs) killed by lynx (Linnell and Brøseth 2003). Despite this widespread depredation there have been few attempts to adopt any effective nonlethal mitigation measures (Bjøru et al. 2002). In

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1994, a quota regulating hunting system was introduced for lynx in Norway. Although this hunting system is operated as a normal form of recreational hunting, it is implicit that it is also intended to help mitigate depredation on livestock. The intention has been to stablize, or even locally reduce, lynx numbers and to try and remove "problem individuals" by focusing harvest in areas with excessive depredation. Despite having been in existence for 10 years, the ability of this hunt to limit or reduce depredation has not yet been evaluated. We examined the relationship between (a) losses of sheep and lynx population size within 3 different counties that have traditionally contained the largest lynx populations and (b) between sheep losses and the number of lynx killed at the level of the individual grazing area.

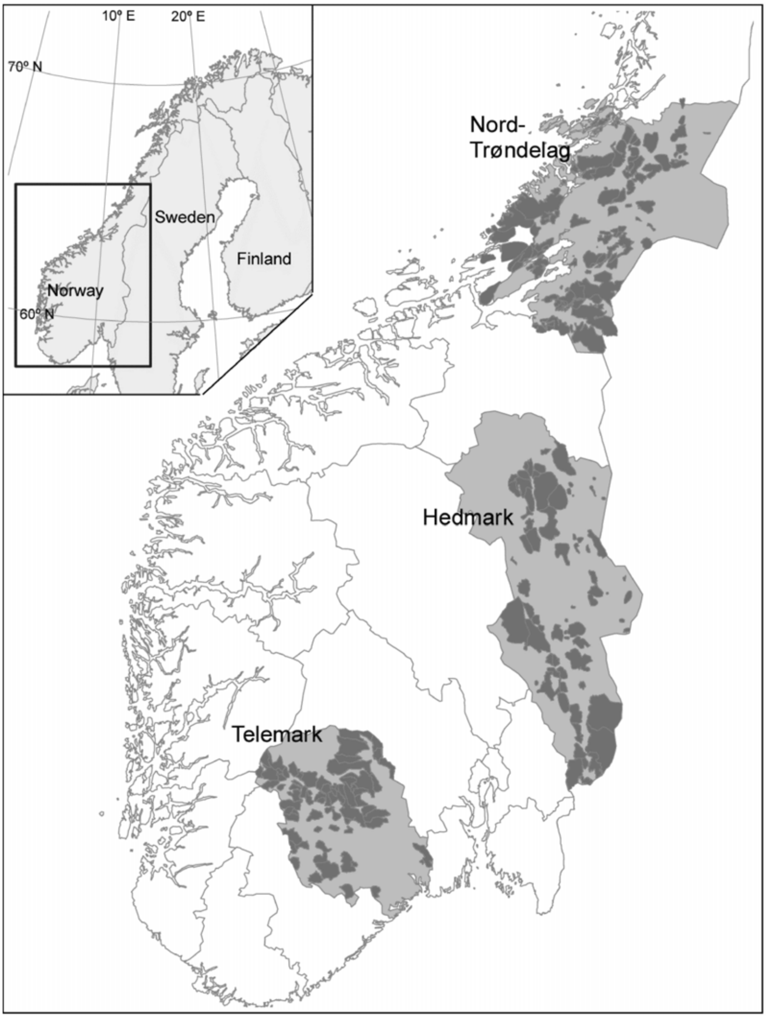

Fig. 1. The locations of study counties (light grey areas) and sheep grazing areas (dark grey areas) used in the analyses of effect of lynx hunting on sheep loss in Norway, 1995–2001.

