2000

COUNCIL OF EUROPE CONSEIL DE L'EUROPE

Strasbourg, 18 May 2000 **T-PVS (2000) 25**
[Bern\T-PVS 2000\tpvs25e_2000]

CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

Group of Experts on Conservation of Large Carnivores

Oslo, 22-24 June 2000

Action Plan for the conservation of Wolverines *(Gulo gulo)* in Europe

Document established by
Mr Arild Landa (Greenland)

by
Arild Landa[a], Mats Lindén[b] and Ilpo Kojola[c]

[a]Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim, Norway
[b]Department of Animal Ecology, Swedish University of Agricultural Sciences, S-90183 Umeå, Sweden
[c]Finnish Game and Fisheries Research Institute, Taivalkoski Game and Fisheries Reserch, FIN-93400 Taivakoski, Finland

With contributions from:
John Linnell, Anders Bjärvall, Jon E. Swenson, Jens Persson, Peter Segerström, Pjotr Danilov, Roy Andersen, Ingmund Halgunset

Funded by:
WWF Sweden, WWF Norway, Council of Europe, Norwegian Institute for Nature Research (NINA).

Acknowledgements

This Action Plan has been founded by WWF-Sweden, WWF-Norway, Council of Europe and Norwegian Institute for Nature Research (NINA). We thank John Linnell, Anders Bjärvall, Jon E. Swenson, Jens Persson, Peter Segerström, Pjotr Danilov, Roy Andersen and Ingmund Halgunset for providing information and valuable comments on earlier drafts of this Action Plan.

The process behind the elaboration of the action plans

Each Action Plan was first elaborated by the author in early 1998. These first drafts included input and comments from many experts throughout Europe. In October 1998, governmental experts then discussed the Plans at a meeting organised by the Council of Europe in Slovakia, after which the authors incorporated the comments received.

The Plans were then reviewed by the Bern Convention Contracting Parties in December 1998 and again by the European Commission and EU governmental experts at a meeting of the Habitats Directive Scientific Committee in September 1999. All the comments received (and forwarded to the authors by the Commission via the Bern Convention Secretariat) were included in the final draft version presented at the Bern Convention Meeting of The Contracting Parties in December 1999. At this meeting, some governments advised that they still wished to comment on National Actions related to their respective countries and they were given until end February 2000 to send their comments to the Council of Europe.

The authors have made every effort to incorporate all the comments received into the final Action Plans and apologise unreservedly should any have slipped through the net. It is clear from the above that these Plans have been through an exhaustive, collaborative process and received a wide consensus, culminating in Recommendation No. 74 (Dec 1999) of the Bern Convention Contracting Parties, December 1999. Where differing figures have been given by various national experts (in particular as regards population numbers), every effort has been made to include both (or all) totals.

Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect the views of the WWF, the Council of Europe or the LCIE and its affiliated organisations. None of the organisations mentioned above, nor any person acting on their behalf, is responsible for the use which may be made of this document.

The designation of geographical entities in the publication and the presentation of material do not imply the expression of any opinion whatsoever on the part of the LCIE, WWF or the Council of Europe, or their supporting organisations concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

May 2000

Contents

Mission statement

The Large Carnivore Initiative for Europe (LCIE)

"To maintain and restore, in coexistence with people, viable populations of large carnivores as an integral part of ecosystems and landscapes across Europe"

Background

- Europe, once a broad mosaic of natural habitats ideal for large carnivores, is now left with only scattered tracts of suitable "wildland". Brown bear, wolf, wolverine, Eurasian lynx and Iberian lynx still occur in Europe but they are forced to live in highly fragmented and human-dominated landscapes.
- There was widespread and bitter opposition to large carnivores in the past but today there is increasing public interest in their conservation. However, the predatory behaviour of large carnivores often conflicts with local economic activity, especially livestock farming.
- Their current distribution is often confined to border areas, which therefore requires cross border co-operation in order to conserve and manage populations.
- The presence of large carnivores is a measure of regional biodiversity. Viable populations of large carnivores demonstrate Europe's contribution to the conservation of global biodiversity.
- The political development within Europe, particularly within the European Union, with the partial disintegration of national borders and more unified legal and planning requirements, creates new and promising opportunities for the successful management of large carnivore populations on a European wide scale.
- Implementation of the Natura 2000 sites in Europe, the increased priority to the conservation of natural areas, and the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), give exciting opportunities for enhancing Europe's biodiversity.
- It is clear that the challenge of conserving large carnivores is complex and dynamic, involving ecological, economic, institutional, political, and cultural factors and any attempt to solve this conservation issue must take this into account. Realistically, no single agency, organisation, or institution will be able to solve the carnivore conservation issue alone. No single plan or strategy can be completely comprehensive and correct as a guide for action and continual monitoring is required.
- Recognising these opportunities, and the need to build strong partnerships with land managers, researchers, citizens, government officials and international organisations and Conventions, the World Wide Fund for Nature (WWF) together with partner organisations and experts in 17 European countries, has decided to get to grips with the issue so that the future for large carnivores (brown bear, Eurasian lynx, Iberian lynx, wolf and wolverine) can be substantially improved, while the opportunity still exists. The first steps towards the development of a "Large Carnivore Initiative for Europe" were taken at a meeting in Abruzzo National Park, Italy in June 1995. Based on input from two subsequent workshops in Neuchatel, Switzerland (September 1995) and Oberammergau, Germany (January 1996), a programme plan has been developed building a network of interested parties and activities.

Actions

- Create a network of interested parties including land managers, researchers, citizens, government officials and international organisations and Conventions;
- Act as a focal point for information relative to large carnivore conservation in Europe;
- Develop and implement new ideas and methods to ensure the coexistence of brown bears, lynx, wolves and wolverines with people;
- Support and build on existing initiatives and projects within Europe, and encourage Europe-wide co-operation in order to avoid duplication of effort.;
- Disseminate valuable experience and knowledge from different countries;
- Encourage public discussion on the future of large carnivores within Europe, especially with regard to rural support systems which maintain the economic and social well being of local people as well as conserve viable populations of large carnivores.
- Address issues in four important fields of activity:
    1. Conservation of Large Carnivore populations and their habitats;
    2. Integration of large carnivore conservation into local development in rural areas;
    3. Support for large carnivores through appropriate legislation, policies and economic instruments;
    4. Information and public awareness with the aim of obtaining the acceptance of large carnivores by all sectors of society.

Species action plans

Large Carnivores in Europe

Europe once offered a wide range of natural habitats for its large carnivore species. Today, however, relict brown bear populations are dangerously small and highly fragmented in Southern, Central and Western Europe. The Iberian lynx has recently been labelled by the IUCN as the most critically endangered cat species world-wide. Wolf populations are under intense human pressure throughout most of their range. The Eurasian lynx has disappeared in much of Europe and even though wolverine numbers in Fennoscandia appear to have stabilised since it became protected, illegal hunting is still a constant threat.

Like many conservation issues, the future of Europe's large carnivores is dependent on cross-border co-operation between nations and, importantly, on managing their interaction with human activities. The challenge of conserving large carnivores is complex and must involve a wide range of stakeholders including land managers, local communities, governments, international Conventions and NGOs.

In response to this challenge, WWF International (the World Wide Fund for Nature), together with partner organisations and experts in 17 European countries, launched a Large Carnivore Initiative for Europe (LCIE) in June 1995. Since its inception the Initiative has grown rapidly with experts from 25 countries actively involved and many others expressing interest. The aim of the LCIE is to support and build on existing initiatives or projects across the continent, avoid duplication of effort and make the most efficient use of the available resources. One of the many activities that was identified as being of priority for the conservation of Europe's large carnivores was the elaboration of Pan-European Conservation Action Plans for the five species.

Species Action Plans for the conservation of the Brown Bear, Wolf, Eurasian Lynx, Iberian Lynx and Wolverine

This Plan is one of a series of Pan-European Action plans elaborated for each of the five species at present dealt with under the LCIE (Brown Bear *Ursus arctos*, Wolf *Canis lupus*, Eurasian Lynx *Lynx lynx*, Iberian Lynx *Lynx pardinus* and Wolverine *Gulo gulo*). The plan should be seen as complimentary with the other four plans and actions should be co-ordinated with those taken under the other plans since in many cases a natural guild of native predators is desirable.

The plans go beyond detailed analysis of local populations' needs and focus on the specific issue of managing the species throughout Europe, stressing the necessity for a continental approach and co-ordinated national efforts. It is hoped that one of the great values of these Plans will be that they generate coherence to actions throughout the whole range of each given species.

These Plans are not management plans per se, but rather aim to form the basis for decisions at international level pointing at the importance of using populations as the management unit, which are often transnational. These Pan-European plans stress the need for national management plans to be drawn up in collaboration with neighbouring States where necessary, and in order to facilitate this process a volume on Guidelines for developing Large Carnivore Management Plans (D. Hofer and C.Promberger 1998) has just been produced by the LCIE.

These Plans serve as an important communication tool and their recommendations should be used to influence players in the conservation sphere at local, national, and international levels. They also provide a baseline record against which to measure change in future years as well as a common framework and focus of action for a wide range of players.

The responsibility for the elaboration of the plans was assigned to teams working under some of the top European experts for each species. During the preparation of these action plans the authors consulted a wide spectrum of sources including management authorities, researchers, NGOs and the literature. This open process included a workshop for governmental experts in Slovakia organised by the Council of Europe (Bern Convention Secretariat) specifically to discuss the five Action Plans in October 1998.

Endorsement

The Council of Europe document "Guidelines for Action Plans for Animal Species" (T-PVS-(ACPLANS)(97) 8) underlines the importance of producing Action Plans for large carnivores at a Pan-European level: "It also makes good ecological sense to choose species that serve as protective "umbrellas" for other species. Such a single species effort avoids many bureaucracies and provides many "inclusive benefits". Umbrella species are species whose own area requirements provide some index on the area requirements of the ecological systems that support them. Top carnivores or other large-bodied, long-lived slowly reproducing species at the top of their ecosystems food-chain are good examples...." The document states that " The Council of Europe through its Committee of Ministers or the Bern Convention's Standing Committee are in excellent position for endorsing such Plans."

Common Themes

All five Action Plans have clearly identified a number of important common themes, which include the following fundamental guiding principles:

- there is a need to concentrate conservation efforts at the population level, which often requires cross-border co-operation;
- the principle of management of large carnivore through a system of zoning including core areas, buffer zones and corridors;
- where re-colonisation of areas by large carnivores is desirable, the following principles should be applied:
  – priority should be to firstly support natural re-colonisation,
  – secondly to work on the augmentation on non-viable populations,
  – thirdly to release animals into areas in order to join up non-viable populations, and
  – finally, to carry out releases into new areas.
- it would be highly desirable that each country sets up a specific body that is responsible for large carnivore management issues, and who would be charged with the preparation of national management plans (A single body that is responsible for all large carnivore species is desirable);
- wherever compensation systems are in place, these should be tied to prevention incentives;
- with regard to identified "problem" animals, which create local damage, emphasis should be given to maintaining populations and not by concentrating on individuals (apart from rare exceptions);
- in-depth and scientific human attitude studies (including work on conflict resolution) have to be initiated;

The points made above just give a brief indication of some of the more important common themes or principles that are shared by all five action plans that have been elaborated as part of the series.

Implementation

It is very important that these Action plans once "endorsed" are acted upon. These Action Plans should guide national authorities in the elaboration of National Plans and the implementation of these plans must be carried out by professional teams that involve a wide range of appropriate interest groups. The plans themselves can act as important fund raising tools to help spark off the implementation. In countries where more than one of the large carnivore species is present the elaboration of National Action Plans (as recommended by these Pan-European Action Plans) for each species should be in harmony with one another.

Conclusion

Finally we would like to thank the authors, all those who have provided data and comments and the Council of Europe for all the hard work and support that has been put in to this. We would also like to thank WWF Netherlands, Sweden, Norway, Mediterranean Programme and the Council of Europe for providing the funding for the elaboration of the Plans. We hope that these plans will form the basis for collaborative pan-European conservation work for these species over the next ten years, and that the success can be an example to other Initiatives.

Magnus Sylven (WWF International, Chair, LCCG)
William Pratesi Urquhart (LCIE Co-ordinator)

Executive Summary

The wolverine has been characterised as one of the northern hemisphere's rarest and least known large carnivores. Its strength, appetite, food habits and shy behaviour are often portrayed in northern folklore. Within their geographic range, wolverines occupy a variety of habitats. General characteristics of wolverine populations are their large area requirements, low densities and remoteness from humans and human developments. Their distribution in the Palearctic is mainly north of latitude 60° and is sympatric with that of reindeer (both wild and domestic). About 500 wolverines exist in Fennoscandia, most of which are in the northern parts of Sweden and Norway. In the Russian part of Europe about 1,500 wolverines are found. In historical times the distribution of wolverines included areas as far south as all Norway, the southern parts of Sweden, Estonia, Lithuania, and northeast Poland. However, wolverines disappeared from the southernmost parts of their distribution during the last century, probably due to persecution, deforestation and human development.

