HUNTING MOOSE OR KEEPING SHEEP? – PRODUCING MEAT IN AREAS WITH CARNIVORES

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ABSTRACT**:** Moose hunting is of considerable economic and social importance in much of Scandinavia. In some parts, such as south-east Norway, it is economically more important than sheep farming. We examine trends in moose harvesting and sheep production over a 12-year period in an area of increasing predator numbers and compare the meat yield before and after the re-establishment of wolves. The production of lamb meat at the county level declined, particularly from within the forest habitat, while the moose harvest showed only localized reductions. We also consider the scale of the economic loss caused by large carnivores and discuss management options for a future with carnivores.

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Unlike many parts of North America where the sale of game meat is restricted or prohibited, moose (*Alces alces*) meat is a valuable commodity in Scandinavia. Since the 1970s the annual Norwegian moose harvest has increased over 6-fold (Statistics Norway 2004a), due to changes in forestry practices and the introduction of a selective hunting regime (Østgård 1987) in the near absence of large carnivores and with reduced competition from domestic cattle grazing (Ahlen 1975). The current yield is around 35,000-40,000 moose per year with an estimated economic value of US$ 40-55 M from meat alone (see also Storaas et al. 2001), making it by far the most economically important game species in Scandinavia (Mattsson 1990). At the local scale, hunting is a significant source of meat and income in rural areas, and plays an important social and cultural role. Although landowners do not legally own game animals on their land, they hold the right to hunt them and proceeds generated from hunting may form a significant part of the annual income of some large landowners. However, much of the meat is consumed privately and hunting rights are rarely sold for more than the meat value. Furthermore, as there is no well developed Scandinavian equivalent of the North American 'outfitting' business, moose hunting contributes little towards local employment. Consequently, much of the potential economic value of moose hunting is not realized.

Sheep production in Norway has also increased since the 1970s but to a lesser extent and for different reasons. Over this period, it has been government policy to support agriculture, including sheep farming, as a means of maintaining human settlements in rural Norway and stabilizing food production (Norwegian Agricultural Authority 2004, see also Zimmermann et al. 2001). The introduction of production subsidies during an era when large carnivores were virtually extinct allowed for a rise in lamb production which peaked in the early 1980s (Rogstad 2003, Statistics Norway 2004b). Changing husbandry practices also meant that lamb production became concentrated on fewer, larger farms and became less labor

intensive with little shepherding (Linnell et al. 1996, Nersten et al. 2003, Rogstad 2003). In general, ewes are over-wintered and lambed indoors or in low-lying fields, due to 5-7 months of snow cover, and then released with their lambs to range freely in unenclosed forest and mountain pastures during the summer months (Drabløs 1997).

The current national production of lambs is about 1.4 million per year (Statistics Norway 2004b), with a meat value of US$ 120M at today's prices and wool production worth approximately US$ 25 M (Rogstad 2003, Statistics Norway 2004b). However, sheep production subsidies total approximately US$ 255 M per year, with 55-70% of sheep farmers' income arising from subsidies (Nersten et al. 2003). On an international scale, sheep farming in Norway is a relatively small industry, providing about 9,000 full-time job equivalents nationwide, held on approximately 19,000 farms. Although both moose hunting and sheep farming occur throughout large parts of Norway, the main sheep farming districts are in the mountainous areas of Western Norway while moose hunting tends to be concentrated in the forested areas in the south-east and further north (Fig. 1).

Concurrent with increases in the Norwegian moose harvest and lamb production, there has been a change in attitudes towards large carnivores in Europe and North America (Linnell et al. 1996, Bjerke et al. 1998, Williams et al. 2002, Ericsson and Heberlein 2002). The Norwegian government has explicitly stated the goal to maintain sustainable, breeding populations of four large carnivore species (Miljøverndepartementet 2003-2004), following their near eradication due to human persecution over the last 150 years (Swenson et al. 1995, Wabakken et al. 2001, Vilà et al. 2003). Bears (*Ursus arctos*) and wolves (*Canis lupus*) have been protected in Norway since 1973 and 1971 respectively, wolverine (*Gulo gulo*) since 1973 in southern Norway and 1981 in northern Norway, and lynx (*Lynx lynx*) since 1992 in southern Norway (Andersen et al. 2003). However, some controlled hunting of lynx and wolverine has been permitted under license since 1994. Wolf numbers began increasing in southern and central Scandinavia in 1991 and rose 10-fold during the following 10 years (Wabakken et al. 2001). After protection, the first confirmed reproduction in Norway occurred in 1997.