STUDY AREA

We collected data from 3 study areas in Norway: Hedmark, Telemark, and Nord-Trøndelag counties (Fig. 1). We included 6 municipalities of Sør-Trøndelag County that were located within a peninsula that is geographically contiguous with Nord-Trøndelag. The 3 areas were broadly similar, being dominated by boreal forest below the treeline and alpine-tundra habitat above the treeline. Agricultural land made up a very small proportion of the area (<10%) and tended to be confined to strips along valley bottoms. The landscapes vary in altitude from sea level to >1,000 m. Sheep were grazed in forest and alpine-tundra habitats from June until September without supervision (i.e., no shepherds or livestock guarding dogs) or constraints on their movement (i.e., few areas were fenced). As a result, sheep dispersed over large areas and occurred singly or in small family groups (Warren and Mysterud 1991, 1993) within predictable grazing areas. Sheep grazing areas covered 29%, 30%, and 33% of the land area in the Hedmark (total area of county = 27,388 km^2), Nord-Trøndelag (22,396 km^2), and Telemark (15,315 km^2) study areas, respectively, and sheep densities were 9.2, 8.1 and 12 per km^2 of grazing area or 2.8, 2.4 and 3.9 per km^2 of total study area.

The main prey for lynx in all 3 counties was roe deer (*Capreolus capreolus*) with small game providing an alternative food source (Sunde and Kvam 1997, Sunde et al. 2000). In addition to sheep, semidomestic reindeer (*Rangifer tarandus*) occurred in the Nord-Trondelag study area. Potential livestock predators consisted of lynx in the forested habitats, wolverines (*Gulo gulo*) above treeline, and some brown bears (*Ursus arctos*) that occurred at very low density in the 3 regions (Swenson et al. 1995). Wolves (*Canis lupus*) have recolonized Hedmark county since 1998 (Wabakken et al. 2001), and 2–3 packs exist within the county. Lynx have been present in all 3 counties during the 1990s, although densities peaked in all 3 counties around 1997–1998 and have since decreased slightly due to hunting. Lynx were distributed widely through the study counties, although the density was low (between 0.2 and 0.4 lynx per 100 km^2 (Brøseth et al. 2003), mainly due to the very large home ranges of individual lynx in Norway (Linnell et al. 2001).

METHODS

Sources of Data

We obtained data on the location of sheep grazing areas and on the associated unit-specific numbers of sheep released in spring and gathered in the autumn from the Norwegian Institute of Land Inventory for 1995–2001. We only included data on lambs because lynx depredation on sheep mainly affects lambs; approximately 90% of sheep killed are lambs (Aanes et al 1996, Odden et al. 2002). We reported losses as total losses because it was difficult to distinguish losses due to lynx depredation from other causes. However, because we used changes in losses compared to different lynx population parameters, we expect that loss from other factors was a random error in our analyses and should not influence our estimates. To minimize the possible confounding effects of depredation due to other predators, we did not include grazing areas that were located close to reproductive wolverine populations or to areas where bear reproduction had been documented.

We collected information on lynx that were shot or killed in other ways through the National Large Carnivore Monitoring Program (operated at the Norwegian Institute for Nature Research) or through the Office for Environmental Affairs in each county. All dead lynx were laboratory processed to determine age (based on tooth sectioning; Kvam 1984) and sex determination. Lynx that died after the end of the grazing season (25 Sep) were included in the analyses for the next year. Dead lynx were included irrespective of how they died, although most died due to legal hunting (82.5%). Other causes of death included road kills, illegal hunting, research associated mortality, disease, and other unknown causes. These data covered 1994–2000 (the summer grazing seasons 1995–2000). During our study, lynx hunting was conducted from 1 February to 31 March. Most lynx were shot by hunting teams, both with and without the use of dogs, although some were trapped in box traps. Quotas are set for the county, with some regional subdivision. Female subquotas also became increasingly common during our study.