Wolverines have small litter sizes and usually do not breed every year and therefore have a relatively low resilience. However, in Fennoscandia, an overall increase in population numbers and distribution has occurred after they received protection during the 1970's and 1980's. Their distribution and numbers still seems to be decreasing in the Russian part of Europe. Wolverines in all Fennoscandia are protected and covered by the Bern Convention, and the UNCED-Convention (Rio Convention). In addition wolverines are protected by the Council Directive 92/43/EEC on Conservation of Natural and Wild Fauna and Flora of the European Union in Sweden and Finland.

The main conservation problem for wolverines is due to their year around predation on domesticated reindeer in northern parts of Fennoscandia, and on unattended sheep during the summer grazing period over most of their distribution in Norway. The conflict with livestock husbandry implies that effective conservation seems difficult to achieve without the support and participation of local people. The management of public opinion will have to be based on a fair treatment of all aspects of the conflicts involved in wolverine conservation. The future of wolverines in Fennoscandia and especially in Norway, which seems to have the greatest conflicts and consequently the largest management problems, will probably require the force of international agreements to set in effect the management measures required for effective wolverine conservation. Wolverine management should be based on the population level.

This action plan has identified five main objectives with suggestions for actions required reaching these goals.

- Conserve viable wolverine populations in Fennoscandia and hereby secure the viability of small populations.
- Co-ordinate carnivore conservation policoes crossborders and between agricultural and environmental ministries.
- Co-ordinate wolverine conservation plans with those for other large carnivores.
- Establish wolverine recovery zones where habitat quality is high. Wolverine populations should be allowed to naturally increase and re-establish within these zones.
- Reduce the conflict between wolverines and humans (mainly livestock depredation) in and around recovery zones by changing husbandry practices.

This action plan is not a management plan per se, but provides guidelines for national plans, and because most populations are shared across national borders, conservation and management should be carried out co-operatively among involved countries. To secure cross-border co-operation, formal agreements between the countries sharing wolverine populations are required. National conservation status should objectively follow the most recent International Red List Categories (IUCN), where the conservation status and management actions are set by population estimates obtained using comparable and scientifically approved methods. Hunting is only applicable within the framework of National and International law and in populations where it is compatible with stated objectives.

1. Introduction

The conservation of large carnivores is among the most challenging tasks facing conservation biologists. Both their killing of livestock and their fundamental ecology makes conservation difficult. Large carnivore conservation is as much, if not more, a problem of sociology and politics as biology.

The range of social attitudes towards carnivores range from the extremely negative to the extremely positive. Because of depredation on livestock and wild ungulates, many farmers and hunters perceive large carnivores as threats to their livelihoods or recreation, or even as a threat to personnel safety, and therefore often have negative attitudes towards them. On the other hand, many people that experience no personnel hardship from large carnivores often value them positively to the point of making practical management difficult.

Large carnivores require a functioning prey base and generally have large area requirements, with individual home ranges being in the order of 100's or 1000's of square kilometres. They are usually found at low densities. Conservation therefore requires large areas of good quality habitat, which is a very rare and expensive commodity in our modern, crowded world.

Wolverines (*Gulo gulo*) are no exception to these problems. There is, however, an additional problem. The platform of scientific knowledge for conservation is relatively poor when compared to that available for other large carnivore species like wolf (*Canis lupus*), lynx (*Lynx lynx*) and brown bear (*Ursus arctos*). Luckily, the last decade has seen a dramatic increase in research into wolverine biology, with projects in Norway, Sweden and North America. Although we still have much to learn, we are now at the stage where a conservation plan can be based on scientific knowledge. Against this background, this action plan describes and presents the most recent population estimates for Europe and the ecological and political aspects of wolverine conservation in Fennoscandia. Thus, this plan covers the Fennoscandian countries, Norway, Sweden and Finland.

2. Background Information

2.1. Description of the species

Wolverines are the largest terrestrial member of the weasel family (Mustelidae) and have a Holarctic distribution ranging across alpine, tundra and northern taiga habitats. Their appearance is somewhat bear-like, although movement and associated behaviour are distinctly characteristic of the weasels. Wolverines are powerfully built, with structural morphology apparently adapted for cold, harsh conditions. The dentition and associated musculature create a powerful bite and enable both sexes to forage on frozen meat and bone. Large paws and a plantigrade posture facilitate movement through deep snow. Their legs are short, with five toes on each foot. A wolverine's head is broad and rounded, with small eyes and short rounded ears. Males (12-18 kg) are typically 30-40% larger than females (8-13 kg). Wolverine pelage is a thick, glossy, dark brown. A light silvery facial mask is distinct in some individuals, and a pale buff stripe runs laterally from the shoulders along the side and crossing the rump just above a 25-35 cm bushy tail. A white hair patch on the throat and / or chest is often prominent in some individuals.

Wolverines communicate through short-range vocalisations and scent marking. A variety of vocalisations are used in the presence of conspecifics and cubs. Chemical communication is accomplished via scent marking with urine and abdominal rubbing. Wolverines have well-developed anal musk glands. It is believed that musk from the anal glands is used primarily in fear-defence situations, but it is also likely that musk is used in combination with faeces in marking behaviour.

2.2. Distribution and population numbers in Europe

2.2.1. Definitions and population estimation methodologies

To reduce potential confusion about important terms, we have used the following definitions:

A population is a group of individuals of a species in a given area. These individuals mate freely with each other, and the genetic interchange is greater within this group than with other groups.

A metapopulation is a group of geographically isolated populations, interconnected by dispersing individuals of both sexes.

Population estimates have been obtained using different methods at different times in the various parts of their range. However, recently Norwegian and Swedish researchers have co-ordinated their efforts and the results presented here are derived from a common methodology. Numbers of natal dens (1995-97) were determined through field registration. From this minimum count of the number of reproductive females, an estimate of the minimum population size was obtained using a calculated population structure.

Monitoring of large carnivore populations in Finland is mainly based on three methods. Firstly, tracks in the snow are recorded along a national network of more than 1000 12-km routes (in the shape of an equilateral triangle). These provide both a record of distribution and a potential index of population trends. Secondly, a national network of trained contacts (about 900) in reindeer herders and game management associations, record observations of tracks, signs and sightings of all large carnivores. These observations are used to estimate a minimum number of individuals each year, with an attempt to avoid duplication using carnivore movement characteristics. A final population index is obtained from the numbers of tracks and individuals recorded by frontier guards that constantly patrol the border between Finland and Russia.

Population estimates from Russia concern only the distribution west of the Ural Mountains (European Russia) and were obtained using data on the numbers of wolverine tracks in snow that cross census routes. Numbers of wolverines are calculated using data on movement rates and movement distances.

2.2.2. Status of the European populations

In historical times the distribution of wolverines included areas as far south as all Norway, the southern parts of Sweden, Estonia, Lithuania, and north-east Poland (Figure 1). However, wolverines disappeared from their southernmost distribution during the last century, probably due to persecution, deforestation and human development. In Europe, present populations of wolverines are found only in the central to northern parts of Norway, Sweden, Finland and Russia, where we estimate that around 2000 wolverines are found. Wolverine distribution in the Palearctic is mainly north of latitude 60° N (Table 1) and is sympatric with that of reindeer *Rangifer tarandus* (both wild and semi-domestic), which constitutes their most important source of winter food.

2.2.2.1. Sweden (265+ wolverines)

At the beginning of the last century, wolverines were found at relatively high densities in the mountainous parts of central and northern Sweden. Reproducing populations also existed in the boreal forest areas even as far south as Dalarna and Värmland counties in southern Sweden. The hunting statistics indicate that the population declined steeply from about 1870 until they received protection from 1969. At that time, wolverines were limited to a small population in the mountain areas along the Swedish-Norwegian border. The population has increased since protection (Figure 2, 3). Based on records of active natal dens during 1995-97, the population was estimated at a minimum of 265 individuals in all of Sweden, with almost 200 of these in the northernmost county (Norrbotten). The population seems to be stable, although limited and restricted local

control actions were introduced in 1996.

2.2.2.2. Norway (150+ wolverines)

The species was, until the beginning of this century, distributed throughout most of the forested and mountain areas as far south as the southernmost counties of Norway. Today wolverines are found mainly in mountainous areas in south-central Norway and along the Norwegian- Swedish border from Hedmark county and northwards. Wolverines were hunted to functional extinction in southern Norway, where the species received protection in 1973, but re-colonised the Snøhetta plateau in south-central Norway in the late 1970's. The 1995-97 population there was estimated to be a minimum of 30 individuals. Reports indicate increasing geographical distribution and numbers in south-central Norway during recent years (Figure 2, 3). This population is isolated by about 100-200 km from the larger population in northern Norway.

The hunting statistics from northern Norway during this century suggest pronounced fluctuations in population densities, but these were at an extreme low when protection was introduced in 1982. However, populations and distribution increased following protection until 1993, when licensed hunting was introduced. The population was estimated to be a minimum of 120 individuals during 1995-97, but seems to be decreasing, as revealed by a decreasing number of active natal dens recorded during recent years. This apparent decline could be a result of the licensed hunting and illegal killing, but could also be a result of variation in the weather / snow conditions during field registration.

2.2.2.3. Finland (115 wolverines)

As in the other Fennoscandian countries, wolverines were historically persecuted in Finland. The population, as revealed by the hunting statistics, showed a steady decline from before the turn of this century, when about 50 individuals were killed annually, to less than half the numbers around 1930. The Finnish wolverines probably reached a minimum population level before receiving protection in 1982. The minimum population was 50-80 animals during the 1980's. The main population is within the areas of semi-domestic reindeer husbandry in the northern parts of the country. However, a smaller part of the population is located adjacent to the Russian part of Karelia in the east-central part of Finland. In recent years, some overall recovery has been observed. The total population was estimated at a minimum of 110 individuals in 1995 and 116 individuals in 1997. The population is stable to slightly increasing (Figure 2, 3).

2.2.2.4. Russia (1,500 wolverines in all European Russia)

In Russia the distribution of wolverines follows the boreal taiga zone and the southern border is roughly around 60^{o} N. The species is absent from the northernmost tundra areas. Populations are believed to fluctuate according to fluctuations in ungulate populations. However, a considerable overall decrease in population numbers seems to have taken place during the last 30 years (Figure 2, 3).

2.2.2.4.1. Komi Republic (885 wolverines)

Komi has the highest numbers of wolverines in the European part of Russia today. The total population was estimated to be 885 individuals in 1990.

2.2.2.4.2. Archangelsk Oblast (410 wolverines)

Wolverines do not seem to have occurred in dense populations in this forested region. In the forest and tundra areas of Nenetsky Autonomous Area, the population is believed to be limited by motorised hunting. The total population was estimated to be 408 individuals in 1990.

2.2.2.4.3. Kola Peninsula (160 wolverines)

The populations in the game hunting districts of the Kola Peninsula were believed to be relatively dense at the beginning of the 1970's (mean density of 0.8 wolverines/100 km^2). Scientific sources reported a sevenfold drop by the 1980's, and the population was estimated to be 160 individuals in 1990.

2.2.2.4.4. Karelia Republic (80 wolverines)

The overall densities in game hunting districts were estimated to be 0.7 wolverines/100km^2 in early 1970's, and decreased to 0.2 wolverines/100km^2 in 1987. The major declines took place in the southern parts of Karelia; the population seems to have been more stable in northern parts. The total population was estimated to be only 80 individuals in 1990.

2.3. Life history

2.3.1. Food

Wolverines could be termed "hyenas of the north" and have evolved as scavengers utilising remains left by other more efficient predators such as lynx and wolf, and also carcasses of animals which have died from accidents or disease. Larger animals in the diet are therefore obtained primarily as carrion. Large amounts of meat may be removed and cached for later consumption. However, wolverines can prey heavily on domestic sheep *(Ovis aries)* and semi-domestic reindeer, and have been documented killing large prey such as moose (*Alces alces*) under certain snow conditions. Smaller prey, such as hares (*Lepus timidus*), and especially small rodents, are also important prey. Beaver (*Castor fiber*) and gallinaceous birds (Galliformes) have also been reported to occur in the wolverine diet, but their significance is probably area-specific, related to populations and accessibility of different prey. Vegetation has been reported in the diet of wolverines, but it may be consumed incidentally with prey rather than in lieu of prey. In general wolverines are generalist scavengers / predators, which enables them to switch between different food sources when one species of prey becomes scarce.