One element of the policy to promote carnivores has been to pay compensation to farmers who lose domestic stock to carnivores (Kaczensky 1996, Linnell and Brøseth 2003). After about a century without any significant number of large carnivores, it has become common practice to graze domestic sheep on unenclosed forest and mountain pastures without shepherding in summer (Mysterud et al. 1996, Linnell and Brøseth 2003). Consequently in some regions Norwegian sheep farmers are now experiencing the highest losses of sheep per carnivore in Europe (Kaczensky 1996, Linnell 2000). Although a number of studies have investigated ways of reducing carnivore-livestock conflicts (e.g., Linnell et al. 1996, Mysterud et al. 1996, Flaten and Kleppa 1999, Krogstad et al. 2000), the problem persists. Furthermore, man is no longer the only significant hunter of moose in Scandinavia, as wolves also adversely affect local moose populations (Gundersen 2003).

Here we present an exploratory analysis of trends in the relative size and economic importance of moose hunting and sheep farming since 1990 in the county of Hedmark, Southeast Norway, where carnivore numbers have been increasing. We examine changes in trends since the re-establishment of large carnivores and quantify the economic loss incurred by local landowners and communities due to a reduced moose harvest and lamb production. We then go on to discuss land management options in an environment of increasing carnivore density and the appropriateness of continuing sheep farming in some areas. We do not attempt to demonstrate causal relationships

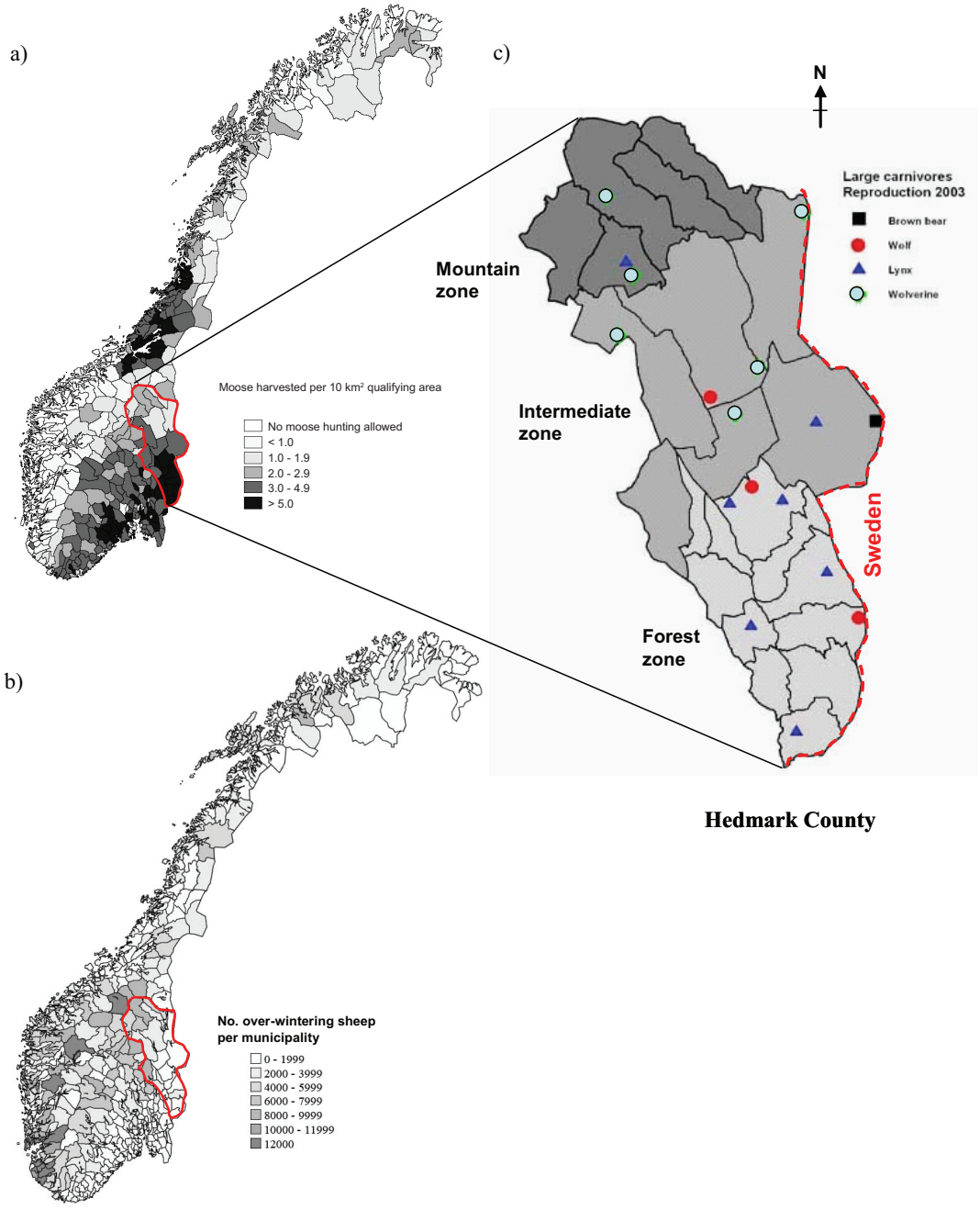

Fig. 1. Map of Norway showing (a) the density of moose shot in 2002 (Statistics Norway 2004b) and (b) the number of sheep kept over winter in each municipality (Norwegian Agriculture Authority 2004) and the location of Hedmark County. (c) Habitat zones and location of reproducing large carnivores in Hedmark in 2003.

between moose, sheep, and predator numbers.

