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Economic Impact of Protected Large Carnivores on Sheep Farming in Norway

Leif Jarle Asheim[1] and Ivar Mysterud[2]

[1]*Norwegian Agricultural Economics Research Institute, P.O: Box 8024 Dep., N-Oslo 1, Norway.*
[2]*Department of Biology, Division of Zoology, University of Oslo, P.O. Box 1050, Blindern, N-0316 Oslo, Norway.*

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Introduction

Norway has historically been a stronghold for carnivore predators. Today there are four protected carnivore species, brown bear (*Ursus arctos*), wolverine (*Gulo gulo*), wolf (*Canis lupus*) and lynx (*Lynx lynx*), together with the golden eagle (*Aquila chrysaetos*). The carnivore populations were significantly reduced, and wolves and bears almost eradicated nationally during the end of the 19th and the beginning of the 20th centuries (Ministry of the Environment, 1992; 1996-97). Today, the species are protected, and management calls for restoring demographically and/or genetically viable populations (Ministry of the Environment, 1996-97). Another proposal is to view Norwegian management goals and responsibilities in accordance to the Bern Convention in combination with those of Sweden and Finland, i.e. shared-predator populations for the Nordic countries (Nordic Farmers Central Council, 1988). The principle has recently been introduced by the authorities for management of wolves in Norway, defining viability based on a common Norwegian-Swedish population.

The suitability of the Norwegian environment for large predators is partly due to its extensive land resources and rugged topography. The soil is generally poor and the area of agricultural land limited. However, due to the Gulf Stream, the climate is wet and relatively mild and well suited for production of grass and herbs. Grazing plants are found throughout the country's mountains and forests and constitute the basic forage for wild ungulates, herded domestic reindeer and livestock. The production systems have traditionally been of utmost significance for inland settlement and development of the local economy. In post World War II times, the national agricultural policy has supported the development of the systems by protecting the market from foreign competition and by providing relatively generous direct support.

In the traditional Norwegian production system, lambs are generally born during late winter or early spring while the sheep are fed indoors. During spring, the sheep and lambs are kept for a short period on fenced pastures before they are released onto open ranges. Flocks graze in forested or alpine areas for about 100 days before they are gathered during the latter part of September (Asheim, 1986). After a period of autumn grazing on fenced pasture, the breeding animals are again fed indoors. The most important production of meat is that by lambs and culled adult animals sold in the autumn. On good pasture, slaughter weights of lambs may reach 25 kg, and ideally, lambs suited for slaughter are sent directly from the range. However, 10 to 12 kg is not uncommon on low-quality ranges ("blue lambs") and sometimes strategies with early gathering and/or on-farm feeding programs are needed to improve lamb quality.

Some sheep producers do not have adequate land for spring grazing and release the animals on the open range more or less directly from the barn. Other farmers may have abundant pasture and/or few animals, and can allow them to remain on the fenced pasture for the whole season. Operational details are often the result of local adaptations. In some limited coastal areas the sheep can graze outdoors year-round (more or less like Western Europe or New Zealand), a system only possible without large numbers of predators. The current system of sheep farming is quite different from the milk sheep production systems found for instance in countries around the Mediterranean. In such systems herding or night pens may be natural operational measures, easy to introduce in case of predator attacks. In Norway, keeping sheep for milk ceased to exist at the same time as wolves and bears were eradicated nationally during the end of the 19th and the beginning of the 20th centuries.

Around 25,000 farms in Norway have sheep, averaging 44 winter-fed animals. Sheep production takes place on fairly small farms; in 1989, about 60% of the sheep were on farms with less than 10 hectares of arable land. Due to the seasonal variation in labor input, combining sheep with forestry, and historically fishing in coastal areas, has been common. Today, different combinations of off-farm work for either the farmer or spouse are making sheep farming the most common agricultural activity on part-time farms in the Norwegian grassland areas.