In Fennoscandia wolverines are sympatric with reindeer, both wild and semi-domestic, which constitute their most important winter food. Hares, ptarmigan (*Lagopus* spp.) and small rodents are also significant winter food and may be the most important foods during summer. Wolverine predation on wild reindeer has been documented only for isolated cases from the Snøhetta plateau in south-central Norway, where they mainly kill old female reindeer in poor condition. In Russia wolverines also occur in areas with other wild ungulates, as well as in reindeer areas.

The importance of small rodent abundance to large-sized carnivores is rarely reported in the literature, and many would consider wolverines to be too large to survive on only small prey. However, there is increasing evidence that small rodent cycles influence wolverine litter size. The abundance of small rodents was a major factor in determining wolverine reproductive success in the Snøhetta plateau in south-central Norway. The lack of other large predators (and therefore a reduced supply of carrion) in a system like Snøhetta could make wolverine reproduction more dependent on peaks in rodent cycles than what might be expected in a more intact system.

Even though the wolverine has been found to be an important predator on free-ranging sheep on mountain ranges, sheep numbers seemed to have little effect on wolverine numbers or reproduction. In Fennoscandia, sheep are only released on mountain ranges in June and graze unattended until the beginning of September, when they are collected. Most documented wolverine predation occurs during the last few weeks of the grazing period. The onset of sheep predation occurs at a time when wolverines' hoarding behaviour is expected to increase before winter. However, results from food studies indicate that hoarded sheep meat is not an essential part of the wolverine diet during the winter-spring denning period. The fact that wolverines did not kill more sheep during summers when small rodents were less abundant, and wolverine reproductive success declined, indicate that sheep are not an alternative prey to small rodents.

2.3.2. Reproduction

Wolverines are polygamous. Females are believed to be monoestrous and, in the wild, mating occurs from April to August. Recent studies of captive animals show that females generally come into estrus from June to early August. Increased vaginal cornification occurs from mid-June through early July; this likely corresponds to the time when most matings occur. However, matings have been observed in April in wild animals.

Late-stage spermatids and spermatozoa are found in the testes as early as March. In adult captive wolverines, maximal size of testes and elevated testosterone levels were attained in early April and maintained through early July. Testicular regression began by late July and was complete by mid-August. During the breeding season, males usually remain close to females, but females take the lead and initiate moves when travelling. Typically, males will mount females from behind, with forelegs clasping the female's sides. The scruff of the female's neck is often grasped, particularly if she attempts to move. Coitus probably induces ovulation.

Wolverines exhibit delayed implantation. Fertilised eggs remain in the blastocyst stage until implantation occurs, usually from November to March. Gestation, following implantation of the blastocyst, is about 30-50 days. Parturition occurs from January through April, with most females giving birth before late March. Litter size is 1-5 and averages 2-3 cubs. Young are born fully furred with eyes closed and teeth not erupted. At birth their fur is white, they weigh about 80-90 grams, and have a crown-rump length of about 120 mm. Young are weaned at 9-10 weeks and begin to travel with mothers by late-April. Adult size is often reached by early winter, although young sometimes remain associated with their mother, siblings, and the resident male until reproductive maturity. Female wolverines attain sexual maturity at about 15 months, but few 2-year-old females produce litters. Males appear to reach sexual maturity at about 14 months of age, but probably do not gain any matings before reaching 2-4 years of age. Records from northern Norway and Sweden also indicate, that adult males may be involved in infanticide. The role of adult males in juvenile mortality clearly requires further investigation.

2.3.3. Denning activity

Wolverines give birth in natal dens, which are situated in snowdrifts on bare, rocky valley slopes near or above the birch forest timberline. Occasionally they can be found far above the treeline and sometimes also in forested areas. In northern areas, where the timberline is at low altitudes, dens have been found close to the sea. In boreal forest areas, dens might be found beneath the roots of a windfall or in a hollow tree. Den entrances are located in snow drifts, usually beneath an overhanging cliff side, near trees or rocks, with a vertical tunnel extending 1-10 meters to ground level accessed by tunnelling through snow into the natural chambers and passage-ways created by the talus. Lateral tunnels extended for up to 50 meters along the ground surface. Cubs are born on the natural substrate of snow, rock or soil.

Use of reproductive dens begins from early February to late March. Females may move the cubs to other dens close to the natal den, between parturition and cub weaning. Why dens become unsuitable is not well understood. This might be forced by snowmelt, response to human disturbance, parasites in the den, or attempts by the female to deter predators from locating the den. In late April to June, when the cubs are 3-4 kg and quite mobile, the females usually leave the natal den area, placing the cubs at different "secondary dens" or rendezvous sites in her territory while she hunts.

Den locations are often used in consecutive years. Observations from areas where wolverines were persecuted to extinction, but have naturally re-established, have shown reuse of the historic den locations. Records also exist of daughters inheriting a den location from old or dead mothers. This implies that suitable den locations might be a limiting factors for wolverines.

2.3.4. Activity and home range

Worldwide, nine studies provide estimates of wolverine home range use from radio-instrumented study animals; six from North America and three in Scandinavia. Researchers focused primarily on home range size, stratified by sex and season. These studies also addressed home range overlap to investigate a postulated spacing pattern of intrasexual exclusion, which is typical of mustelids.

Compared to similar-sized carnivores, wolverines have very large home ranges. However, home ranges do vary with habitat, sex and status of the different individuals. Females with cubs usually utilise the smallest home ranges, varying from 40 - 100 km^2. The area used by non-breeding females and adult males varies from 200 -1500 km^2. Sub-adults and very old individuals (that is, individuals that not breed) might use several thousand square kilometres. Food availability and dispersion and also habitat quality probably determine female distribution in general. It seems reasonable to assume that wolverine populations are structured around breeding females. Therefore, it is reasonable to expect larger home range use, especially by males in populations with low densities. Home range use appears to vary with season. Most studies report a seasonal switch to lower altitudes in winter, probably due to a greater availability of small prey and carrion in the low-lying areas.

The larger home ranges (and therefore activity radii) of males generally will expose them to a greater risk of human-induced mortality than females. This is especially true during the mating season. It is likely that males travel more at the onset of, and during the mating season (January-August). For females, the opposite is true, as this is the season when they use the smallest ranges. However, females increase their area use considerably during the autumn and have long activity radii in late autumn / early winter. This does not correspond to any specific period of the reproductive cycle, but may be related to searching for good den sites or winter areas with abundant food resources to allow fat deposition.

2.3.5. Social organisation and dispersal

Our knowledge of wolverine social organisation and dispersal is poorly documented and needs further investigation. However, we know that wolverines are solitary, like most mustelids. That wolverines are solitary does not mean that they do not regularly interact with conspecifics. A degree of overlap between home ranges of both sexes is one of the few common aspects of wolverine spatial patterns reported in wolverine studies. The amount of within-sex overlap varies considerably, but seasonal patterns seem to be apparent. Most

resident females accompanied by cubs maintain exclusive home ranges, with spatial separation most prominent during summer. They overlap during late autumn and early winter. Females without cubs seem to overlap throughout the year. For males, territoriality seems to be most prominent during the mating season (April-August), whereas they overlap to a greater extent during the rest of the year.

The cubs are increasingly independent during late summer and early autumn. They are fully independent by mid-September. Their ranges increase throughout autumn and some undertake long movements outside their natal areas during late autumn. In some areas cubs disperse during their first year, whereas others disperse later when they are forced out by conspecifics. Subadults might overlap the home range of the resident male, as well as their mother and siblings. One study in Idaho reported two cases of subadults associating with a neighbouring adult female and adult male. In both instances the adults were kin to the subadults.

Females might inherit their mother's den site. Females have been reported to have litters at 10 years of age, but generally they seem to be over the reproductive stage at 8 years of age. Old individuals might be forced away from their territories by younger animals. Males seem to be reproductively senescent at even younger ages (5-7 years of age). Of course, such animals are no longer important for the productivity of the population, but could hypothetically be important as predators on domestic livestock, and thus important in management considerations.

2.3.6. Habitat requirements

Habitat components can be grouped into three main categories: food, shelter and suitable den sites. Little is known about wolverine habitat requirements or their adaptability to changing environments. However, wolverines demonstrate broad habitat use, using alpine habitats, the birch forest zone, and even the deciduous forest. Historical records reveal that wolverine distribution, both in America and Europe, has contracted northwards (and upwards) in the face of human development and urbanisation. Today wolverines are most prominent in remote upland areas. However, after receiving protection in Fennoscandia, wolverines have returned to formerly inhabited areas, which have undergone considerable human-induced changes in the mean time; i.e. the building of roads and railways, industry, settlement, hydropower dams, recreational cabin building and associated traffic. However, the wild prey that wolverines are dependent on are still abundant, or have even increased in many areas. Although it seems clear that available habitat not inhabited by wolverines exists, we do not understand wolverine requirements well enough to predict habitat limitations. Their huge home ranges require very large areas to provide habitat for a viable population.

Their sympatric distribution with semi-domestic and wild reindeer indicates that they are vulnerable to indirect loss of habitat, because if reindeer are removed, wolverines will most likely also disappear. Wild reindeer is one of the ungulate species most sensitive to habitat fragmentation and human disturbance.

Wolverine den sites are usually located in remote valleys, halfway up from the bottom in steep slopes around the tree line. Human activities in the mountains are usually confined to the valley bottoms or to clustered downhill skiing facilities. Exceptions are hunters and their dogs searching for game. Furthermore, nature photographers and adventurers increasingly seek less developed areas to experience "undisturbed" nature, which is often in wolverine habitat. This provides an additional and possible serious source of disturbance at female denning sites.

2.4. Wolverines and humans

2.4.1. Public attitudes

Surveys of public attitude towards large carnivores have been conducted in Norway and Sweden, but to our knowledge, not in Finland or Russia. The overall opinion of the general public in Norway gives a clear mandate to protect wolverines. However, in areas where wolverines prey upon livestock, the public attitudes are more varied, and are usually negative to wolverine conservation. It is reasonable to believe that the attitudes in Norway are representative of the other Nordic countries. However, the most pronounced negative attitudes in Norway, are within areas with heavy wolverine predation on sheep. In the other Nordic countries sheep farming within wolverine distribution is almost non-existent.

2.4.2. Threats to humans

No records of wolverines injuring humans exist, although there are some records of bluff attacks when humans have come too close to females with cubs in early summer, when the cubs are small. However, most females leave the site after sudden encounters with humans, but return to the cubs after the “intruder” has left.

2.4.3. Damage to livestock

One of the main barriers to large carnivore conservation is their depredation on domestic livestock. Wolverines are rarely associated with such depredation in North America, largely because their range does not greatly overlap with that of domestic sheep and where it does, the sheep are usually herded. However, wolverine depredation on livestock has been one of the main reasons for their control, and historical decline, in Fennoscandia.

Wolverine predation on semi-domestic reindeer (throughout the year) and on unattended sheep (during summer) is well documented in Norway. In Sweden and Finland, almost no untended sheep grazing occurs in wolverine areas. However wolverine predation on semi-domestic reindeer is well documented in all the Nordic countries. Extensive sheep husbandry (leaving sheep unattended on mountain pastures) as practised in Norway is not compatible with either the present wolverine populations or their expansion into former parts of their range. Wolverine recovery has occurred without a change in the causes behind the original decline (sheep depredation, ignorance, etc.), and the conflict potential due to livestock predation has even increased because of increased stock numbers and the loss of herding and livestock guarding traditions.

2.4.4. The husbandry systems

Two species of livestock dominate in this conflict, domestic sheep and semi-domestic reindeer. Sheep are grazed on mountain and forest pastures only during the summer (June to August), because winter conditions are too harsh. Although shepherds were commonly used to protect sheep in former times, the dramatic reduction in large carnivore populations during this century allowed the development of a herding system whereby sheep are largely left unattended during the summer grazing season. Supervision consists of, at best, frequent checks on the flock. As there are few fences to restrict sheep movements, flocks can spread out over 10’s and 100’s of square kilometres. Therefore this supervision is at best a way of documenting losses rather than preventing them. Sheep farming is widespread throughout Norway (about 2.4 million sheep are released each summer), although it is especially intensive in the southwest, where very few wolverines currently exist.