STUDY AREA

The county of Hedmark is in south-east Norway on the Swedish border and is composed of 22 municipalities (Fig. 1) with a low and scattered human population density, averaging 6.8 persons / km^2. The county covers about 27,000 km^2 of which approximately 60% is boreal forest dominated by Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*), managed primarily for commercial timber production. Hedmark has a relatively high moose density (>1 moose / km^2 (Gundersen 2003)). It is the most important moose hunting county in Norway (Fig. 1a), accounting for 20% of the national harvest (Statistics Norway 2004a). Over 25,000 inhabitants are registered hunters. By contrast, sheep farming is not a major component of the local economy except in the north of the county. There are about 45,000 over-wintering adult female sheep in the whole of Hedmark (6% of Norway's total flock, Fig. 1b) which provide less than 600 full-time job equivalents (Wabakken et al. 1996). But, more importantly for local rural politics, sheep farming provides income or part-time employment for over 1,100 households for whom having sheep may make the difference between keeping or abandoning the farm. Although cattle farming also occurs throughout the county, there are about 7 times as many free-ranging sheep as cattle. Until recently there has been little conflict between carnivores and cattle (Zimmermann et al. 2003) so public and media interest has focused on the issue of sheep farming.

The county can be divided into 3 habitat zones (Fig. 1c). The north of Hedmark is a mountainous area, characterized by a high proportion of alpine vegetation above the tree-line at about 900m above sea level. The south of Hedmark is dominated by forest with over 70% forest cover and < 0.1 % of the land area above the tree-line. Between these areas is an intermediate zone with a mixture of both forest (60% cover) and mountain habitats (Table 1). Moose density, indexed by harvest density, is highest in the forest zone and lowest in the mountain zone (Fig. 1a), while sheep densities are considerably higher in the mountain zone and than in either the forest or intermediate zone (Fig. 1b, Fig. 3).

Hedmark is the only county in Norway where breeding populations of all 4 species of large carnivores occur (Fig. 1c) and has one of the largest numbers of carnivores. Carnivore distribution is strongly influenced by proximity to the Swedish border, with dispersing individuals, particularly bears and wolves, frequently crossing into Hedmark. Overall, carnivore numbers are highest in the forest zone. Wolverines tend to occur most in the mountainous north while lynx numbers are highest in forest areas. Both wolf and bear populations occur in the area east of the Glomma River to the Swedish border. Breeding wolves have gradually been re-colonizing the area since 1997 but resident wolves are only found in the forest and intermediate zones. The Norwegian Parliament has declared a wolf conservation zone which was implemented in spring 2005, partly in southeastern Hedmark, while a bear conservation zone in Hedmark existed between 1993 and spring 2005 (Miljøverndepartementet 2003-2004). However, these zones, which incorporate suitable habitat, are essentially political demarcations and dispersing individuals of both species can often be found in areas outside these zones.

DATA & ANALYSES

Local municipalities act as the executive game management authorities in Norway (Danielsen 2001). We therefore used data from hunters and sheep farmers collated at the municipality scale, by hunting teams, landowner and grazing organizations, municipality offices, and the County Governor. Variables included the number and age- and sex-class of all moose shot during the hunting season,

Table 1. Size and vegetation of the habitat zones within Hedmark County. Qualifying area (QA) is based on the land considered suitable moose habitat for the purpose of hunting license allocation and is related to the population's productivity (Østgård 1987). TA: Total area. The change in moose population size is the proportional change in the number of moose observed per hunter per day during the hunting season between the period 1990-1996 and 1997-2002.