We used estimates of lynx population size within the counties from Brøseth et al. (2003) from 1996 to 2002. Lynx population size was estimated based on the cumulative collection of all indications of reproduction (i.e., observations of tracks of family groups or kittens of dependent age that had been shot) during the winter. Distance rules based on telemetry data were used to determine the minimum number of discrete, family groups that were likely to be responsible for the observations (Knight et al. 1995). We then extrapolated this minimum number of family groups to a total estimate of lynx population size (Andrén et al. 2002). The data allowed for analyses on the county level from 1996 to 2001 and on the grazing area level from 1995 to 2000. We wanted to ensure that our data on sheep loss caused by lynx was independent of other reasons for sheep loss. Therefore, we ran a Pearson correlation on the number of lambs documented as killed by lynx in each year inside the study area and the total number lost minus the documented lynx killings within the study area the same year. If there was no correlation, the loss by other causes than lynx would be independent of lynx killings. Data on lambs documented as killed by lynx was obtained from the Directorate of Nature Management (DN).

Analysis at County Level

We tested whether the lynx population size within a county could explain the between-year variation in sheep losses with a linear regression model. To account for potential effects of differences between years in the total number of free-ranging lambs, we added this as a factor in a multivariate linear model. However, because the variance increased with increasing absolute values, we log-transformed the number of lambs lost within each county each year. We also log-transformed the total number of free-ranging lambs in order to improve the general relationship between lamb losses and total number of lambs. Lynx population size was held linear.

Analysis at Grazing Area Level

We calculated the number of lynx killed each year that could have potentially preyed on lambs in each grazing area within a buffer of 25 km (male lynx), 15 km (female lynx), and 20 km (sex not specified). The male and female distance rules reflect a radius of an average home range for the specific sex (Linnell et al. 2001), while we used a mean value for both sexes combined for lynx of unknown sex. We measured the distance from the edge of each grazing area to the location where each lynx was killed. Also, we calculated how many different grazing areas each lynx had available within the same distance radius. The proportion of forest within a grazing area was calculated as (forest area) / (total available area). We considered water and human settlements to be unavailable as habitat. We then reclassified the proportion of forest into 2 classes, with the mean proportion of forest as the break point. This categorized grazing areas with less than a mean proportion of forest to a low-forest class, while grazing areas with more than the mean proportion of forest were assigned to a high-forest class.

We wanted an index of the total kill of lynx (i.e., the effective reduction in depredation potential) within an effective distance of each grazing area, using the buffers specified above. However, there were differences in the relative depredation rates of males and females (Odden et al. 2002), where male lynx were estimated to kill approximately 3 times more lambs than female lynx killed. We therefore weighted the influence of sex differently, such that 1 "lynx removal index" represented 1 female or 1/3 male killed. For lynx of unknown sex, we used 1/2. This gave the total lynx index killed for each grazing area as [(no. males * 3) + (no. females) + (no. unknown sex * 2)]. The change in total number of lambs lost during grazing season was calculated as [(no. lost in year 1) – (no. lost in year 2)], such that a decrease in the number of lambs lost from 1 year to another gave a positive value.

We used a multiple linear model to estimate the effect of the lynx removal index on the difference in lamb loss from year 1 to year 2. We included the difference in lambs released in grazing area from year 1 to year 2 in order to account for the effect of changes in number of total lambs on number of lambs lost. We also included proportion of forest as a factor in an interaction with the lynx removal index to examine if the effect of lynx removal was different in areas with high proportion of forest cover (i.e., preferred lynx habitat) than in areas with less forest.

We conducted the analysis on 3 different time scales: (1) differences in lamb loss from 1 year to the next year, (2) differences in lamb loss from 1 year to 2 years later, and (3) differences in lamb loss from 1 year to 3 years later. For the latter 2, we used the sum of annual lynx removal indices for each grazing area.

When modeling regression analyses, extreme observations will have a disproportionate influence on the final model and the slope of the regression. This effect can be calculated as the Cook's distance (Cook and Weisberg 1982), where observations with high Cook's value have greater influence on the regression model, often recognized as outliers. In our data, grazing areas that had a very high difference in the number of lambs released from year 1 to year 2 will also have a great difference in the number of lambs lost in the same period. They will therefore be extremes in the explanatory and the dependent variables; therefore, we removed cases with large differences (>250) in the numbers of lambs released from year 1 to year 2. In addition, there were other observations with high Cook's distance. We found no reason to remove them, since they were correct observations, but we instead used a robust linear model (Venables and Ripley 2002). All statistical analyses were run in S-PLUS for Windows, version 6.0 (Insightful Inc. 2002) and with a 0.05 significance level.