Sheep farming is still based on the use of open ranges, most lamb growth occurs there and it constitutes 40 to 50% of the production system's total forage harvested (Asheim, 1978). The animals are not herded, but tended at regular intervals. This makes the sheep vulnerable to predators, and locally losses are considerable (Mysterud and Mysterud, 1995a). The conflict with sheep farming is the most problematic obstacle to viable carnivore populations. The paper describes the conditions and assesses the economic consequences for sheep farming nationally and regionally of restoring viable carnivore populations in Norway. It is based on premises concerning

national agricultural policy and viable carnivore populations in the middle of the 1990s as presented in an environmental impact assessment (EIA) (Mysterud and Mysterud, 1995a). Consideration is also given to the present situation of predators and losses of sheep. However, the paper does not address the national socio-economic (cost and benefit to society) question of balancing agricultural and environmental policies with respect to sheep and large carnivores on Norwegian ranges.

Materials and Methods

The population of ewes and lambs grazing on open ranges in the snow-free period is approximately 2.4 million, unevenly distributed throughout the country. The most important sheep farming regions are in the west and southwest with approximately 53% of the sheep. The greatest losses to predators occur in the upland rural areas in Trøndelag and in northern Norway, as well as in upland rural areas in eastern Norway, all of which contain approx. 40% of the country's sheep population (Fig. 1).

In this study three categories of sheep farming were identified, based on statistics for subsidies as of January 1, 1993 and standard labor input values (Ministry of Agriculture, 1991; 1992). About 52% of the sheep were on specialized sheep farms (including part-time farms) i.e. farms where sheep accounted for more than 85% of the calculated labor input and with total farm labor input of 400 hr or more. On the mixed sheep farms (often with dairy cows) 15 to 85% of the labor input was due to sheep. These farms accounted for another 28%, whereas the remaining 20% of the sheep were found on versatile farms where they accounted for less than 15% of total farming labor input or on small "sheep hobby farms" with less than 400 hr of total farming labor input.

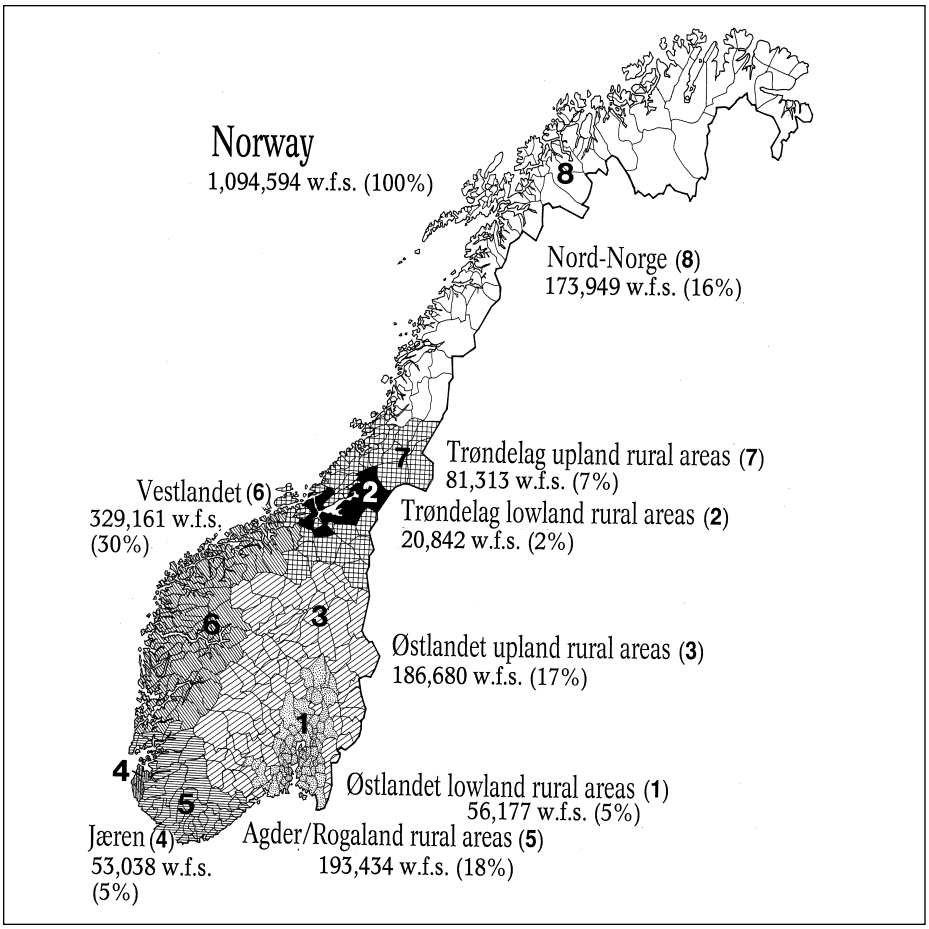
The sheep farming in each region was represented by one, two or three of the categories above, and economical data for each category were computed as average of approximately 30 farm records for 1992 and 1993 (Table 1). The records were drawn from a sample of Norwegian farm accounts (Norwegian Agricultural Economics Research Institute, 1993a; 1994). Stratified-random sampling was used to achieve the same average number of sheep in each sample as in the represented category. As the total meat production of the samples was approximately 10% higher than the national figure, the average incomes were adjusted accordingly. The results were converted into US $ using the average exchange rate for 1992 and 1993[1] (Table 1).