Habitat zone	Total area (km^2)	Proportion forest	Proportion bog	Qualifying area (km^2)	QA /TA	Change in moose pop
Mountain	81,400	0.38	0.09	42,800	0.53	0.98
Intermediate	171,300	0.6	0.13	124,750	0.73	1.2
Forest	103,450	0.74	0.09	87,250	0.84	1.31

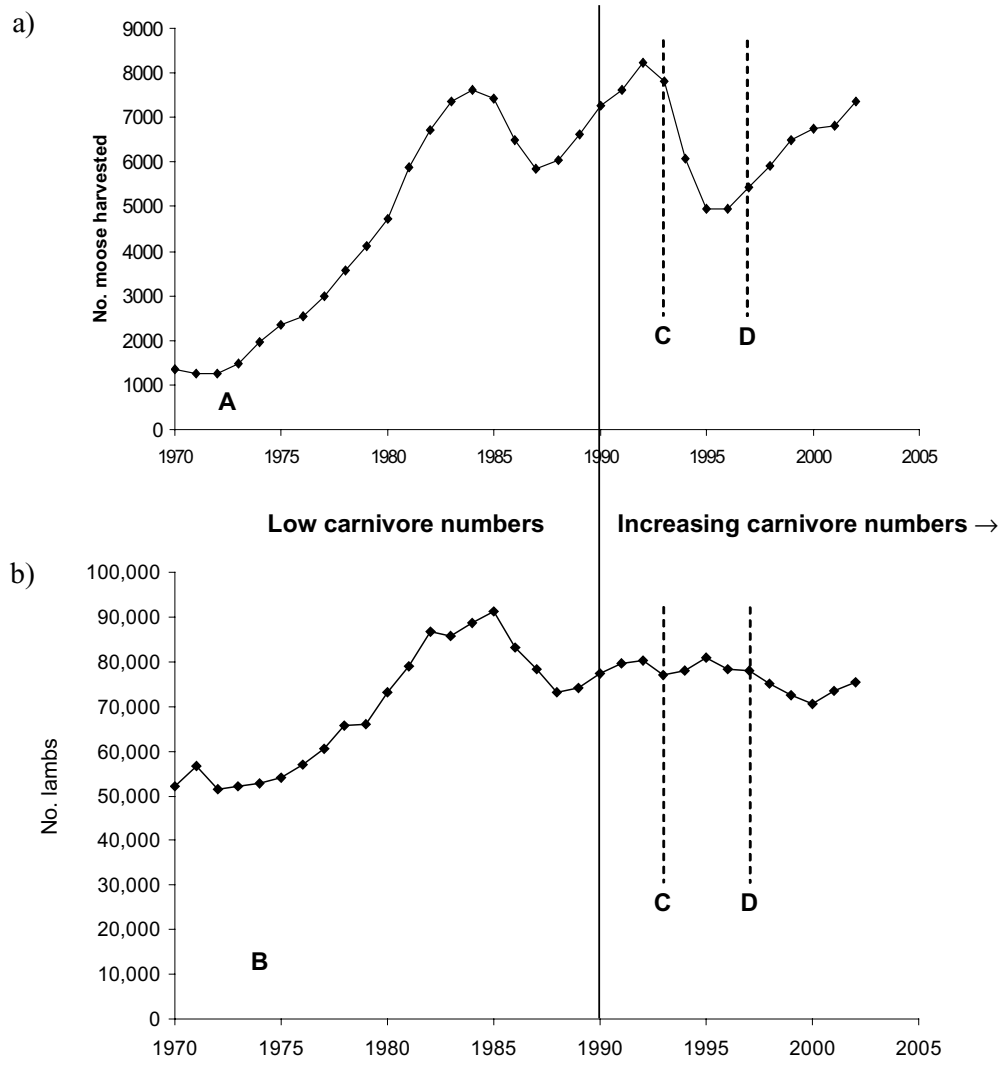

Fig. 2. Trends in (a) number of moose shot and (b) number of lambs produced in Hedmark since 1970. A: introduction of selective hunting, B: introduction of sheep production subsidies, C: implementation of the brown bear conservation zone, D: re-establishment of breeding wolves in Norway.