RESULTS

We found no correlations between the number of lambs documented as killed by lynx and the number of lambs lost by other causes ($t = 0.95$, $P = 0.379$, $r = 0.36$). This supported our belief that our data was independent of losses caused by other factors than lynx.

County Level

The annual mean proportion of lambs lost was 10.9, 5.7, and 10.5% for Hedmark, Telemark, and Nord-Trøndelag counties, respectively (Table 1). One hundred and sixty-eight male and 126 female lynx were killed during the study (1995–2001) in the 3 counties; 81 males and 60 females were killed in Nord-Trøndelag, 56 males and 37 females were killed in Hedmark, and 56 males and 29 females were killed in Telemark.

The model showed significant positive effects of both the log of the total number of free-ranging lambs within a county ($F = 277.2$, $P < 0.001$) and the lynx population size in the county ($F = 8.3$, $P = 0.011$) on the lamb losses (Table 2). These 2 factors explained the variance in lamb losses fairly well ($r^2 = 0.95$, $F_{2,15} = 150.9$, $P < 0.001$). The numerical effect of decreases in the lynx population within a county was larger in counties with more sheep (Fig. 2). For example, a reduction in lynx

Table 1. Estimates of lynx populations, lynx killed, and percentages of free-ranging lambs lost in Hedmark, Telemark and Nord-Trøndelag counties in Norway, 1995–2000.

County	Year	Population size (Lynx)	Male lynx killed	Female lynx killed	% lamb lost
Hedmark	1995		7	4	9.7
	1996	57	12	4	9.2
	1997	45	10	5	9.2
	1998	66	7	10	10.0
	1999	66	11	7	10.5
	2000	46	9	7	11.0
	2001	57			10.8
Telemark	1995		3	2	5.2
	1996	33	5	4	6.0
	1997	75	5	5	6.2
	1998	51	10	9	6.6
	1999	57	5	6	5.4
	2000	39	3	3	4.5
	2001	48			4.6
Nord-Trøndelag	1995		7	7	10.3
	1996	93	18	15	12.6
	1997	114	24	16	9.2
	1998	84	10	9	9.3
	1999	78	7	7	10.1
	2000	87	11	4	8.8
	2001	42			9.0

Table 2. Estimates of effects of lamb and lynx abundance on between year differences (t to $t + 1$, t to $t + 2$, and t to $t + 3$) in sheep loss in 3 Norwegian counties, 1995–2001. LM = linear model, RLM = robust linear model.

	Model type	Variable	Effect	SE	*t*-value	*p*-value
1 year	LM	Difference in lamb out	0.1194	0.0168	7.1274	<0.0001
		Lynx index	0.7952	0.2860	2.7804	0.0056
	RLM	Difference in lamb out	0.0979	0.0092	10.6434	<0.0001
		Lynx index	0.6118	0.1571	3.8943	0.0001
2 years	LM	Difference in lamb out	0.0936	0.0190	4.9238	<0.0001
		Lynx index	0.5350	0.2327	2.2993	0.0219
	RLM	Difference in lamb out	0.0752	0.0090	8.3863	<0.0001
		Lynx index	0.3574	0.1097	3.2585	0.0012
3 years	LM	Difference in lamb out	0.0923	0.0203	4.5479	<0.0001
		Lynx index				NS
	RLM	Difference in lamb out	0.0759	0.0108	7.0238	<0.0001
		Lynx index	0.2800	0.1122	2.4965	0.0128

population from 90 to 60 individuals would reduce the number of lambs lost by 780 with 60,000 grazing lambs, while the corresponding reduction with 30,000 grazing lambs would be 216 lambs.