Semi-domestic reindeer herding is intrinsically tied to the Sami/(Lapp) culture of central and northern Norway, northern Sweden, northern Finland and northwest Russia. Further east in the northern part of Russia other ethnic groups, such as the Nenets also herd reindeer. Therefore, the herding of reindeer needs to be considered as both an economic activity, and as part of the cultural identity of ethnic minorities. Although the age of the tradition is debated, evidence suggests that it go back hundreds and maybe thousands of years. The development of motorised vehicles (snow-scooters, helicopters and trucks) has lead to changes in the form of husbandry during recent decades. However, the central principles of the herding system are based around large flocks of reindeer moving over large areas of mountain (or tundra) pasture, often with distinct seasonal patterns. The degree of herding and supervision varies greatly, but herds are often left unattended for long periods. The main difference with respect to sheep husbandry is that reindeer are free ranging for the entire year, and therefore, are vulnerable to predation for a longer period. There are presently an estimated 210,000 semi-domestic reindeer grazing in Norway, 250,000 in Sweden and 300,000 in Finland.

2.4.5. Detection of losses to carnivores and compensation

Since herding began, herders have known that carnivores kill many sheep and reindeer. However, because of the low intensity of supervision in the modern husbandry systems, most animals that die are never found. Therefore, there have been many debates about the extent to which carnivores are responsible for this mortality. A series of studies using mortality-detecting radio-collars during the 1980's and 1990's have documented that predation is a major cause of mortality. For example, studies in areas where sheep losses are high have revealed that predation is responsible for up to 64 % of all mortality on lambs grazing on summer pasture.

Among free ranging sheep, a loss of 2% of ewes and 5% of lambs is regarded as a “normal loss” (i.e. to sources other than predation). Anything over this is often attributed to predation. Such “normal loss” figures for semi-domestic reindeer are still debated. A system of compensation for losses attributed to protected carnivores was introduced along with the enactment of protection in 1969 in Sweden, 1973 in southern Norway and 1982 in northern Norway and Finland. The system in Norway depends on the ability of herders to document at least some carnivore predation on livestock, but does not require that all missing animals be found. In chronic “damage” areas, compensation is usually paid for most losses above the normal loss threshold. Since this system was introduced, the numbers of sheep and reindeer for which compensation has been paid have increased dramatically. Although an increasing number of wolverines in some areas may have lead to an increase in depredation, in other areas the number of grazing sheep has increased.

A new compensation scheme for losses of semi-domesticated reindeer to carnivores was introduced in Sweden in 1996. Compensation is paid according to the number of carnivores that are documented to reproduce in the grazing areas. This system is especially important because the new compensation scheme makes it economically profitable to verify as many active wolverine dens as possible within the area of reindeer husbandry. Nearly SEK 100,000 (about ECU 11,800) was paid for each active den in 1996 and 1997. The number of documented natal dens increased by 50% when this was initiated. However, the weakness is that a fixed amount of money is put aside each year, so increased numbers of active natal dens means lower compensation per den. When a husbandry area verifies more than 6 successful reproductions of wolverines and lynx, or more than 4 reproductions by one of the species, a discussion about control measures is opened.

Numbers of sheep and domestic reindeers compensated in Fennoscandian countries during recent years are given in Table 2.

2.4.6. Methods to reduce depreciation

As losses due to wolverine predation in Fennoscandia are several orders of magnitude higher than those reported from other regions where carnivore-livestock conflicts occur it seems obvious that wolverine conservation will depend on finding a way to reduce the conflict. Even after protection in south Norway in 1973, permits have been issued by management authorities for the killing of wolverines in areas associated with high rates of depredation. In addition a number of wolverines have been killed illegally. Between 1979 and 1995 a minimum of 15 wolverines were killed (legally and illegally) within the Snøhetta plateau area. The only significant reduction in sheep losses was found among lambs in the same grazing season as the wolverine was killed. No long-term benefits could be detected. Clearly the removal of individual wolverines was not a suitable means to reduce depredation over the long term. Further reduction in depredation would require the killing of more wolverines, a process not compatible with the objective of maintaining a viable population within the plateau.

Traditional herding methods are very labour intensive. Therefore it was hoped that a system of aversive conditioning and repellents could provide a relatively easy and cheap solution. Many studies in North America have attempted to reduce carnivore predation on sheep using similar methods. However, a large scale test with a series of volatile chemicals inside a dispenser as a repellent where wolverines did not have access to lambs without dispensers lead to no reduction in depredation. It appears that the wolverines were able to habituate to the chemicals or learned to change their bite site so as to avoid the dispenser. Further work needs to either concentrate on re-adopting traditional herding methods, testing different sheep breeds or increased spatial separation (zoning) of wolverines and sheep. Switching from sheep to a less vulnerable livestock species like cattle could dramatically reduce or even eliminate conflicts.

2.5. Threats, limiting factors, and obstacles to conservation

Wolverines have a slow recovery rate after population reduction. This is because they are relatively slow breeders, with small litters (1-5), averaging 2.4 in Fennoscandia. A variable proportion of adult females do not breed, possibly to the extent that individuals only breed every second year. This relatively slow reproductive rate explains the observed low resilience of many wolverine populations. A surprising feature of their reproductive ecology in Snøhetta was the importance of small rodent abundance. The occurrence of small rodents in wolverine diet was dependent on the cyclic variation in rodent abundance and explained much of the variation in wolverine cub production. This has lead to a pulsed reproductive pattern on the Snøhetta plateau.

Except for the Sarek area in northern Sweden, no areas large enough to support wolverines in Fennoscandia can be classified as true wilderness, so that wolverines will always have to coexist with some human activity. It is this pattern of human use of wildlands that most differentiates Fennoscandian conservation strategies (the multi-use landscape) from that in North America, where some wilderness remains. Identified threats to wolverines at present ranges in Fennoscandia are listed in Table 3.

2.5.1. Demographic viability

Small population sizes in general are a threat to population viability, because stochastic events may influence sex and age distribution when numbers are few. In general, a population that exceeds 30 individuals will have a considerably increased demographic viability. A population that is small enough to be inbred might meet serious demographic problems before facing the effects of inbreeding. A continuous and evenly distributed population is not considered to be in any demographic danger. However, wolverines are unevenly distributed over much of their range. In some places, i.e. southern Norway, wolverines are distributed in a mosaic of

upland areas. These small and partly isolated populations (metapopulation structure) are at risk of local extinction caused by demographic "accidents". The combined factors of demographics and inbreeding are believed to cause synergistic effects, which means that a population below the criteria for viability can easily become extinct.

2.5.2. Genetic viability

The northern Norwegian and Swedish population form one apparently continuous distribution, with the highest densities along the Norwegian-Swedish border. Exchange occurs between Finland and Russia, and in the north among Norway, Sweden, Finland and Russia. The proximity of these populations, and movements among populations, might be expected to reduce population differentiation. However, populations may not become completely genetically mixed, even when individuals make long-distance movements.

Examination of DNA microsatellite heterozygosity in wolverines sampled in southern Norway, northern Norway and in northern Sweden, showed lower variability than in other mammals. The results revealed that genetic variability in these three populations is relatively low and significantly different from each other. This result is not surprising, given that wolverine numbers are only now recovering after a long period of decline and suggests a limited amount of gene flow between pairs of populations. The finding that there is significant population differentiation is somewhat surprising, given that wolverines are capable of long-distance movements and that the populations along the Norwegian-Swedish border seem to form a continuous distribution. However, similar observations have been made from some other large mammal studies.

2.5.3. Habitat loss

The perception in Fennoscandia is that wolverines are a high-elevation species, because, when people surround wolverines, they are usually found in the most inaccessible habitats, the uplands or mountain ranges. Besides direct persecution, wolverine populations or potential habitat have been relegated to the last available habitat that has not been developed, extensively modified or accessed by humans (roads, trails etc.). Food availability is an important habitat factor. Wolverine population density and range have been affected by the abundance and density of important prey species (i.e. wild reindeer) and loss of other carnivores, i.e. wolves, which were likely an important carrion supplier for scavenging wolverines. However, food is probably not limiting hunted populations, and much unoccupied wolverine habitat cannot be used because of socioeconomic reasons (depredation on livestock), especially in Norway. Most habitat loss and habitat degradation is likely to be a result of human activity. The effect might be summarised as: 1) Loss of suitable habitat, 2) wolverines avoid areas with human activity (especially serious if it causes the abandonment of critical denning sites), 3) loss of prey species and 4) loss of other carnivore species.

2.5.4. Fragmentation and isolation of habitat

In modern times, human activities have induced multi-factorial changes in the Fennoscandian boreal/alpine ecosystems. Especially in its southern distribution, wolverines are confined to more or less discrete alpine areas (effectively habitat islands) that are surrounded by boreal forest and human settlement. While the forest habitat is not a barrier per se, there is much more human activity in low lying forest areas. Such fragmentation is serious to a species with large home range requirements like the wolverine. The areas of continuous habitat might be too small to support viable populations. However, it should be stressed that the degree of development is low compared to other European countries. Therefore, most areas still represent potential habitat for

wolverines. Radio-tracking of wolverines has revealed that they are able to pass the sources of disturbance and cross barriers that occur within their home ranges. Reindeer, either wild or semi-domestic, are found in most alpine areas, and small game is relatively abundant.

Given the extensive habitat needs of large carnivores like wolverines, and the continuing encroachment of human activity on wilderness areas, provision of adequate habitat where there is no potential for conflict could be difficult. In Norway, three core conservation areas for wolverine were established in 1994, two in northern Norway and one in south-central Norway. However, the two northern core conservation areas were abolished by the parliament in 1997. The remaining south-central Norwegian core conservation area has an area of 13 505 km^2 and consists of three upland plateaux (Snøhetta, Rondane and Reinheimen), separated by forested valleys that contain transportation corridors and human settlements. There is room for about 36 to 50 resident wolverines in the south-central Norwegian core conservation area, given the present density of 0.28-0.38 wolverines per 100 km^2. It has been suggested that the ecological conditions exist for this population to survive. The degree of contact with the nearby Swedish population will greatly affect both the demographic and genetic viability of this population.

However, the conflict between animal husbandry and wolverines makes maintaining conservation areas controversial. Wolverine predation on semi-domestic reindeer and unattended sheep results both in strong local pressure on central management authorities to issue licences to kill wolverines, and in illegal killing, despite compensation payments for lost livestock. For this reason, the use of predator control as a management tool and human habitat utilisation in the corridor between these two populations will probably greatly affect the long-term survival of wolverines in south-central Norway.

2.5.5. Increased human access to wolverine habitat

Most recorded wolverine mortality is human caused. The areas where wolverines survived in Scandinavia prior to their protection were typically steep mountain areas inaccessible to snowmobiles and humans in general. Increased construction of roads into roadless areas will obviously increase wolverine mortality through legal hunting, poaching, and traffic caused deaths because these roads give humans easy access to once remote areas and may also affect wolverines in their habitat. Increased human “recreational” activities in wolverine habitat may cause reduced ability for the animals to perform daily activities, making the habitat less optimal or in worst cases, causing wolverines to avoid the disturbed area.

2.5.6. Livestock husbandry and farming

The historic livestock guarding techniques of sheep farming have been lost during a period of absence/low density carnivore populations and simultaneously, demands for increased rate of economic profit. Wolverines are now re-expanding into parts of their former range, and conflicts escalate rapidly, with demands for killing permits, even though all Fennoscandian countries offer compensation for livestock killed by wolverines.

Recent research suggests that intensive grazing by huge numbers of sheep may alter the conditions for other smaller herbivores, as well as other wildlife. This is because the intensive grazing causes change in the natural plant community composition, and also increase unpalatable or less digestible plants in the community. If this is true, such changes could probably also affect wolverines negatively because of a reduced natural prey base throughout the year.

2.5.7. Hunting, legal killing of problem wolverines, and poaching

In response to the ever increasing losses of sheep and semi-domestic reindeer to carnivores, a number of management actions have occurred after the enactment of protection which have weakened the protection of wolverines, especially in Norway. Since the enactment of protection (1973 in southern Norway and 1982 in northern Norway), depredation control measurements have resulted in the legal killing of 15 wolverines in south-central Norway and 51 wolverines in northern Norway. Licensed hunting as a form of population control was introduced in northern Norway (Nordland and Troms counties) in 1993. In the four hunting seasons since then, a total of 30 wolverines have been shot from a quota of 51. In southern Norway licensed hunting was introduced in 1997 and 2 wolverines were killed from a quota of 6. In Sweden a total of 32 wolverines have been legally killed as depredation control since protection in 1969.

Incidents of wolverine poaching are regularly revealed in all three countries. It has been speculated that the number of illegally killed wolverines could reach as high as 15-20 % of actual populations. The true extent of poaching is however, impossible to know. Any poaching could pose a serious threat to small populations. However, opportunistic poaching probably is not a serious threat in areas where wolverine populations are stable. However, organised illegal actions, as promoted by spokesmen for the livestock industry, could quickly be a serious threat to the sustainability of even a large population.