The total weighted 1992 to 1993 net farm income from agriculture was estimated to $ 643.5 million (NOK 4.3 billions) for all sheep farms. Based on the share of the specialized sheep farms, the net income from sheep production was estimated to about US $ 133.2 million (NOK 886.1 million), a figure to which the costs of the predators have been related.

Approximately 70% of the sheep farmers are members of centrally organized grazing groups, which report number of released animals, total losses, and labor input (standard man days) to supervise and gather the sheep in each grazing area. Nationwide total losses of sheep and lambs while on open ranges are available from the central organization of the grazing groups (Coordinated Pasturing Database; Norwegian Sheep and Goat Association), showing an average loss of 2.31% for adult sheep and 5.21% for lambs for the period 1988 to 1993. These numbers do not show the share of the total losses caused by protected predators.

The number of lost animals has been calculated as minimum and maximum values. The minimum values are based on the official compensation statistics (County Governors offices; Database Biomys).[2] The minimum, showing an average of 1,962 adult sheep and 8,381 lambs compensated during the period,

Figure 1. Regional distribution of winter-fed sheep (w.f.s.) in Norway as of January 1, 1993.



[1] US $ 1 = 6.65 Norwegian kroner (NOK).

[2] The minimum or unquestioned losses were collected before the result of the farmer's appeal of the outcome for each area and predator. Losses to protected predators that are unspecified to predator species have been distributed in accordance with losses to specified species in each area. Lynx was not protected during the years 1988 to 1991 and has been attributed 25% losses for sheep and 80% for lambs these years, based on the situation in 1992 to 1994.

Table 1. Sheep per farm model, number of farms represented and net farm income (measured in US $) in 1992-1993 on Norwegian sheep farms; for region specification, see Figure 1.

Region and category of sheep farming	Adult sheep	No. farms	Net Farm Income, US $ Per farm, thousand	Total, million
Lowland r. areas (Østlandet and Trøndelag), versatile	45	1,726	21.2	36.5
Østlandet upland rural areas, specialised	62	1,906	7.6	14.4
Østlandet upland rural areas, versatile	33.5	2,012	29.7	59.8
Agder/Rogaland rural areas, mixed	60	2,937	34.8	102.1
Agder/Rogaland rural areas, versatile	31.5	1,916	46.2	88.6
Vestlandet, specialized	53	3,098	4.8	14.8
Vestlandet, mixed	41.5	2,254	25.8	58.2
Vestlandet, versatile	19	3,853	31.1	120.0
Trøndelag upland r. areas and N-Norge, specialised	95	1,357	15.6	21.2
Trøndelag upland rural areas and N-Norge, versatile	30	3,972	32.2	127.9
Sum		25,031		643.5

represented a small fraction (5 to 10%) of the total losses in the period. The maximum values (50 to 70% of total losses), are based on data from mortality transmitter studies for the period 1988 to 1993 (Mysterud and Warren, 1991; 1994; Warren and Mysterud, 1995), and have been estimated at 14,890 sheep and 37,018 lambs lost to predators. The maximum values have been distributed across area and predator species in accordance with the minimum values.