Grazing Area Level

Three hundred and twenty-four lynx (179 males, 134 females, and 11 unknown) were killed within the study area (specified within the county borders and a home range diameter buffer) during the study (1994–2000). All lynx that were killed, except 3 females, were within the buffer distance to at least 1 grazing area and could therefore influence the lamb loss. The grazing areas had a mean of 4.32 lynx removal units killed within the specified distance rules on a 1-year scale. This corresponds to approximately 4.3 females or 1.4 male lynx per grazing area per year. For the 2 and 3 year analyses, the lynx removals units were 9.07 and 13.09, respectively (cumulative values). This corresponds to approximately 4.54 and 4.36 lynx killed near each grazing area per year. Each killed male and female lynx had on average 7.02 and 3.24 grazing areas available, respectively, within their potential area of influence.

The mean number of lambs per grazing area was 826 (range 28–9,623), while the mean number of lambs lost per grazing area was 71 (range 0–584). Average percent loss was 8.41% per year. The difference in lambs lost from year 1 to year 2 was –1.77 (overall increased losses), while the difference in lambs released was –2.60 (increased number of lambs released). Similarly, values were –2.24 and 1.17 for the 2-year analysis and –1.16 and 12.64 for the 3-year analysis.

All robust models excluded forest as both an interaction factor and as a main factor, and only the difference in the number of lambs released and the lynx removal index were retained as significant effects. This was also the result in most of the ordinary linear models, and the estimates of effects were on average 20% higher in the linear models than the robust linear models (Table 2). Further interpretation of the results only considered the robust linear model analyses. The effect of 1 lynx removal index unit led to a decrease of approximately 0.61 lambs lost from 1 year to the next per grazing area. This gave a total reduction in lambs lost of approximately 13 and 2 per male and female lynx killed, respectively (calculated as [effect of removing a lynx index] * 3 [males, 1 for females] * [number grazing areas available for males or females]). The effects of each lynx removal index unit on differences in lambs lost in the 2- and 3-year analyses was 0.36 and 0.28, respectively. The effect measured in reduction in lamb loss per year for each male lynx killed was 15.16 and 17.69 for 2 and 3 years, respectively. For females, the corresponding values were 2.33 and 2.72.

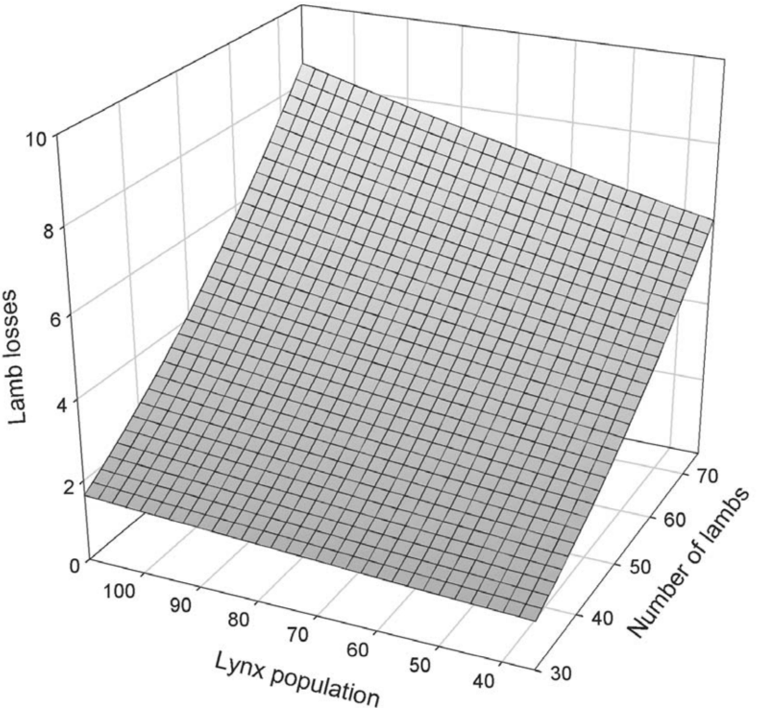

Fig. 2. Relationship between lamb losses, total number of lambs, and lynx population size within 3 Norwegian counties, 1995–2001. All lamb numbers represent 1,000 individuals.