2.5.8. National and sub-national management and fragmentation of management authority

In Norway the responsibility for issuing quotas was delegated from the Norwegian Directorate for Nature Management to two regional "democratically" appointed committees in 1997, one for southern, and one for northern Norway, respectively. This is a trial project. Issuing of quotas for control permits during the grazing season rests with the Norwegian Directorate for Nature Management (DN), which delegates conditional licences to the Environmental Protection Offices of the various counties. In winter 1997-98 a hunting season was also opened in south Norway. The regional committee, consisting entirely of representatives of the livestock industry, was responsible for setting a quota of 13 individuals in southern Norway. Hunting was not allowed inside the core conservation area, but could occur right up to its border. During mid-winter, there is a risk that wolverines will make excursions outside their normal home ranges, thus there will always be a risk of draining individuals from the core area. This committee was allowed to reach its decision without scientific advice, was able to ignore all systematic population estimates, and is empowered to evaluate any complaints against itself. However, if a complaining party is not satisfied with this evaluation, it can appeal the case to DN. DN reduced the hunting quota from 13 to 6 wolverines, based on complaints from nature conservation organisations.

In light of the results from Snøhetta, where limited control had no long-term effects on losses of sheep, the logic of this policy has to be questioned. In addition there appears to have been a decline in the wolverine population in Troms County as a result of the quotas being based on apparent overestimates of the population size. For example in 1996-97 a total of 10 licenses were issued, even after 2 cubs had been removed from a den in spring 1996. A minimum population estimate based on the number of documented active dens was 43 ± 11 (SD). In other words they issued permits for >25% of the population. Nor are there any data on the effect of this control on the social structure and reproduction within populations. Recent studies on brown bears in Sweden have revealed that the killing of adult males results in high rates of infanticide. The population level effect of killing male wolverines has not yet been evaluated. However, there is cause for concern as infanticide has been documented in this species.

2.5.9. Public opinion

The wolverine has been characterised as one of the northern hemisphere's rarest and least known large carnivore. Its strength, appetite, food habits and shy behaviour are often portrayed in northern folklore. Within their geographic range, wolverines occupy a variety of habitats. However, a general trait of areas occupied by wolverines is their remoteness from humans and human developments. Furthermore, the wolverine is a management and conservation enigma because the attributes of wilderness upon which it depends are not known. The conflict with husbandry implies that a significant conservation objective seems difficult to reach without the support and participation of local people. The management of public opinion will have to be based on a fair treatment of all aspects of the conflicts involved in wolverine conservation. The future of wolverines in Fennoscandia and especially in Norway, which seems to have the greatest conflicts and consequently the largest management problems, will probably require the force of international agreements to set in effect the management measures required for effective wolverine conservation.

2.6. Conservation status and recent conservation measures

2.6.1. International agreement

Wolverines are protected and covered by the Bern Convention, the UNCED-Convention (Rio Convention) in all Fennoscandia. The wolverines in Sweden and Finland are additionally protected by the Council Directive 92/43/EEC, Conservation of Natural and Wild Fauna and Flora (ABL L 206, 22.07.1992) of the European Union (Table 4).

2.6.1.1. Bern Convention: Convention on the Conservation of European Wildlife and Natural Habitats (10.09.1979, Bern)

Sweden, Norway and Finland have signed the Bern Convention, with no reservations for the wolverine. The goal of the convention is to preserve wild living animal species and their natural habitats. Special attention has to be paid to endangered and potentially endangered species. Measures have to be taken to preserve populations of wild living animal species or to raise them to a level that is ecologically, scientifically and economically appropriate. Protective measures have to be included in planning and development. The spreading of information on the necessity of preserving wild animal species and their habitats has to be promoted. The wolverine is listed in Appendix II (strictly protected fauna species). Useful and necessary actions have to be taken to enhance the special protection of species listed in Appendix II; especially forbidden is every form of capture, keeping or killing, the wilful disturbance and the possession and trade with these species. Exceptions can be granted under following conditions: prevention of serious damages on livestock, culture and property; public health and safety reasons; use for scientific purposes, restocking and re-colonisation. The re-colonisation of indigenous species has to be promoted, if it contributes to the preservation of an endangered species.

2.6.1.2. Biological Diversity Convention: UNCED-Convention (Rio de Janeiro, 05.05.1992)

The main-objective of the convention is the conservation and sustainable use of biological diversity. The presupposition is the preservation of ecosystems, natural habitats and wild populations of species of wild fauna and flora. To reach this goal, the following actions have to be taken: identification of specially protected areas; strengthening of the protection of ecosystems,

and preservation of natural habitats of viable populations; degraded ecosystems have to be restored and the restoration of endangered species has to be promoted. Research for the identification, protection and the spreading of information on the status of biological diversity has to be promoted; protective measurements have to be included in planning and development. The wolverine is not mentioned specifically in this convention.

2.6.1.3. Council Directive 92/43/EEC (Habitat Directive)

The main goal of Council directive on Conservation of Natural and Wild Fauna and Flora, the so called, Habitat directive, is to secure species diversity by protection of habitats and protection of species of wild fauna and flora. Actions have to be taken by the signature states to preserve all species of wild fauna and flora and their habitats. The wolverine was included as a priority species in the Habitat directive by the Council directive 97/62/EC. It is listed in Appendix II (needs specially protected areas) and Appendix IV (strictly protected species; capture, killing and wilful disturbance is not allowed). A priority species is a species, which needs special actions for its conservation. An area of common interest is an area, which is significant for the conservation of a priority species. The possessions, transports and trade with Appendix IV species is strictly prohibited. Exceptions can be given only if this has no negative impact on the preservation of the species. Exceptions can be allowed: 1) for the prevention of serious damage to culture and livestock, 2) public health, 3) sanitary and safety reasons, 4) for scientific, restocking and re-colonisation purposes. Neither Sweden, nor Finland has made any reservations for the wolverine.

3. Goals and objectives

3.1. Goals

The remote distribution, low densities and shy lifestyle makes the wolverine an exotic species from a European perspective. However, its ecological role as an important species for the integrity and health of ecosystems is being increasingly recognised. For the Fennoscandian countries the overall goal is to maintain viable populations in coexistence with people. Before this goal can be achieved, threats to the wolverine population and their habitat must be identified and removed.

Objective 1

Conserve viable wolverine populations in Fennoscandia and hereby secure the viability of small populations.

Objective 2

Co-ordinate carnivore conservation policies cross borders and between agricultural and environmental ministries.

Objective 3

Co-ordinate wolverine conservation plans with those for other large carnivores.

Objective 4

Establish wolverine recovery zones where habitat quality is high. Wolverine populations should be allowed to naturally increase and re-establish within these zones.

Objective 5

Reduce the conflict between wolverines and humans (mainly livestock depredation) in and around recovery zones by changing husbandry practices.

4. Actions required to meet the goals at the European level

4.1. Species protection

Wolverine management should be based on the population level. Because most populations are shared across international borders, conservation and management should be carried out co-operatively among involved countries. To secure cross-border co-operation, formal agreements between the countries sharing wolverine populations are required. National conservation status should objectively follow the most recent International Red List Categories (IUCN), where the conservation status is set by population numbers obtained using comparable methods.

The Bern Convention should adopt this Action Plan and thereby make wolverine recovery/conservation a political goal for all member countries.

To implement the European continental policy on the national level, it is essential to work out a national wolverine management plan, designed and approved within the guidelines of the present Action Plan. By doing so, each national authority should co-ordinate strategies with neighbouring countries sharing a wolverine population.

It will be most important to include all the authorities and organisations interested or affected by wolverines from the beginning in the process of elaborating such a national strategy. Especially potential special interest groups, like the sheep and semi-domestic reindeer industry, game management boards in wild reindeer hunting areas, and regional authorities must be taken seriously. However, no special interest group should be allowed to dominate these groups.

A national plan should include detailed regulation on legal matters concerning damage assessment, damage prevention and compensation, educating and training of specialised staff, public awareness, implementation of a monitoring program, and promoting scientific research. The national Management Plan should also identify and suggest all changes to the national and/or sub-national legislation that will be necessary to implement the plan. To initiate, co-ordinate, enhance and supervise all this work, the national authorities in each country should form a "wolverine management group". Each national management plan should be based on scientific data concerning wolverine ecology and population status.

In order to set up a realistic, feasible, and effective wolverine management plan, the government should first identify priorities. A working group, including several interested groups of persons (administrators, scientists, representatives from the sheep and semi-domestic reindeer industry, nature protection organisations, etc.), may help the government to identify priorities for wolverine management.

Wolverines are killed illegally across most of their range. To secure a viable population and to allow appropriate management of the populations, intensified law enforcement is necessary, followed by substantial penalties that make poaching very expensive. Hunting should only be legalised in populations that are documented to be viable and where management plans have been completed that identify population goals and how hunting will be used to realise these goals.

Actions

4.1.1 The Bern Convention adopts this Action Plan.

4.1.2 Wolverine conservation status within each country should be listed according to the IUCN criteria and based on comparable population estimation methods.

4.1.3 All countries identify and establish national wolverine management groups and empower them to design and produce national wolverine management plans on the population level according to this Action Plan. Countries sharing wolverine populations produce these national management plans co-operatively to secure cross border management.

4.1.4 Laws should protect wolverines, and hunting should only be allowed in populations that are documented to be viable and where management plans have been completed listing population goals and how hunting will be used to realise the goals. Hunting is only

applicable within the framework of National and International law and in situations where it is compatible with conservation objectives.

4.1.5 Law enforcement should be intensified and provide for appropriate penalties in areas where poaching is identified as an important threat or limiting factor for the population.

4.2. Recovery of endangered populations

The partly isolated population in south central Norway is likely to vanish if it is not allowed to increase naturally within its core area and if individuals are not allowed to move safely between the core-conservation area and the more continuous wolverine population along the Norwegian-Swedish border to north east. Taking into account the documented dispersal ability of wolverines, the lack of large barriers, and the low intensity land use throughout most of Fennoscandia, natural movements should be sufficient to ensure this connectivity. This means that artificial population augmentation (translocations) will probably not be required. Finally, it is crucial that wolverine control or hunting in areas surrounding the core conservation area does not drain animals from inside the core area.

Actions

4.2.1 Identify and ensure the survival of small populations through strict protection of wolverines within core conservation areas, and by ensuring that conditions are favourable for contact with other populations.

4.3. Habitat protection and recovery zones

Because of the large conflicts that exist between wolverines and livestock, the evaluation of wolverine habitat must include both biotic factors (ecological suitability) and anthropomorphic factors (conflict potential). The potential magnitude of such conflicts forces us to accept that wolverines will never be able to colonise all ecologically suitable areas. In other words a zoning policy will be required. Wolverine recovery should be planned with such zoning in mind. Areas of high ecological suitability and with low conflict potential should be identified and form the core of a recovery plan. Ideally these areas should be as large and continuous as possible. When not continuous, provision should be made for linkage zones to enhance connectivity. The habitat within these recovery zones should receive special management:

a. Conflict potential with livestock should be reduced through changes in livestock husbandry practices.

b. Infrastructural development (roads, railways, hydropower dams etc) should be evaluated to ensure that they do not cause fragmentation.

c. Human access to potential denning areas should be limited through road closures or imposing access restrictions.

d. New recreational developments, like ski slopes, should be avoided in potential denning areas.

e. Prey populations should be conserved. Because wild reindeer are so sensitive to human disturbance, their conservation requires careful management of human activity.

Actions

4.3.1 Classify areas within present and potential wolverine range according to their suitability and importance as wolverine habitat in order to identify and manage core areas for wolverine conservation.

4.3.2 Identify and maintain linkage zones in fragmented populations.

4.3.3 Evaluate the impact of existing and planned infrastructure within wolverine range and mitigate potentially negative impacts where necessary.

4.3.4 Carefully control or prohibit human activities proven or suspected to be detrimental to

wolverines or their prey in wolverine core areas and linkage zones.

4.4. Conflict with humans and public attitude

Conflicts with humans usually involve sheep farmers and domestic reindeer herders (Table 2, 3). Conflicts should be reduced to avoid legal and illegal killing of wolverines. In areas with high levels of conflict between wolverines and domestic sheep and reindeer, there is likely to be little tolerance of individuals outside conservation areas. Moreover, the expense of improved husbandry methods required to reduce predation will limit the area over which they can be applied. Therefore, the most effective use of public funding would be to create wolverine management zones, including zones where wolverines receive high priority. If possible, the range expansion of wolverines should be encouraged in areas where potential conflicts are low or can be reduced.