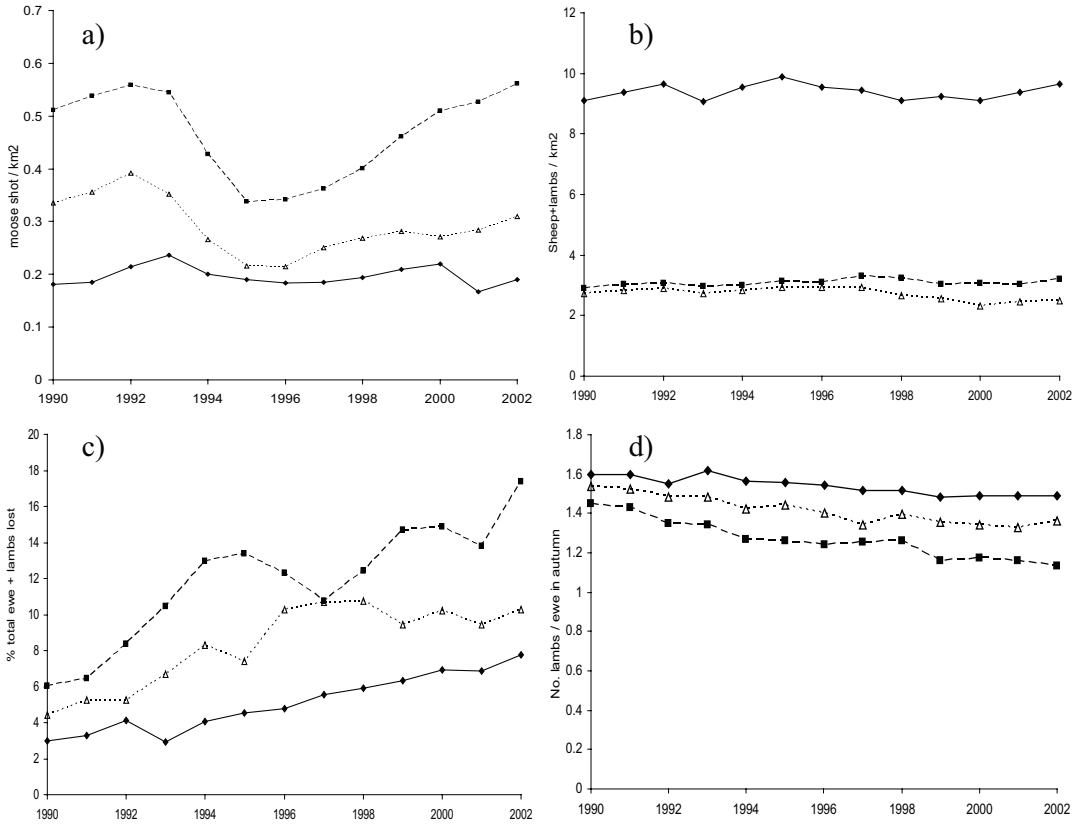

Fig. 3. Trends by habitat zone in (a) number of moose shot, (b) number of ewes plus lambs released to hill and forest pastures in June, (c) percentage losses of ewes and lambs to large carnivores during summer, and (d) number of lambs per ewe in autumn. Square symbol with dashed line: forest zone, triangle with dotted line: intermediate zone, diamond with solid line: mountain zone.

the number of adult sheep and lambs released onto the unenclosed forest and mountain pastures during the summer, the number of adult sheep and lambs lost over the summer period, the number of compensation claims made by sheep farmers for different predators, and the number and size of compensation payments made. Numbers of sheep were those of farmers belonging to grazing organizations only (about 90% of all sheep farmers in Hedmark; E. Maartmann, personal communications). We restricted our analysis to the time period 1990-2002 allowing a comparison of years before and after the re-colonization of wolves, the only carnivore to have a significant impact on both sheep and moose in Hedmark.

All values are expressed in US$ assuming a constant exchange rate of 1 Norwegian kroner = US$ 0.145 and adjusted for inflation to 2002 values using the Norwegian consumer price index (Statistics Norway, http://www.ssb.no/kpi/tab-01.html). The value of moose meat was assumed to be US$ 10.2 / kg throughout the study period, corresponding to a decrease in value in real terms from $13.4 / kg in 1990. Average stripped moose carcass weights showed a density-dependent decrease during the study period and were taken as 70 kg prior to 1994 and 68 kg since 1994 for male calves, 70 kg and 64 kg for female calves, 149 kg and 139 kg for 1.5-year-old males, 142 kg and 131 kg for 1.5-year-old females, 221 kg and 200 kg for older males, and 183 kg and 176 kg for older females prior to and since 1994,

respectively (Statistics Norway 2004a). The wholesale market price of lamb meat fluctuated between a minimum of US$ 5 / kg in 1990 to a maximum of US$ 6.2 /kg in 2002 (Statistics Norway 2004b), which after adjusting for inflation, meant a decrease in value from US$ 6.7 / kg in 1990. Although there is significant variation in autumn lamb weights between years (Steinheim et al. 2001, 2004), for simplicity we have assumed a constant stripped lamb carcass weight over time but varying between municipalities from 17 kg in the forest zone to 19.5 kg in the mountain zone (Steinheim et al. 2001). We have assumed that all lambs rounded up in autumn are slaughtered rather than used for stock replacement.

A generalized linear mixed modeling approach (McCullagh and Nelder 1989), in which municipality and year were fitted as random effects, was used to evaluate the trends which were investigated by habitat zone. The Wald statistic approximates to a χ^2 distribution.

RESULTS

Regional Trends in Moose Hunting

An average of 6,600 moose (range 4,958 - 8,215) have been shot annually in Hedmark since 1990 (Fig. 2a), yielding over 880 tonnes of meat per year. Assuming all meat was sold, this represents a value of US$ 7.5 M - 14.6 M per year.