DISCUSSION

We have documented that recreational hunting of lynx can produce a reduction in sheep losses when the hunting leads to a reduction in the lynx population. On a finer scale, the local removal of lynx led to a statistically significant, but very small, reduction of losses for grazing areas within a potential action radius of the removed lynx.

Because our analysis was based on rather rough data (i.e., overall lamb losses), it is possible that other factors might have influenced our analyses of lamb losses or otherwise influenced lynx depredation on lambs. The main prey for lynx in the study area is roe deer (Linnell et al. 1996, Solberg et al. 2003). Available hunting statistics for the study area suggest that the roe deer population has been rather stable, with small annual variation throughout the study. It is therefore reasonable to expect variation of losses to not be influenced by densities of other prey. Studies of radiocollared lynx in the area also show that even though lynx kill sheep frequently, they rarely utilize them as prey (Odden et al. 2002).

The presence of other carnivores could also have influenced our results. There was no recorded breeding of other large carnivores in the study area, except for 1 pair of wolves breeding in Hedmark from 1998 through 2001 (Wabakken et al. 2001). We therefore treated the effect of other large carnivores as being too small and unbiased to affect the statistical analyses of lamb losses due to lynx removal.

Other lamb mortality factors, like illness and accidents, were occasionally reported in the study area (Aanes et al. 1996,). They were recognized as normal losses that were suspected to be constant from year to year and between areas. However, even if there was variation between years and areas (Warren and Mysterud 1995) there was no reason to believe that this variation would show covariance with changes in losses due to lynx occurrence and density. Therefore, factors like illness and accidents (and incidentally also predation from other carnivores) acted as an unbiased random error in the loss numbers. They therefore entered the statistical model's error term. These factors did not influence the estimates of parameters but rather the uncertainty of the estimates, making the analyses more conservative.

Most studies of carnivore depredation have been conducted on canids, particularly coyotes (*Canis* *latrans*), dingos (*Canis lupus*), and wolves (Ciucci and Boitani 1998, Sacks and Neale 2002, Treves et al. 2002). This is especially true for evaluations of control as a mitigation strategy (Harris and Saunders 1993, Allen and Sparkes 2001, Blejwas et al. 2002). However, felids also can be serious predators of livestock. In North America, members of the genus *Lynx* (Canada lynx [*L. canadensis*] and bobcat [*L. rufus*]) are rarely associated with high levels of depredation (Neale et al. 1998); however, their congener, the Eurasian lynx, is associated with depredation on sheep and lambs throughout western and northern Europe, especially in France (Stahl et al. 2001*b*), Switzerland (Breitenmoser and Angst 2001), and Norway (Linnell and Brøseth 2003). As for all carnivore species, the per capita levels of lynx depredation observed in Norway are 1 to 2 orders of magnitude higher than those seen in other European countries (Kaczensky 1996). This is probably due to the husbandry system (developed after the historic near-extermination of large carnivores), in which unguarded sheep are released directly into carnivore habitat for 3–4 months a year. The average lamb losses observed in this study, 6–11%, were very high by any standards, represented a serious economic loss, and raised questions about domestic animal welfare. Although lynx are not the only cause of lamb mortality, they represent a significant additive factor (Mysterud and Mysterud 1995). However, partly because full compensation was paid and because this depredation was quite evenly spread over many livestock owners, there has been insufficient incentive for owners to make substantial changes to their husbandry practices purely because of lynx depredation. Instead they appear to have relied on hunting of lynx to keep the depredation within levels that are regarded as acceptable by the industry and society at large.