Coexistence of wolverines and free-ranging domestic livestock without some depredation appears to be impossible. Limited losses can be acceptable for conservation purposes, but extensive damages can hardly be tolerated. In areas where livestock farming in wolverine range is a threat towards wolverine conservation, effective guarding techniques should be adopted or livestock farming should be substituted with more compatible forms of production. Economic incentives to reduce conflicts with livestock holders may be necessary for successful wolverine conservation. Incentives should be given to encourage farmers to adopt forms of livestock husbandry that are compatible with wolverines in important wolverine habitat. Among the techniques to protect livestock, the most efficient seems to be to concentrate on re-adopting traditional herding methods, introduce more predator-adapted sheep breeds or switch to beef cattle, collect sheep from pasture before the onset of the major wolverine predation in late August, and finally increase the zoning of wolverines and sheep. Given the high levels of subsidy already spent on European agriculture, it should be possible to provide economic incentives for wolverine-compatible activities rather than wolverine-incompatible activities.

Measures to reduce wolverine predation on semi-domestic reindeer are little investigated. In Finland no damage to livestock has occurred outside the reindeer husbandry region, and translocation of wolverines from domestic reindeer regions to reindeer-free regions has been implemented since wolverines received protection. The effects of this have so far not been investigated. However, based on international experience with the translocation of problem large carnivores, the effort is likely to be unsuccessful.

One of the most important steps in helping mitigate the conflict between farmers and wolverines is a system of compensation for the extra costs and damages caused by wolverines. There are several possible ways of establishing compensation programs. However, we believe that for success it is important to integrate the concept that compensation for depredation loss should be linked to the farmers' effort to prevent damages.

The new compensation scheme in Sweden for semi-domesticated reindeer losses to carnivores makes it economically profitable to verify as many active wolverine dens as possible within the area of reindeer husbandry. This reward system should reduce both illegal actions and demands for killing permits, and encourage good husbandry. To get the maximum payback a herder should both tolerate the presence of carnivores and herd his flock so as to minimise losses. However, it is also important to take into account that some farmers do not accept that any livestock should be killed. In these cases the question is not only financial, but also emotional. This is why predation prevention is important. However, a compensation / insurance system is also necessary, especially when dealing with protected wolverine populations. Compensation programs should be designed with certain precautions and conditions: a) Compensation alone is passive. Prevention is active and is the only system that will help to diminish damages. Thus, compensation has to be linked with prevention (herding, night enclosures, change of sheep breed etc.). b) The level of

compensation paid should be equal to the damage done by the different predator species living in the area. A strict monitoring of causes of death, the identification of natural causes and species specific identification of the carnivore species responsible is very important.

Allowing closely regulated wolverine hunting where populations are viable will limit the numbers of wolverines and their distribution. People living in wolverine habitat may feel that this is a positive aspect and will more readily accept wolverines. Secondly, short-term effects in reduced predation might be gained. Finally, hunting will be required for preventing wolverine colonisation of zones where the conflict potential has been evaluated as being too high to support wolverines.

Actions

4.4.1 Improving existing compensation programs.

4.4.2 Link these compensation programs to the individual farmer's use of preventive measures.

4.4.3 Allow closely regulated hunting in viable populations where the management plan lists hunting as an action required to reach the population / management goal.

4.5. Problem wolverines

It is not known whether "problem" individuals, or certain age / sex classes, exist within wolverine populations that kill more sheep or semi-domestic reindeer than the average wolverine. However, this is presently an issue under study and no scientific knowledge has become established yet, therefore implementing the following actions should await further knowledge, and is conditional on the documented existence of "problem" individuals. Selectively removed individuals could, if desirable, be captured alive and used in the co-ordinated Wolverine Breeding Programme (Wolverine EEP) of the European Zoo and Aquarium Association (EAZA), and hence also serve educational and research purposes. However, given the extreme difficulties involved in live capturing wolverines at all, let alone specific individuals, it is not clear how practical this solution would be as a management tool.

Actions

4.5.1 Identify problem individuals.

4.5.2 Selectively remove problem wolverines in viable populations if preventive efforts have failed.

4.5.3 Carry out cost (for the population in short and long term) - benefit (for the society and wolverine population in the long-term) analysis before considering removal of problem wolverines in threatened populations.

4.6. Public involvement in wolverine management

If people affected by wolverines oppose their presence or reestablishment, this could result in either their illegal eradication or require expensive guarding systems to enforce legal protection. Acceptance of wolverines by local people is increased if they have been part of the management process. Local involvement is best achieved through a public participation program (PPP). This PPP includes a management board, which is involved in the planning process. The idea is that people support decisions they helped make. A PPP board with local stakeholders or representatives for the values and activities that exist in the area (conservation, sheep and semi-domestic reindeer industry, tourism etc.) will ensure that the planning process is responsive to local conditions. The PPP should be involved in deciding how many wolverines should be allowed in an area and where wolverines should be allowed to re-establish. The final decision should be political, preferably at the national level. These boards should not be dominated by people who suffer negative effects of wolverines.

Actions

4.6.1 Identify opinion leaders and stakeholders in wolverine management; set up local management boards and involve them in management planning and implementation.

4.6.2 Establish a protocol of consultations with local people about their needs and the management actions to be implemented in their area.

4.7. Public awareness, education and information

In order for the wolverine conservation strategy to be successful, the public must be committed to making it work. Only an informed public will be able to share a commitment to wolverine conservation. People living in, or frequenting, wolverine habitat must be educated about the presence of wolverines. This information should be directed to decision-makers, those with commercial interest within wolverine habitat, and the public in general (Table 5).

A good educational campaign should be prepared and conducted by going through the following steps: a) Find a lead agency that raises the funding for all the other necessary steps. b) Identify target groups, their existing knowledge levels and attitudes as well as assess the current educational information. c) Design efforts and messages for each group. d) Identify individuals within the different target groups to deliver the messages in order to increase the chance of a successful implementation. e) Implement the educational campaign. f) Conduct an evaluation of the educational efforts. What effects did they have? What has to be improved? How far were attitudes of the target group changed and what brought about the change? g) Monitoring. Attitudes and beliefs of the target groups as well as the goals of the campaign have to be reassessed in a continual process. In other words, after running an educational campaign for some time, we have to go back to step "b" again and start the process over again.

A campaign to inform the public will be an integral part of the conservation program. Its action must be continuous and widespread. It could be assigned to a credible association, which would follow a plan previously agreed upon in terms of content, instruments and personnel with the concerned ministries and regional administrations. The more precisely the information has been tailored, the more effective it will be. An information campaign will cover several aspects, including:

Wolverine ecology: People should be informed about wolverine ecology to understand the management of the wolverines and their habitat. Their large area requirements, low population densities, vulnerability to human activities, and possible impact on prey populations should be priority topics.

Damage to livestock, and how to limit damage: People should be informed about the magnitude of the damages caused by wolverines to sheep and semi-domestic reindeer, and the real facts about the way in which these damages occur (where, when, why, under what conditions). In particular the information will have to cover the husbandry methods that can be used to prevent and limit damage.

Actions

4.7.1 Initiate information campaigns designed for different target groups following the guidelines listed in the management plan.

4.8. Monitoring Research

Given the general lack of knowledge concerning wolverines, as compared to the other large European carnivores, further research should clearly be given high priority. This will enable management to be based on the best available science. Management actions should also be used as ecological experiments. As well as ensuring close co-operation between scientists and managers, this will provide tests of hypotheses with potential value for applied ecology.

Furthermore, it is important that scientific research on wolverines is co-ordinated at the European level. A close link among all researchers working on wolverines world wide should be promoted. Co-ordinated research implies that research funds, such as European Union funds, should be made available at the European level, including adjacent non-Union countries that can conduct relevant research. We recommend that future research be concentrated on the following topics (not listed in prioritised order):

4.8.1. Population dynamics

We must learn more about alternatives methods to reduce the loss of sheep and semi-domestic reindeer other than killing wolverines. As the killing of wolverines seems to be the most widely used and socially accepted (among livestock herders) management tool at present, we suffer from a lack of knowledge about how this affects wolverine populations. To be able to adequately manage a wolverine population, its population dynamics need to be carefully studied and described. This is because hunting is the most reasonable way to stabilize the number of wolverines after a population goal has been reached. However, wolverine populations are known to be very sensitive to over-harvest. Research should focus on rate of reproduction, age and sex structure, survivorship, and the effects of various harvest rates. Our knowledge of population size, reproduction, use of area, and dispersal of wolverines is still too limited to provide enough data for viability analysis. Thus, we cannot predict the future of the southern Norwegian population, although it will probably depend to a great extent on the level of connectivity with larger populations to the northeast.

4.8.2. Dispersal

The reestablishment of wolverines in new areas depends on the species' ability to disperse. As population size increases, information about dispersal patterns and which factors promote and hinder dispersal will become very important to predict dispersal directions and speed.

4.8.3. Wolverine-prey relationship

Various studies have been carried out on the feeding habits of wolverines in Europe, most of them have used indirect methods based on analysis of digestive remains, scats and by tracking. This approach has limited value in clarifying the relations between wolverines and their prey. We know far too little about the reproductive success achieved by wolverines in relation to food availability and, especially, the importance of semi-domestic reindeer as a prey species in northern areas.

4.8.4. Habitat use

A large-scale study of habitat selection by wolverines and mapping of suitable wolverine habitat in Fennoscandia by using radio telemetry and Geographical Information Systems (GIS) would provide information about where reestablishment could be expected to secure the wolverine populations and their habitats from fragmentation. Linkage zone prediction models should be developed to identify critical areas needed for genetic interchange between subpopulations and to enhance reestablishment of wolverines into new areas. Most research in Fennoscandia has concentrated on wolverines in alpine habitats. Clearly, they have the potential to occupy boreal forest habitats as well, however, we know very little about their ecology in forest habitats. Data on wolverine ecology and the effect of forestry on wolverines in forested habitats are required.

4.8.5. Wolverine behaviour and human activities

Behavioural studies of wolverines should be undertaken to document behavioural responses

to human disturbance in the form of recreational activity and human-caused mortality. The effect of different types of forestry practices and other forms of resource management on wolverines should be better documented to make human resource use more compatible with wolverine conservation. In general, it is important to document the human-influenced factors that are least compatible with wolverine conservation. With this knowledge, managers can regulate the important human activities. Over-regulation of human activities would be detrimental to public acceptance of wolverine management and conservation.

4.8.6. Public opinion

Human-dimension studies should be conducted to determine special target groups for information, how information should be presented, and identify which management actions are most likely to be accepted and successful.

4.8.7. Monitoring

Monitoring of wolverine populations is difficult, and population estimates based on different criteria and data from the same population may give different results. To ensure a sustainable management of the wolverine populations, the development and evaluation of reliable methods to estimate population size and population trend should be given high research priority.

When a new conservation strategy is implemented, one of the most essential programs that has to be put into place is a plan for monitoring the state of the environmental components and the positive and negative aspects of the strategy's application. Monitoring is essential for evaluating the progress of the new course, for adjusting and correcting erroneous actions, and for suggesting new ones. A monitoring program must be implemented at the same time as other actions called for by this Action Plan.

4.8.8. Prevention and limitation of damages

Methods to limit the conflict between wolverines and humans (such as sheep farmers, semi-domestic reindeer herders) should be developed further.

4.8.9. Wolverine genetics

While habitat reduction and human interference are the most immediate problems facing the wolverine, the possible implications of low genetic diversity should be considered in any long-term management plan. Nuclear DNA based studies could provide more information on diversity trends and mating and dispersal strategies, especially given that males usually disperse further from their natal range than females. The continued application of genetic testing should not only enhance our knowledge of the wolverine, but also a greater ability to ensure its long-term survival.

4.8.10. Intra-guild studies

The nature of wolverine interactions with other large carnivores (wolf, lynx, and brown bear) requires further study. Most authors stress the importance of other large carnivores as food providers for the scavenging wolverine. This knowledge is so far based on anecdotal observations of wolverines scavenging remainders of wolf and lynx kills.

Actions

4.8.1 Co-ordinate scientific research on wolverines at the Fennoscandian level, and maintain a close link among other researchers working on wolverines in North America.

4.8.2 Co-ordinate the regular gathering of all necessary data to monitor the status of wolverines in the Fennoscandian countries.