Since most of the costs of sheep farming are incurred before releasing the animals on the open range and lambs are sent directly or shortly afterwards, we have employed the principle that the loss of income will be the same whether a lamb is killed on the first or the last day on the range. Another principle of the calculations is that there might be economical losses on surviving animals if carcass quality or breeding values are affected. Farmers are paid a substantially lower price per kg for "blue lambs" weighing 10 kg or less and such lambs are unsuited for breeding. This may be the case if lambs loose their mother ewe.

The costs of predators to sheep farming consist first in the value of the meat, wool, and hide of the killed animals. Second, breeding programs are affected when animals are lost and this is taken into account by adding 10% for the life (life value). Third, when ewes are lost they have to be replaced with lambs from the same flock that are adapted to the local range. Consequently, because yearlings have a lower lambing rate than older ewes, there will be lower production the following year and a skewed-age composition of the flock for one or more years after a considerable loss of ewes. In the standard rate of compensation payment the value of 0.86 lambs is added to the value of the meat and wool of the ewe, as the lambing rate has been estimated to be 0.86 lambs lower for yearlings compared to older ewes.

Fourth, there will be consequential costs on lambs having lost their mother ewe. Such lambs may have lower weights, leading to lower breeding value or a lower price for the carcass. In a study of the live weights for lambs (Mysterud and Mysterud, 1995a; Asheim and Mysterud, 1995), the slaughter weight was computed to be 0.55 kg lower for lambs in communities with bear or wolf, while no such effects was reported for communities with other predators. The price effect due to quality deterioration on lambs is estimated to NOK 1.85 a kg and the farm price per kg of lamb meat to NOK 48.48 in Trøndelag upland rural areas and northern Norway and NOK 42.83 elsewhere. In the rounded values, US $ 9.0 (NOK 60) per lamb in bear/wolf communities within Trøndelag upland rural areas and northern Norway and US $ 8.3 (NOK 55) elsewhere, some consideration is also given to effect of depredation on breeding values of surviving lambs.

Fifth, excess fat accumulation and increased risk of mastitis are the main consequential costs to ewes having lost their lambs. The cost due to excess fat accumulation is assumed to be US $ 36.1 (NOK 240) per ewe, based on price grading according to fat content for carcasses of ewes. The effect is most important in areas with predators that apparently specialize in attacking lambs, such as wolverine, lynx, and the golden eagle, and would probably be most pronounced with respect to ewes having lost their lambs early in the grazing season, for instance due to golden eagle depredation. However, some ewes lose only one of two lambs, and some of those having lost all lambs still could perform well for more years. It is estimated that one ewe in three has to be slaughtered after having lost its lambs (Skjevdal, personal communication).

Sixth, extra labor input due to predators has been assessed on the basis of studies of the connection between loss percentage and labor input (standard day's work). Data were derived from the grazing groups (Coordinated Pasturing), with totally 5,982 observations for the period 1981 to 1992 (Mysterud and Mysterud, 1995a; Asheim and Mysterud, 1995). This database has no information about the cause of the losses. However, we have assumed that the extra labor required would be the same no matter what caused the loss. The extra labor input required amounted to 0.00225 standard man days per animal for each extra percent of loss (F-value = 3.82, Standard Error 23.6%) whereas for lambs it amounted to 0.00096 standard man days (F-value = 3.69, Standard Error 27.1%). The value of the extra hours has been determined by using the hourly wage for hired farm labor.