On the level of the individual grazing area, we were able to document a statistically significant effect of lynx hunting. The more lynx that were shot close to a grazing area, the fewer lambs were lost the following summer. However, there was considerable variation in the relationship, and the overall benefit in terms of the number of lambs actually saved was very small. For every lynx removal index unit (e.g., 1 adult female or 0.3 of an adult male), 13 fewer lambs would be lost on average. These lambs were spread across all grazing areas within the lynx's home range (up to 1,500 km^2 for a resident male lynx), such that each livestock owner on average would lose <1 lamb less after shooting a lynx. We were able to detect this effect, albeit in a declining manner, for up to 2 years after the removal. This result was similar to studies in the French Jura Mountains that documented a short-term effect of lynx removal, although in some cases, depredation resumed within 40 days on the same pasture from which the lynx was removed (Stahl et al. 2001*a*).

Therefore, even after successfully removing a lynx from the vicinity of their grazing area, sheep owners can only expect a small, short-term benefit in the reduction of numbers of lambs lost. This is probably due to the fact that each lynx in the population only kills 0–50 lambs during a summer, and as most lynx probably kill at least some lambs each summer (Odden et al. 2002), only total removal of all lynx overlapping with a grazing area would reduce depredation to 0. The estimate of the number of lambs saved per lynx shot corresponded well with our estimated depredation rates based on individual radiocollared animals (i.e., 8 and 38 lambs per grazing season per adult female and adult male, respectively). Furthermore, as sheep tend to graze in areas more remote than those where lynx are shot (Sunde et al. 1998), and hunting occurs 3–5 months before the start of the grazing season, hunting clearly did not specifically target individuals responsible for depredation in either time or space. The effect declines because of the potential for new lynx to immigrate or for neighbors to shift their territorial borders. Thus shooting lynx will only lead to a long term benefit if the local population is reduced to, and kept at, a lower density.

Accordingly, on the county level we found a clear relationship between lynx population size and numbers of lambs lost. During our study, the lynx population in all 3 counties increased in the first years followed by a decrease (probably due to unsustainable levels of hunting; Andersen et al. 2003), and the levels of lamb losses closely tracked this trend. Thus lynx hunting appeared to mitigate lamb depredation through its effect on lynx population size. This supports our radiotelemetry data (Odden et al. 2002) that indicated that there was no evidence of so-called "problem-individuals" (Linnell et al. 1999) that kill widely disproportionate numbers of livestock. This was probably due to the dispersed nature of sheep grazing in Norway (Linnell et al. 1999). We therefore speculate that depredation rates are mainly determined by the rates of chance encounters between lynx and sheep while lynx are hunting for wild prey or engaging in territory maintenance. This is supported by several lines of evidence: (1) Lynx do not appear to select foraging patches that contain sheep, but instead they select patches in which they have the greatest chance of encountering wild prey (Moa et al. 2005); (2) sheep losses are highest in grazing areas with higher densities of wild prey (Stahl et al. 2001*b*); (3) we found that depredation rates were highest in areas with higher sheep densities; and (4) most sheep were not fully consumed after being killed, indicating that they were not killed specifically as food (Odden et al. 2002). This implies that most sheep killing is in fact "surplus killing."

MANAGEMENT IMPLICATIONS

These results indicate that sports hunting can only influence sheep losses on a practical level through its overall effect on lynx population size and distribution. Its value as a selective removal tool appears to be very limited. Therefore, sports hunting may be a legitimate tool to keep lynx numbers at a level where their depredation impact falls within limits that sheep herders and society feel is acceptable. However, if managers seek to increase lynx numbers above this level, reducing the impact of lynx on sheep can only be achieved through changes in sheep husbandry.

ACKNOWLEDGMENTS

The authors are especially grateful to I. Strømnes and H. Brøseth for assistance in data collection. The study was financed by the Norwegian Research Council, the Directorate for Nature Management, and the Norwegian Institute for Nature Research.

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Associate Editor: Cypher.