5. Required actions by country

5.1. Sweden

- Action 4.1.1 The Bern Convention adopts this Action Plan.
- Action 4.1.2 Wolverine conservation status should be listed according to the IUCN criteria and based on comparable population estimation methods.
- Action 4.1.3 All countries identify and establish national large carnivore management groups and management plans. Countries sharing wolverine populations produce these national management plans co-operatively.
- Action 4.1.4 Protection of wolverines by law, and hunting should only be allowed in populations that are documented to be viable and hunting is used to reach population goals identified by management plans.
- Action 4.1.5 Intensification of law enforcement and appropriate penalties in areas where poaching is identified as an important threat or limiting factor for the population.
- Action 4.3.1 Classification of areas within present and possible wolverine range according to their suitability and importance as wolverine habitat.
- Action 4.3.2 Identify and maintain linkage zones in fragmented populations.
- Action 4.3.3 Evaluating of impact of existing and planned infrastructure within wolverine range and mitigation of negative impacts.
- Action 4.3.4 Control or prohibition of human activities detrimental to wolverines or their prey in wolverine core areas and linkage zones.
- Action 4.4.1 Improving existing compensation programs.
- Action 4.4.3 Regulated hunting in viable populations where hunting is listed as an action to reach the population / management goal.
- Action 4.5.1 Identify problem individuals.
- Action 4.5.2 Removal of problem wolverines in viable populations if preventive efforts have failed.
- Action 4.5.3 Evaluation of costs and benefits before removing problem wolverines in threatened populations.
- Action 4.6.1 Identification and involvement of public opinion leaders and stakeholders in wolverine management.
- Action 4.6.2 Establishment of consultation protocol when necessary with locals about their needs and necessary management actions.
- Action 4.7.1 Initiate information campaigns designed for different target groups.
- Action 4.8.1 Co-ordinated scientific research on wolverines in Fennoscandia.
- Action 4.8.2 Co-ordinate the regular gathering of all necessary data to monitor the status of wolverines in the Fennoscandian countries.

5.2. Norway

- Action 4.1.1 The Bern Convention adopts this Action Plan.
- Action 4.1.2 Wolverine conservation status should be listed according to the IUCN criteria and based on comparable population estimation methods.
- Action 4.1.3 All countries identify and establish national large carnivore management groups and management plans. Countries sharing wolverine populations produce these national management plans co-operatively.
- Action 4.1.4 Protection of wolverines by law, and hunting should only be allowed in populations that are documented to be viable and hunting is used to reach population goals identified by management plans.
- Action 4.1.5 Intensification of law enforcement and appropriate penalties in areas where poaching is identified as an important threat or limiting factor for the population.
- Action 4.2.1 Identify and increase viability of small isolated populations through augmentation.
- Action 4.3.1 Classification of areas within present and possible wolverine range according to their suitability and importance as wolverine habitat.
- Action 4.3.2 Identify and maintain linkage zones in fragmented populations.
- Action 4.3.3 Evaluating of impact of existing and planned infrastructure within wolverine range and mitigation of negative impacts.
- Action 4.3.4 Control or prohibition of human activities detrimental to wolverines or their prey in wolverine core areas and linkage zones.
- Action 4.4.1 Improving existing compensation programs.
- Action 4.4.2 Link of compensation programs to the individual farmer's use of preventive measures.
- Action 4.4.3 Regulated hunting in viable populations where hunting is listed as an action to reach the population / management goal.
- Action 4.5.1 Identify problem individuals.
- Action 4.5.2 Removal of problem wolverines in viable populations if preventive efforts have failed.
- Action 4.5.3 Evaluation of costs and benefits before removing problem wolverines in threatened populations.
- Action 4.6.1 Identification and involvement of public opinion leaders and stakeholders in wolverine management.
- Action 4.6.2 Establishment of consultation protocol when necessary with locals about their needs and necessary management actions.
- Action 4.7.1 Initiate information campaigns designed for different target groups.
- Action 4.8.1 Co-ordinated scientific research on wolverines in Fennoscandia.
- Action 4.8.2 Co-ordinate the regular gathering of all necessary data to monitor the status of wolverines in Fennoscandia.

5.3. Finland

- Action 4.1.1 The Bern Convention adopts this Action Plan.
- Action 4.1.2 Wolverine conservation status should be listed according to the IUCN criteria and based on comparable population estimation methods.
- Action 4.1.3 All countries identify and establish national large carnivore management groups and management plans. Countries sharing wolverine populations produce these national management plans co-operatively.

- Action 4.1.4 Protection of wolverines by law, and hunting should only be allowed in populations that are documented to be viable and hunting is used to reach population goals identified by management plans.
- Action 4.1.5 Intensification of law enforcement and appropriate penalties in areas where poaching is identified as an important threat or limiting factor for the population.
- Action 4.2.1 Identify and increase viability of small isolated populations through augmentation.
- Action 4.3.1 Classification of areas within present and possible wolverine range according to their suitability and importance as wolverine habitat.
- Action 4.3.2 Identify and maintain linkage zones in fragmented populations.
- Action 4.3.3 Evaluating of impact of existing and planned infrastructure within wolverine range and mitigation of negative impacts.
- Action 4.3.4 Control or prohibition of human activities detrimental to wolverines or their prey in wolverine core areas and linkage zones.
- Action 4.4.1 Improving existing compensation programs.
- Action 4.4.3 Regulated hunting in viable populations where hunting is listed as an action to reach the population / management goal.
- Action 4.5.1 Identify problem individuals.
- Action 4.5.2 Removal of problem wolverines in viable populations if preventive efforts have failed.
- Action 4.5.3 Evaluation of costs and benefits before removing problem wolverines in threatened populations.
- Action 4.6.2 Establishment of consultation protocol when necessary with locals about their needs and necessary management actions.
- Action 4.7.1 Initiate information campaigns designed for different target groups.
- Action 4.8.1 Co-ordinated scientific research on wolverines in Fennoscandia.
- Action 4.8.2 Co-ordinate the regular gathering of all necessary data to monitor the status of wolverines in the Fennoscandian countries.

6. References

Aanes, R., Swenson, J.E. & Linnell, J.D.C. 1996: Rovvilt og sauenæring i Norge. 1. Tap av sau til rovvilt; en presentasjon av tapets omfang basert på brukeropplysninger. (In Norwegian with English summary: Carnivores and sheep farming in Norway. 1. Loss of sheep due to large depredation; a presentation of the magnitude of loss based on information from sheep farmers.) - NINA Oppdragsmelding 434: 1-46.

Bjärvall, A. & Lindström, D. 1991: Vinterens däggdjur och fåglar i Fjällvärlden, en 10-årigskoterinventering i Norrbotten ovan odlingsgränsen. - Naturvårdsverket. Sweden, Rapp. 3919: 134 pp. (In Swedish).

Bjärvall, A., Franzén, R., Nordqvist, M. & Åhman, G. 1990: Renar och rovdjur, rovdjurens effekter på rennärningen. Naturvårdsverket, Solna. 296 pp. (In Swedish).

Banci, V. 1987: Ecology and behaviour of wolverines in Yukon. M. S. Thesis, Simon Fraser University. Vancouver, British Columbia, Canada. 177 pp.

Banci, V. 1994: The scientific basis for conserving forest carnivores, American marten, fisher, lynx, and wolverine, in the western United States. - USDA Forest Service. General Technical Report RM-254: pp. 99-127.

Banci, V. & Harestad, A. 1988: Reproduction and natality of wolverine (*Gulo gulo*) in Yukon. - Annales Zoologici Fennici 25: 265-270.

Becker, E.F. 1991: A terrestrial furbearer estimator based on probability sampling. - Journal of Wildlife Management 55: 730-737.

Bergström, M.R., Bø, T., Franzèn, R., Henriksen, G., Nieminen, M., Overrein, Ø. & Stensli, O.M. 1993: Bjørn, gaupe, jerv og ulv på Nordkalotten. Nordkallottkomiteens rapportserie 30: 1-56. (In Norwegian with English summary).

Bergström, M.R., Bø, T., Franzèn, R., Henriksen, G., Nieminen, M., Overrein, Ø. & Stensli, O.M. 1994: Forslag til samordna bestands-overvåking av bjørn, gaupe, jerv og ulv på Nordkalotten. Nordkallottkomiteens rapportserie 34: 1-60. (In Norwegian with English summary).

Bevanger, K. 1992: Report on the Norwegian wolverine (Gulo gulo L.). - Small Carnivore Conservation 6: 8-10.

Brehm, A.E. 1873: Pattedyrenes liv. P.G. Philiplens Forlag, Kjøbenhavn, Denmark, pp. 279- 281 (In Danish).

Bø, T. & Schølberg, E. 1990: Rovdyr, bufe og tamrein i Nordland. Fylkesmannen i Nordland. - Rapport 7: 1-33. (In Norwegian).

Caro, T. M. 1994. Cheetahs of the Serengeti Plains. - Chicago University Press, Chicago.

Caughley, G. 1977. Analysis of vertebrate populations - Chichester: Wiley.

Caughley, G. 1994. Directions in conservation biology. - J. Anim. Ecol. 63: 215 - 244.

Caughley, G. & Sinclair, A.R.E. 1994. Wildlife ecology and management. - Blackwell Science, Camebridge, Massachusetts, USA.

Caughley, G. & Gunn, A. 1995. Conservation biology in theory and practice. - Blackwell Science, Camebridge, Massachusetts, USA.

Clark, T.W., Curlee, A.P. & Reading, R.P. 1996. Crafting effective solutions to the large carnivore conservation problem. - Cons. Biol. 10: 940-948.

Craighead, J.J, Varney, J.R. & Craighead, F.C. Jr. 1974. A population analysis of Yellowstone grizzly bears. - Bull. 40. Montana Forestry and Conservation Experiment Station, Missoula, Montana.

Creel, S. & Creel, N.M. 1996. Limitation of African wild dogs by competition with larger carnivores. - Conser. Biol. 10: 526-538.

Copeland, J. 1996. Biology of the wolverine in central Idaho. M.S. Thesis, University of Idaho, Moscow. 138 pp.

Copeland, J.F., Cesar, E., Peek, J.M., Harris, C.E., Long, C.D. & Hunter, D.L. 1995: A live trap for wolverine and other forest carnivores. - Wildlife Society Bulletin 23: 535-538.

Duffy, A.J., Landa, A., O'Connel, M.O., Lindén, M. and Wright, J.M. (In prep.) Genetic variability and population differentiation in Scandinavian wolverines.

Eisenberg, J.F. 1989: An introduction to the Carnivora. In: Gittleman, J.L. (ed.); Carnivore behaviour, ecology

and evolution. Cornell University Press, N. Y., pp. 1-10.
Gudvangen, K. 1995: Jerv (*Gulo gulo)* og tap av sau *(Ovis aries)* i Snøhettaområdet. M. Sc. Thesis, University of Trondheim, Norway. pp 1-28. (In Norwegian).
Haglund, B. 1966: Winter habits of the Iynx (Lynx Iynx L.) and wolverines (Gulo gulo L.) as revealed by tracking in the snow. - Viltrevy 4: 81-310. (In Swedish with English summary).
Hastings, A. 1991. Structured models of metapopulation dynamics. Biological Journal of the Linnean Society, 42:57-71.
Hornocker, M.G. & Hash, H.S. 1981: Ecology of the wolverine in north-western Montana. - Canadian Journal of Zoology 59: 1286-1301.
IUCN. 1996: 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland, 368 pp.
Kucera, T.E. & Zielinski, W.J. 1995: The case of the forest carnivores: small packages, big worries. - Endangered Species Update 12: 1-7.
Landa, A. 1992: Tetthetsavhengighet og betydning av størrelse i reproduksjonen hos jerv (Gulo gulo) i Norge. M. Sc. Thesis, University of Trondheim, Trondheim, Norway. 39 pp. (In Norwegian).
Landa, A. 1997: The relevance of life history theory to harvest and conservation. – Fauna nor. Ser. A 18:43-55.
Landa, A. 1997: Wolverines in Scandinavia: Ecology, sheep depredation and conservation. PhD thesis, Norwegian University of Science and Technology, 28 pp + papers.
Landa, A., & Skogland, T. 1989: Bestandstelling av jerv i Snøhetta og omliggende fjell vinteren 1989. Norwegian Inst. Nature Res., Oppdragsmelding 11. (In Norwegian).
Landa, A. & Skogland, T. 1995: The relationship between population density and body size of wolverines in Scandinavia. - Wildlife Biology 1: 165-175.
Landa, A. & Tømmerås, B.Å. 1996: Do volatile repellents reduce wolverine predation on sheep? - Wildlife Biology 2: 119-126.
Landa, A., Strand, O., Swenson, J.E. & Skogland, T. 1997: Wolverines and their prey in southern Norway - Canadian Journal of Zoology 75: 1292 - 1299.
Landa, A., Strand, O., Linnell, J.D.C. & Skogland, T. 1998: Home range size and habitat selection for arctic foxes and wolverines in an alpine environment. - Canadian Journal of Zoology 76: 448-457.
Landa, A., Krogstad, S., Tømmerås, B.Å. & Tufto, J. 1998: Do volatile repellents reduce wolverine *Gulo gulo* predation on sheep? Results of a large-scale experiment. – Wildlife Biology 4: 111-118.
Landa, A., Tufto, J. Franzén, R., Bø. T., Lindén, M. & Swenson, J.E. 1998: Active wolverine dens as a minimum population estimator in Scandinavia. – Wildlife Biology 4: 159-168.
Landa, A., Gudvangen, K., Swenson, J.E. and Røskaft, E. 1999. Factors associated with wolverine *Gulo gulo* predation on domestic sheep in south-central Norway. Journal of Applied Ecology 36: 1-12.
Lee, J. & Niptanatiak, A. 1996: Observation of repeated use of a wolverine, Gulo gulo, den on the tundra of the Northwest Territories. - Canadian Field-Naturalist 110: 349-350.
Lindén, M., Segerström, P. & Stuge, J. 1996: Det svenska järvprosjektet - ekologi och bevarande, Årsrapport 1996, 4 pp (In Swedish).
Linnell, J. D. C., Aanes, R., Swenson, J. E., Odden, J. & Smith, M. E. 1997: Translocation of carnivores as a method for managing problem animals: a review. – Biodiversity and Conservation 6: 1245-1257.
Linnell, J. D. C., Smith, M. E., Odden, J., Kaczensky, P., Swenson, J. E. 1996. Strategies for the reduction of carnivore-livestock conflicts: a review. Norwegian Institute of Nature Research Oppdragsmelding 443: 1-118.
Liskop, K.S., Sadleir, R.M.F.S. & Saunders, B.P. 1981: Reproduction and harvest of wolverines (*Gulo gulo L.*) in British Columbia. In: Chapman, J.A. & Pursley, D. (eds.) Proceedings of the Worldwide Furbearer Conference, Worldwide Furbearer Conference. Frostburg, Maryland, pp. 469-477.
Lönnberg, E. 1936. Bidrag til järvens historia i Sverige. - K. Svenska vetenskapsakademiens skrifter i naturskyddsärenden, Nr. 32: 1-38.
MacArthur, R.H. and Wilson, E.O. 1967. The theory of island biogeography. Princeton University Press, Princeton.
Magoun, A.J. 1985: Population characteristics, ecology and management of wolverine in northwestern Alaska. Ph.D. Thesis. University of Alaska. Fairbanks, Alaska, USA, 197 pp.