The standard rates of compensation payment for ewes and lambs (Norwegian Agricultural Economics Research Institute, 1993b; 1993c) have been employed to assess the first three kinds of costs. However, the standard rates do not account for consequential costs on lambs having lost their mother ewe or on ewes having lost their lambs as well the extra labor input required to search for lost animals, identifying the cause of loss and

Table 2. General population estimate, distribution and densities of protected carnivores, including golden eagle in Norway, based on official 1994 figures and maps.

Species	Number[1]	Area (Km^2)	Number/Area (1,000 Km^2)
Brown bear	20-25[2]	49,200[3,4]	($\bar{x}$ = 0.45 (0.4-0.5)
Wolverine	200	56,107[3,5]	($\bar{x}$ = 3.6 (3.6-3.6[*2])[9]
Wolf	5-10[7] (20-25)[6]	961[3]	($\bar{x}$ = 7.8 (5.2-10.4)
Lynx	300-400	142,560[3]	($\bar{x}$ = 2.45 (2.1-2.8)
Golden Eagle	700-1,000[8]	273,790	($\bar{x}$ = 3.1 (2.5 - 3.7)

[1] Revised 1994 population estimates from Directorate for Nature Management (1994).
[2] Swenson et al. (1994).
[3] Measured with digital planimeter (PLACOM KP-90) on maps with species distribution (Ministry of Environment 1992).
[4] The sum of three sub-areas; 35,690 km^2 (South- and Middle-Norway), 3,025 km2 (Troms) and 10,485 km^2 (Finnmark).
[5] The sum of two sub-areas; 8,317 km^2 (South-Norway) and 47,790 km^2 (Trøndelag and North Norway).
[6] Population figure for the common 1994 Norwegian-Swedish population (Wabakken et al. 1994) in brackets.
[7] Estimate for Norwegian part of the 1994 Norwegian-Swedish population.
[8] Gjershaug et al. (1994).
[9] No population estimate interval given.

extra supervision due to predators. These costs have been computed separately. Surviving animals may additionally have different kinds of injuries due to predator attack, such as beats, scratches, or torn up udders etc., which have not been considered, and may become difficult to gather and feed and unsuited for breeding. Another basis for assessing the damage of the different predator species, has been the official 1994 statistics, as well as official distribution maps for the four species of large carnivores (Ministry of the Environment, 1992) and the golden eagle (Gjershaug et al., 1994) (Table 2).

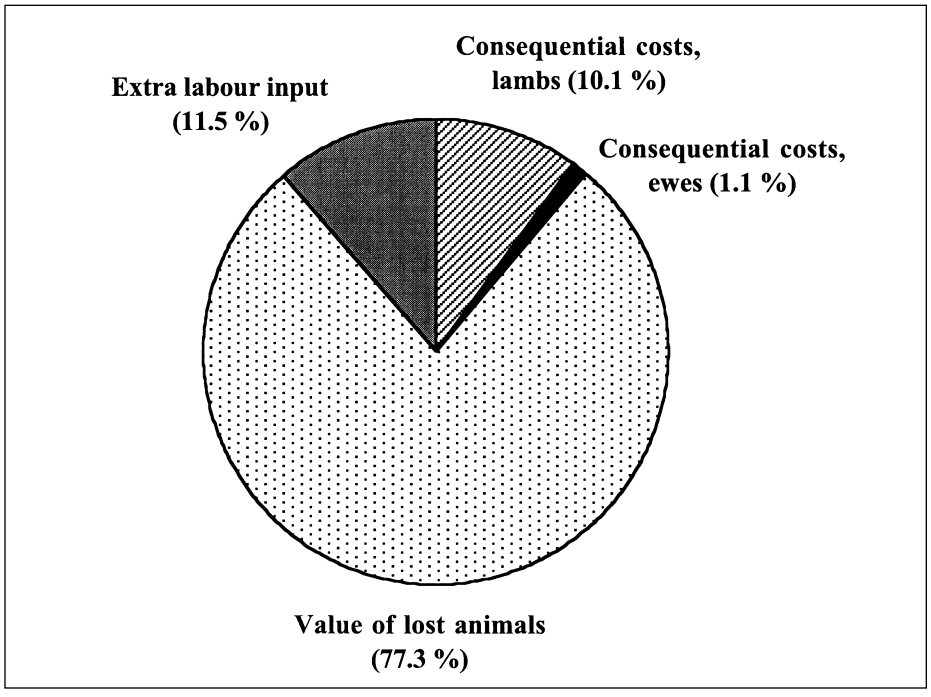
At the time of the EIA, only the Norwegian populations of lynx, wolverine and golden eagle were regarded to be demographically viable[3]. For calculating cost of viable numbers of all predators, the population of bears has been expanded to approximately 70 animals and to approximately 50 animals for wolves. These are regarded as minimum demographically viable numbers in order not to overestimate the costs. The expanded demographically viable populations are distributed geographically by assuming expansion northward, southward, and westward from the core areas of bears and wolves in the Norwegian-Swedish border zone (See Ministry of Environment, 1992).