There has been considerable variation in the number of moose shot per year, both at the county level (Fig. 2a) and when a comparison is made by habitat zone (significance of year: $\chi^2_{12,267} = 244.4$, $P < 0.001$; Fig. 3a). Inter-annual variation was greatest in the forest zone, showing a sharp decline in harvest yield in 1994-95 followed by a recovery to pre-decline levels. However, there was no evidence of a difference in the number of moose shot per year in the periods before (1990 - 1996) and after (1997 - 2002) the re-establishment of wolves in any habitat zone (mountain: $\chi^2_{1,60} = 0.45$, $P = 0.50$; intermediate: $\chi^2_{1,73} = 0.27$, $P = 0.61$; forest: $\chi^2_{1,136} = 0.09$, $P = 0.77$) and moose were not affected by any other large carnivore species. There were, nonetheless, clear differences in the number of moose shot /km^2 qualifying area between habitat zones ($\chi^2_{2,277} = 42.83$; $P < 0.001$), with considerably higher yields in the forest zone than in either the intermediate or mountain zone in all years. These differences probably reflect differences in moose densities between the habitats. Furthermore, the number of moose seen per day by hunters increased over the study period in the forest and intermediate zones but not in the mountain zone (Table 1). Consequently, habitat zone has a much greater influence on hunting yield than the presence of wolves, at the regional scale.

Regional Trends in Lamb Production

Since 1990 the adult female sheep flock in Hedmark has remained steady at around 46,000 ewes (range 43,673 - 48,375), while the total number of lambs produced and surviving until autumn has decreased significantly ($\chi^2_{1,247} = 7.20$; $P = 0.007$), falling from a peak of over 80,000 in the early 1990s to 70,000 in 2000 (Fig. 2b). The decline, from 1,280 tonnes of meat in 1990 to 1,130 tonnes in 2002 is equivalent to a 12% reduction in annual production, or a loss of 150 tonnes per year over 13 years, worth almost US$ 1M at 2002 prices. The decline in lamb yield corresponds with a decrease over time in the number of lambs released in June to range freely ($\chi^2_{1,247} = 23.29$; $P < 0.001$) and a dramatic increase over time in the proportion of lambs going missing during the summer ($\chi^2_{1,247} = 82.23$; $P < 0.001$; Fig. 3c). Compensation claims for both sheep and lambs lost to large carnivores in Hedmark increased over 5-fold in real terms between 1990 and 2002, with claims paid amounting to US$ 300,000 in 1990 after adjusting for inflation, rising to US$ 1.7M in 2002 (Fylkesmannen i Hedmark, unpublished data). This was despite a decrease in compensation payment per head in both actual and real terms between 1990 and 2002. Most of the compensation paid

out was for claims against bear (23%), lynx (19%), and wolverine (17%) predation, with only 6% due to wolves and a further 34% in the case of unspecified predators.

The rate at which autumn lamb yield declined differed significantly between habitat zones, being considerably greater in the forest zone than in the mountains (habitat zone-year interaction: $\chi^2_{2,243} = 15.83$; $P < 0.001$). Although all habitat zones have shown a steady increase in losses of both ewes and lambs since 1990 as carnivore numbers have increased ($\chi^2_{1,247} = 88.79$; $P < 0.001$), proportional losses have been highest in the forest zone (habitat zone-year interaction: $\chi^2_{2,243} = 8.35$; $P = 0.015$; Fig. 3c), reaching over 20% of lambs in 2002. This, combined with lower ewe productivity within the forest zone (average number of lambs per ewe in June is 1.48 in forest zone compared with 1.65 in mountain zone; $\chi^2_{2,246} = 7.66$; $P = 0.022$) and lower autumn weights of lambs that have spent the summer grazing in forest areas (Steinheim et al. 2001), is reducing the viability of sheep production in the forest zone relative to other parts of the county.

Relative Value of Moose Hunting and Sheep Production

Within the forest zone, the value of moose meat is nearly 2.5 times greater than the value of lamb meat (including compensation for lost animals) (Fig 4). By contrast, in the mountain zone, the lamb meat produced has over 5 times the value of moose meat. The total value of moose and lamb meat together is considerably lower in the intermediate zone than in either of the other areas (averaging US$ 474 /km^2, compared with US$ 859 /km^2 and US$ 793 /km^2 in the mountain and forest zones, respectively, over the last 5 years), with the value of moose meat being 1.5 times greater than lamb meat.

However, income from sheep farming is considerably enhanced by government production subsidies. Although subsidy payments have gradually been eroded since the 1970s, in 2002, total expenditure on sheep production subsidies amounted to approximately US$ 1.3 M in the forest zone, US$ 1.6 M in the intermediate zone and US$ 3.0 M in the mountain zone (Fylkesmannen i Hedmark, unpublished data). This has the effect of raising the total moose and lamb value to US$ 1,347 /km^2, US$ 1,043 /km^2, and US$ 613 /km^2 in the mountain, forest, and intermediate zones, respectively, in 2002. Of this, 90%, 41%, and 52%, respectively, was contributed by sheep enterprises.