If the populations of large carnivores should be expanded further in size to genetic viability, bear populations would be roughly 1,250-2,500 individuals (Mysterud and Mysterud, 1995a). As articulated during the Yellowstone reintroduction program, genetic viability would involve at least ten breeding pairs of wolves in three different areas, starting with 210 individuals. Such numbers would, in practice, mean to re-establish the bear and wolf over most of Norway (Mysterud and Mysterud, 1995a).

Results

The main cost of the predators is the value of the lost animals, which constitute more than three quarters of the total cost (Fig. 2). The consequential cost on lambs having lost their mother would be approx. US $ 809,600 (NOK 5.4 million). A total of 6.4% of the sheep graze in bear/wolf communities. The effects on ewes having lost their lambs was smaller, by comparison, ranging from an estimated minimum of US $ 45,000 (NOK 299.2) to a maximum of US $ 123,800 (NOK 823.4). The value of the extra labor input amounted to US $ 268,300 (NOK 1.8 million) (minimum) and US $ 1.6 million (maximum) (NOK 10.4).

Figure 2. Composition of predator costs. Percent



[3] A risk assessment of demographic viability takes into account characteristics relating to number, age and sex distribution in the short-term survival of populations. Genetic viability on the other hand, takes into account the longer-term genetic processes, both systematic (migration, mutation, selection) and dispersive (drift, inbreeding) (see Mysterud and Muus Falck, 1989). The actual carnivore population sizes needed to meet the criteria of viability are discussed (i.e. for bears, see Sæter et al., 1998; and Wiegand et al., 1998).

Measured together, the consequential costs and extra labor input constitute 22.7% of the costs.

The effects of the protected predators on net farm income from the sheep are shown in Table 3. Based on documented losses from the period 1988 to 1993, the five predator species appear to have reduced farm incomes by US $ 3.0 million (NOK 20.2) annually or 2.3% of the total net sheep farm income. These results are in line with estimates by the U.S. Agricultural Statistics Board (1991), showing that $ 22 of $ 895 million or 2.46% of the sheep value was lost to predators. However, such numbers only indicate the magnitude of the problem in a given country, since different predator species and agricultural systems occur nationally and regionally.

Based on loss figures from radio transmitter studies, maximum cost was estimated at US $ 12.9 million (NOK 86.1) in 1992/93 or 9.7% of the net income from sheep farming (Table 3). The cost of the predators is slight in Vestlandet, Jæren and Agder/Rogaland. In the southwest, losses are mainly to lynx and golden eagles, whereas wolverines are also present in parts of Vestlandet. Losses are also moderate (1.7 to 5.5%) in the lowland rural areas around Oslo and Trondheim (grain areas). However, dispersing bears do occasionally cause some damage in lowland rural areas of Trøndelag, and lynx can also be present in the forests of central areas, quite close to the cities of Oslo or Trondheim.

In upland rural areas of Østlandet, losses range from 4.1% (minimum) to 15.0% (maximum) of net income from sheep farming. About 27% of the total losses occur in the region. All predators are present in the area, however bears and wolves (measured together) were most important. Bears and wolves are mainly a problem along the border with Sweden, however dispersing animals can from time to time cause damage in the whole region. The costs of the losses due to lynx are almost as important as costs due to bears/wolves. Lynx prefer forested areas, and no important natural obstacles significantly influence the movement of the lynx in the region. Wolverines on the other hand, prefer alpine areas, and losses to wolverine are therefore reported only in the northern parts of the region. In these areas, losses can become very severe, increasing local conflicts with respect to size of the wolverine population.

Table 3. Economic impact of the present protected predator situation on Norwegian sheep farming in 1992 to 1993.

Region	Net Farm Income from sheep. Million US $	Cost of predation, million US $. Minimum	Maximum
Lowland rural areas	9.3	0.2 (1.7%)	0.5 (5.5%)
Østlandet upland rural areas	23.3	1.0 (4.1%)	3.5 (15.0%)
Jæren and Agder/Rogaland	29.2	0.1 (0.2%)	0.3 (1.0%)
Vestlandet	40.0	0.2 (0.5%)	1.0 (2.4%)
Trøndelag upland rural area and N-Norge	31.4	1.7 (5.3%)	7.7 (24.4%)
Sum	133.2	3.0 (2.3%)	12.9 (9.7%)

By far, the most significant losses are found in the Trøndelag upland rural areas and in northern Norway where they range from 5.3 to 24.4% of net farm income from the sheep. Estimated by region, about 59% of the total losses occur in this region. Lynx, wolverines and bears/wolves cause about equal shares of the maximum costs by predators in the region. Losses to golden eagle are generally small by comparison to the other predators, however in northern Norway damage by golden eagle is also important. The golden eagle clearly prefers lambs (Bergo, 1990). Northern Norway is also the most important region for domestic reindeer herding that causes additional conflicts between predator conservation and reindeer production.

Although the number of bears (and wolves) has been far below that considered viable populations in the period, losses due to these animals have been considerable. An important reason for this is that bears prefer adult ewes, subsequently leading to costs to lambs after having lost their mother. Approximate estimates of the effects of expanding the 1994 wolf and bear populations to demographically viability are shown in Table 4.

Expansion to demographic viable predator populations increases damage sustained by the sheep farms to US $ 5.4-20.9 million (NOK 35.6 to 138.8). The cost associated with further expansions of bear and wolf populations to genetic viability has been estimated by extrapolating today's costs computed for these species to the whole country. This would yield an annual loss for the sheep farms of between US $ 20 and 68 million (NOK 130 and 450), including losses to the three other currently viable predator species. In areas where it is economically difficult to sustain sheep farming under

Table 4. Economic impact (in 1992/93 prices) of the 1994 predator situation on Norwegian sheep farming compared with computed effects from expanded viable Norwegian and Nordic countries predator populations.

Alternative	Predation cost, in million US $. Minimum	Maximum
1994 situation, lynx	0.8	3.9
1994 situation, wolverine	0.6	3.3
1994 situation, golden eagle	0.2	0.9
1994 situation, bears/wolves	1.4	4.8
Demographic viability of bears/wolves	3.8	12.7
Genetic viability of bears/wolves	18	60
Nordic countries shared populations (lower limit) [1]	3.0	12.9

[1] Increased costs for Norway under a Nordic countries management strategy with shared populations are not considered, as they will depend on negotiations and agreements.

the 1994 conditions, it will become virtually impossible to continue profitable production without additional subsidies and/or comprehensive adaptation of operating conditions to the new predator management policy. As for the Nordic countries co-operative alternative, the lower limit might be seen as the total costs of the 1994 situation in Norway (Table 3).