In all zones, total meat value decreased between 1990 and 2002 after adjusting for inflation, but the decrease in value was much greater in the forest and intermediate zones than in the mountain zone (Fig. 4). Trends over time reflected the trends of the dominant meat source in each habitat type and consequently the forest and intermediate zones were affected by the relatively greater devaluation of moose meat than lamb meat. By contrast, the effect of increasing carnivore numbers in these zones was relatively minor because lamb meat was a less important component of the total meat value, and losses were generally compensated. Consequently, the overall economics have not been strongly affected by increasing carnivore numbers. However, as discussed below, this may not be the case for individual landowners.

Local Impact of Carnivores

The only carnivore to have a significant impact on moose hunting yield is the wolf, but within Hedmark, at the regional and even municipality scales, no effect of predation was apparent. However, in localized parts of the study area and for individual landowners within a wolf territory, wolves may have a profound economic impact. For example, Gundersen (2003) suggests 27% of moose calves per year (24 - 31% ± 2 SE) are killed by the Koppang wolf pack, in central Hedmark. This equates to approximately 100 moose

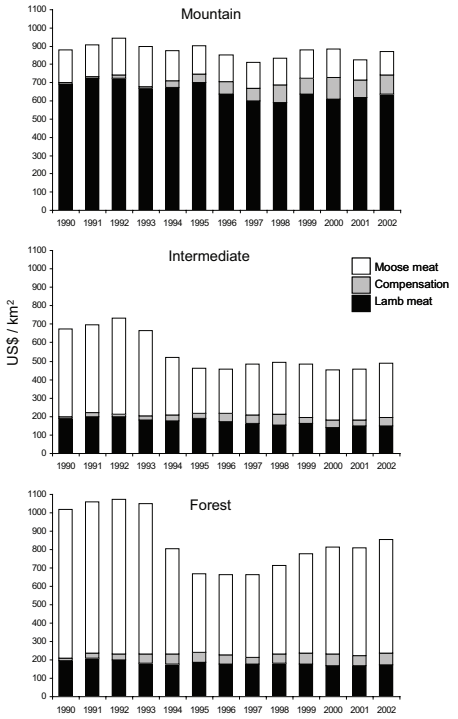

Fig. 4. Value per km^2 of moose and sheep meat (assuming all meat is sold) and compensation from sheep lost to large carnivores in three habitat zones for the period 1990-2002, adjusted for inflation.

per year. To minimize any decline in moose numbers due to predation, the landowners in that area have voluntarily imposed a restriction on the number of moose shot per year (Fig. 5). This has cost them over US$ 150 /km^2 from the loss of meat sales alone. In addition, some landowners have experienced a considerable loss of rental income from the letting of cabins and small game hunting since the arrival of the wolf (C. Mathiesen, personal communication). Rising numbers of other carnivores have had a less dramatic effect on rental income because it is mainly wolves that pose a threat to hunting dogs.

Sheep and lamb numbers expressed at the regional scale also hide the trends at the scale of individual carnivore territories. Brown bears kill more sheep in Hedmark than other carnivores but the annual removal of some problem bears has not halted the increase in sheep losses (Zimmermann et al. 2003). Within wolf territories, many farmers have moved their flocks to alternative grazing areas but high predation rates have forced some to abandon sheep production, either switching to cattle or alternative enterprises. However, the alternatives, one of which may be moose hunting (Storaas et al. 2001), are somewhat limited and sheep farmers only rarely have hunting rights for the areas they graze.

DISCUSSION

The increase in carnivore numbers experienced throughout the 1990s in Norway has stimulated a reappraisal of land management strategies and considerable debate about options for the future. It is clear that as carnivores have increased, sheep production in Hedmark has declined, particularly where sheep are released into forest habitat for summer grazing. However, our data cannot demonstrate a causal link between the two. By contrast, the moose harvest has shown no such change due to a low bear density, the lower vulnerability of moose to carnivores such as lynx and wolverine, and a greater variability in population size and yield between years. Although some commentators comparing the current moose hunting yield with the yield 10 years earlier note a drop which they attribute to wolves, our data suggest that at a regional scale this was largely a result of a decline in moose population size before the arrival of wolves. Nonetheless, at the spatial scale of the wolf territory, some landowners have experienced a considerable economic loss due to reduced sustainable hunting yields (Nilsen et al. 2005). This is also true of other game species and areas beyond Hedmark (Aanesland and Holm 2003).

In Norway, natural summer mortality of lambs in the absence of carnivores is assumed to be around 4% (Drabløs 1997), while lamb losses in some parts of the forest zone in southern Hedmark are in excess of 20% (Norwegian Institute of Land Inventory, http://beite.nijos.