Discussion

The study is based on the official number of carnivore predators in 1994 and losses in the period 1988-93. The overall number of carnivore predators has increased in later years (Ministry of Environment, 1996-97), however so has also the losses of sheep. According to the database, Coordinated Pasturing, the average loss percentage of sheep and lambs increased from 4.17% for the period 1990 to 1993 to 5.38% for the period 1995 to 1997, and to 5.87% for 1998 to 2000. In the same periods, an average of 8,963, 23,365 and 31,704 animals were compensated as killed by a protected predator. In recent years, about one in four lost animals has been compensated. One aspect in the ongoing management conflict (see Blekesaune and Strete 1997) has been the different opinions of the extent of the damage by farmers and Non-Governmental Groups. Some animals will always die from causes other than predators. Obviously, the acceptance of a predator-caused damage by the government can become a budget question. The maximum and minimum values presented here may be a foundation for an agreement.

The experienced losses may cause sheep-farm decline, and if viable populations of all the five predators in Norway are realized, it will undoubtedly have serious consequences for the present sheep farmers and reindeer herders as well as the hunting interests. Perhaps the most serious result of discontinuing sheep operation in many rural communities is the lack of alternative employment in the affected areas. Development of the Norwegian sheep farming has been shaped through a series of agricultural policy decisions designed to make the industry cost-efficient through investments in infrastructure, modern breeding programs, etc., and help to utilize local resources under conditions with few carnivores. The sheep-milk production system was lost early in the process. A new predator regime with viable populations of protected carnivores will greatly affect sheep farming in its present form. As predator populations increase, losses are expected to increase considerably, escalating the conflict between agricultural and environmental policies.

The current conflict probably could be dampened by a Nordic countries predator solution. Since the Fennoscandian (Norway, Sweden and Finland) populations of the four protected large carnivores and the golden eagle are naturally connected across national borders, long-term (genetic) viability and protective efforts might be discussed in a habitat area of 1.1 million km^2 (Mysterud and Mysterud, 1995b). The strategy for such cooperative sharing of carnivore populations across national borders has, as mentioned, been developed (Nordic Farmers Central Council, 1988). Such a solution might allow better consideration of and adaptation to the different problems and conflicts in each country. This is due to, among other things, different habitat conditions including different physiographical features as well as economical, sociological, and other differences in conflict structure in the involved countries.

The potential of a Nordic Countries' management solution lies in its probable ability to dampen national conflicts by presenting solutions that make it easier for the sheep-farming business to adapt even to carnivore populations that will meet any "scientific criteria" of viability. Under a cooperative-predator management, the various countries could take primary responsibility for differing shares and numbers of the different species, securing long-term survival of genetically viable populations. A common management plan does not, however, exempt each individual country from its responsibility to protect all species occurring naturally in its fauna.

The future development of the conflict also depends upon whether efficient loss-preventive measures can be defined and introduced, or the infrastructure of the industry otherwise strengthened. Removing the sheep from the range, either totally or for parts of the grazing season in the most affected areas, seems promising, but will require alternative pastures. Herding the sheep on the ranges seems too expensive under Norwegian conditions (Flaten and Kleppa, 1999). Herding with night pens for small ruminants is probably most competitive in connection with milk production. Reintroduction of sheep milk might be part of a more permanent management strategy. Changes in management practice in one area might, however, lead to damage displacement (external costs) if predators move to another area. A creative-research effort taking these questions into consideration would be highly needed and appreciated. More research is also needed to evaluate and clarify the conditions for the domestic reindeer industry and game users' interests in future carnivore areas without sheep.

Finally, the study does not address the national socio-economic (cost and benefit to society) question of balancing agricultural and environmental policies with respect to sheep and large carnivores on Norwegian ranges. Sheep-industry losses cannot be considered a loss to a country's total economic system (Wagner, 1988), and that advantages of replacing sheep by predators may surpass the costs. In a protected market, increased costs may be passed on to consumers, otherwise national agricultural support and compensation payments are saved by more import of sheep meat. However, free-ranging sheep seems only possible without large numbers of predators wherever production takes place.

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