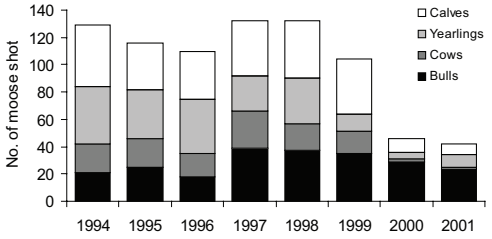

Fig. 5. Number of moose shot per year within the Koppang wolf territory showing a voluntary restriction on the size of the hunt since 2000 (from Gundersen 2003).

no/kart.htm). This is one of the highest rates of sheep loss per carnivore in Europe (Kaczensky 1996, Linnell 2000) and raises ethical questions about the appropriateness of releasing lambs onto unenclosed land in summer. Since it is government policy to maintain breeding populations of large carnivores, including demarcation of a zone for wolf reproduction, it can be expected that carnivores will remain in most of these areas. Consequently, unless changes are made, sheep losses and declines in lamb production are likely to continue (Sagor et al. 1997), particularly in forest habitat where carnivore numbers are higher and dense vegetation restricts prey vigilance.

This presents a dilemma for the government which wants to promote both large carnivores and the rural population, without trading one off against the other. There are a number of ways in which sheep losses could be reduced (Kaczensky 1996, Linnell et al. 1996) but apart from moving flocks out of wolf territories, few measures have been taken. This is primarily because radical changes to the current husbandry system of extensive grazing of unguarded flocks would be needed and are likely to be costly (Linnell and Brøseth 2003). It appears that using shepherds or guarding dogs could prevent much of the predation but would increase production costs compared to current practice (Krogstad et al. 2000, Linnell 2000). Furthermore, there is no tradition of using dogs in this way in Norway and using children, as in former times, is no longer realistic without payment.

If such measures are not implemented for economic reasons, it may be that in some habitats it is no longer appropriate to continue sheep production. If, for example, sheep farming was stopped in Hedmark's forest zone, the primary economic loss to the area would be the loss of the production subsidy payments which amounts to about US$ 1.3 M per year. However, this represents an equal saving to the government. Could this money instead be used to promote alternative economic activities associated with moose hunting and ecotourism or widen compensation schemes? Here, the principal challenge would be to ensure that the individuals who were keeping sheep do not lose out.

Currently farmers are eligible for compensation for any of their domestic stock killed by large carnivores (Kaczensky 1996). However, landowners are not eligible for compensation for losses of moose hunting yield. If the government wants to continue its policy of keeping rural areas populated, maybe it should consider widening the terms under which compensation is offered. However, it should be noted that compensation payments do not always improve tolerance towards carnivores, especially where emotional stress is caused (Naughton-Treves et al. 2003). Furthermore, it would be undesirable if the effect was to shift compensation payments from many small farmers to fewer, relatively large landowners. A more appropriate approach may be for affected municipalities to receive some kind of 'carnivore bonus' to counteract the negative economic impact of having large carnivores in the area.

A second approach may be to explore ways of increasing the yield, and consequently income, from moose hunting, if a higher moose population density could be sustained. To do this, measures would have to be taken to prevent, alleviate, or pay for forest damage (Johansson et al. 1988,

Storaas et al. 2001, Gundersen 2003) or time and money invested in growing additional moose fodder such as willow. However, a high density moose population is also likely to increase both road and rail traffic accidents (Johansson et al. 1988, Gundersen et al. 1998, Storaas et al. 2001) and have adverse effects on biodiversity, so additional costs would be incurred in mitigation measures.

Thirdly, there may be opportunities to realize a greater proportion of the existing value of moose. Although moose meat makes a considerable contribution to the household for many hunters (Mattsson 1990), much of the value is never converted into cash. Furthermore, in addition to the meat value, hunting has a recreational value (Mattsson 1990) which is currently barely realized. Consequently, value could be added by developing outfitting and guiding businesses and promoting moose hunting to non-residents, as long as access to local hunters is not compromised. Optimizing the allocation of moose hunting between individual hunters could also help maximize the value of moose (Mattsson 1990). Apart from hunting tourism, there appears to be scope, as yet unrealized, for promoting eco-tourism, specializing in wildlife viewing or wolf-tracking. For example, in Romania, the Carpathian Large Carnivore Project has demonstrated that considerable tourism revenue can be brought into an area by promoting its association with large carnivores (http://www.clcp.ro/etour/eco-prog.htm). In Norway, while tourism in areas such as Hedmark is marketed by focusing on outdoor pursuits, no mention is made of the large carnivores.

It appears that in some parts of Hedmark it may not be possible to maintain the status quo in sheep production for much longer. Expansion of moose enterprises and eco-tourism may have the potential to provide some alternative income if moose management can be implemented appropriately and in such a way that farmers, as well as landowners, can benefit.

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