Magoun, A.J. 1987: Summer and winter diets of wolverines, *Gulo gulo*, in arctic Alaska. - Canadian Field-Naturalist 191: 392-397.

Miljøverndepartementet 1997: St. meld. nr 35 (1996-97) Om rovviltforvaltning. Pp. 1-131. (In Norwegian).

Ministry of Agriculture and Forestry. 1997: Management of bear, wolf, wolverine and lynx in Finland. Report of the working group for large terrestrial carnivores, Helsinki, Finland, MMM:n julkaisuja 6a, 50 pp.

Myhre, R. 1968: Jerven i Norge, aldersanalyse, reproduksjon og ernæring, Gulo gulo (L). M. Sc. Thesis, University of Oslo, Norway. 72 pp. (In Norwegian).

Myrberget, S. 1968: Jervens ynglehi (In Norwegian with English summary: The breeding den of the wolverine (Gulo gulo)) - Fauna 21: 108-115.

Novikov, B.V. 1994: The modern state of the population and numbers of the wolverine. - Luteola 3: 22-27.

Pasitschniak-Arts, M. & Larivière, S. 1995: Mammalian Species, Gulo gulo, The American Society of Mammalogists 499: 1-11.

Pulliainen, E. 1968: Breeding biology of the wolverines (Gulo gulo) in Finland. - Annales Zoologici Fennici 5: 338-344.

Rausch, R.A. & Pearson, A.M. 1972: Notes on the wolverine in Alaska and the Yukon Territory. - Journal of Wildlife Management 36: 249-268.

Sandell, M. 1989: The mating tactics and spacing patterns of solitary carnivores. - In: Gittleman, J.L. (ed.); Carnivore behaviour, ecology, and evolution, Cornell University Press, N. Y., pp. 164-182.

Semenov-Tyan-Shanskii, O., 1987. (originally published in Russian; Murmansk 1982) Pattedyrene på Kola. - Fylkesmannen i Finnmark, Rapp. nr. 25: 93-98.

Swenson, J.E., Wabakken, P., Sandegren, F., Bjärvall, A., Franzèn, R. & Söderberg, A. 1995: The near extinction and recovery of brown bears in Scandinavia in relation to the bear management policies of Norway and Sweden. - Wildlife Biology 1: 11-25.

Swenson, J.E., Sandegren, F., Söderberg, A., Bjärvall, A., Franzén, R. & Wabakken, P. 1997: Infanticide caused by hunting of male bears. - Nature 386: 450-451.

Tapper, S. & Reynolds, J. 1996: The wild fur trade: historical and ecological perspectives.In: Taylor, V.J. & Dunstone, N. (eds.): The exploitation of mammal populations Chapman & Hall, London, pp. 28-44.

Wabakken, P., Kvam, T. & Sørensen, O.J. 1984: Wolves *Canis lupus* in southeastern Norway. - Fauna Norvegica Series A, 50-52.

Wabakken, P. & Maartmann, E. 1997: Bestandsstatus for ulv i Sørøst-Norge og Skandinavia i 1996. Rapport nr. 8/97, Fylkesmannen i Hedmark 22pp. (In Norwegian).

Weber, W. & Rabinowitz, A. 1996: A global perspective on large carnivore conservation. -Conservation Biology 10: 1046-1054.

Whitman, J.S. & Ballard, W.B. 1984: Susitna hydroelectric project, Phase II, final rep., vol. VII, Alaska Department of Fish and Game, Anchorage, USA.

Zielinski, W.J. & Kucera, T.E. 1995: American marten, fisher, lynx and wolverine: survey methods for their detection. - Gen. Tech. Rep. PSW-GTR-157. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, 163 pp.

8. Tables

Table 1. The present status, distribution and expected population trend of the European wolverine populations covered by this Action Plan (including continuous populations outside the countries covered by the Action Plan).

Population in	Numbers	Total area km^2	Densities Number of ind/100 km^2	Estimation method	Present status / expected trend
Sweden	265	?	0.20-1.5?	Number of active natal dens	Stable/increase
Norway		?			
Northern Norway	120		0.20-1.0?	Number of active natal dens	Decreasing?
South-central Norway	30	13,500	0.20-0.40	Number of active natal dens	Stable / increase
Finland	110-120	65.000	0.10-0.40	Tracs/observations/index	Stable / increase
Russia	1,500	?	0.10-2.5	Index / movement rates	Decreasing?

Table 2. Damage prevention and compensation for wolverines in Fennoscandia.

Country	Losses sheep	Losses domestic reindeer	Compensated		Total paid in 1996/97 (ECU)		Total claim 1996/97 damage (ECU)		Prevention methods
			Sheep	Reindeer	Sheep	Reindeer	Sheep	Reindeer	
Sweden	0	3400	0	3400*	0	753,000*	0	?	Control
Norway	11,623	12,830	7,615	1,722	1,300,000	350,000	2,000,000	2,600,000	Control
Finland	0	1669	0	1669	0	940,000	0	940,000	Translocations

* Long term average yearly claimed losses to wolverine predation. A new compensation system was introduced in 1996 (for number of predators present at grazing grounds).

Table 3. Identified threats to wolverines in present ranges in Fennoscandia.
XX: Serious threat, X: Minor threat, (X): Suspected threat in the future, L: locally restricted threat.

Population	Reindeer herding	Sheep farming	Habitat fragmentation and isolation	Human access to wolverine habitat	Traffic kills	Hunting of wolverines	Legal killing of problem wolverines	Poaching	Negative public attitude	Management fragmentation
Sweden	X			(X)			L	X	L	
Northern Norway	X	X		L		X	L	X	X	X
South-central Norway		XX	XX	X	X	XX	XX*	XX	XX	XX
Northern Finland	X							X		
South-central Finland										

* Inside core conservation area.

Table 4. Legal status and management of wolverines in European countries

Country	Legal status	Bern Conv.	Institution in charge	Management level (national, regional, local)	Legal kills	Illegal kills	Management plan
Sweden	Year round protection	Yes	Swedish Env. Protection Agency	National	Yes	Yes	In prep.
Norway	Hunted 1.10-15.02	Yes	Norwegian Dir. for Nature and Management	Regional (politically appointed committees)	Yes	Yes	In prep. for the core cons. area
Finland	Year round protection	Yes	Ministry of Agriculture and Forestry	National	No	Yes	Yes

Table 5. Monitoring, information and research

Country	Monitoring	Research	Education programs	Conservation programs
Sweden	Yes	Yes	No	In prep.
Norway	Yes	Yes	No	No
Finland	Yes	No	No	Yes

Figure 1. Distribution of wolverines in Europe in the middle of the 19th century.

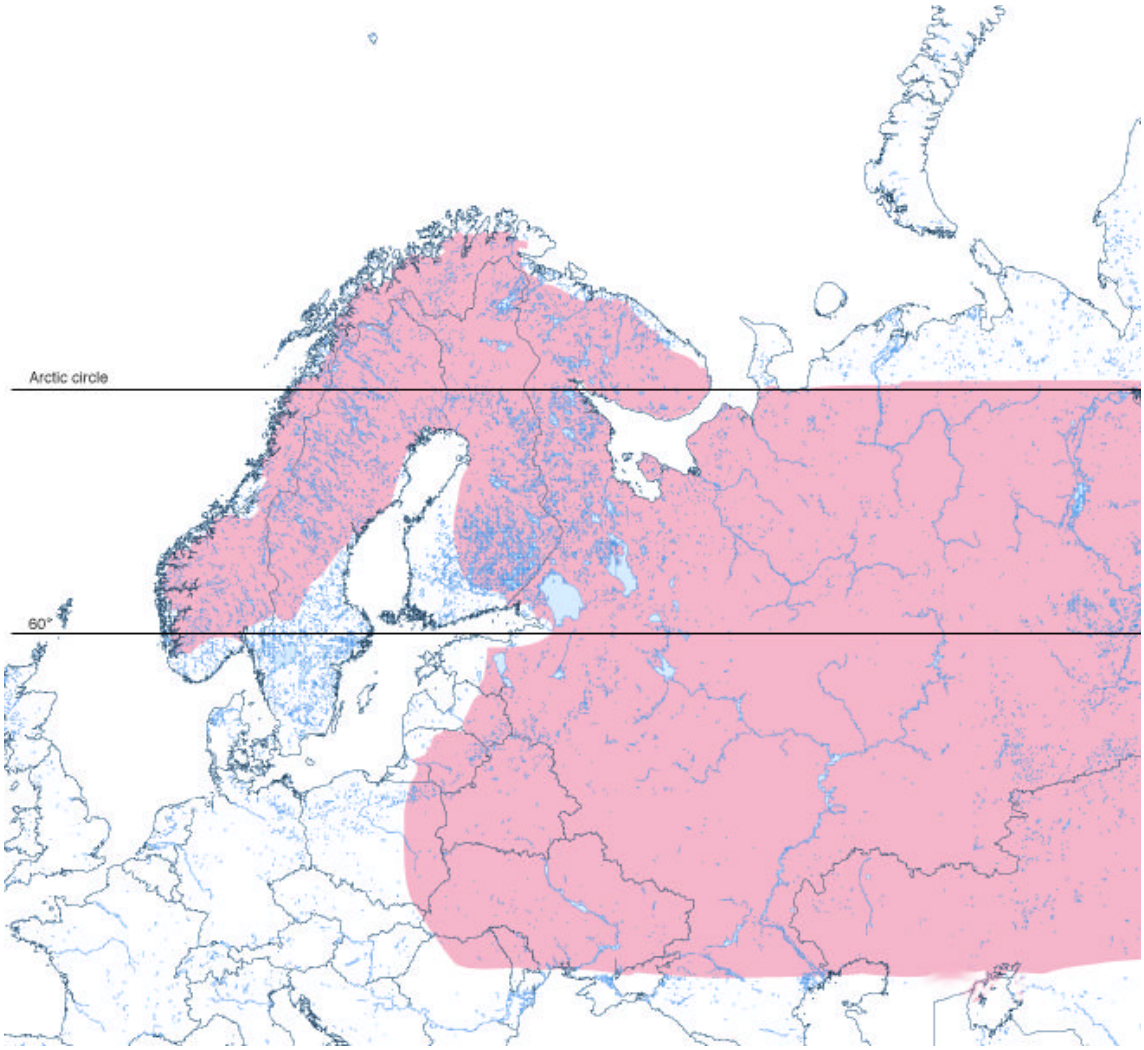

Figure 2. Distribution of wolverines in Europe around 1970, when protection was introduced in Fennoscandia.

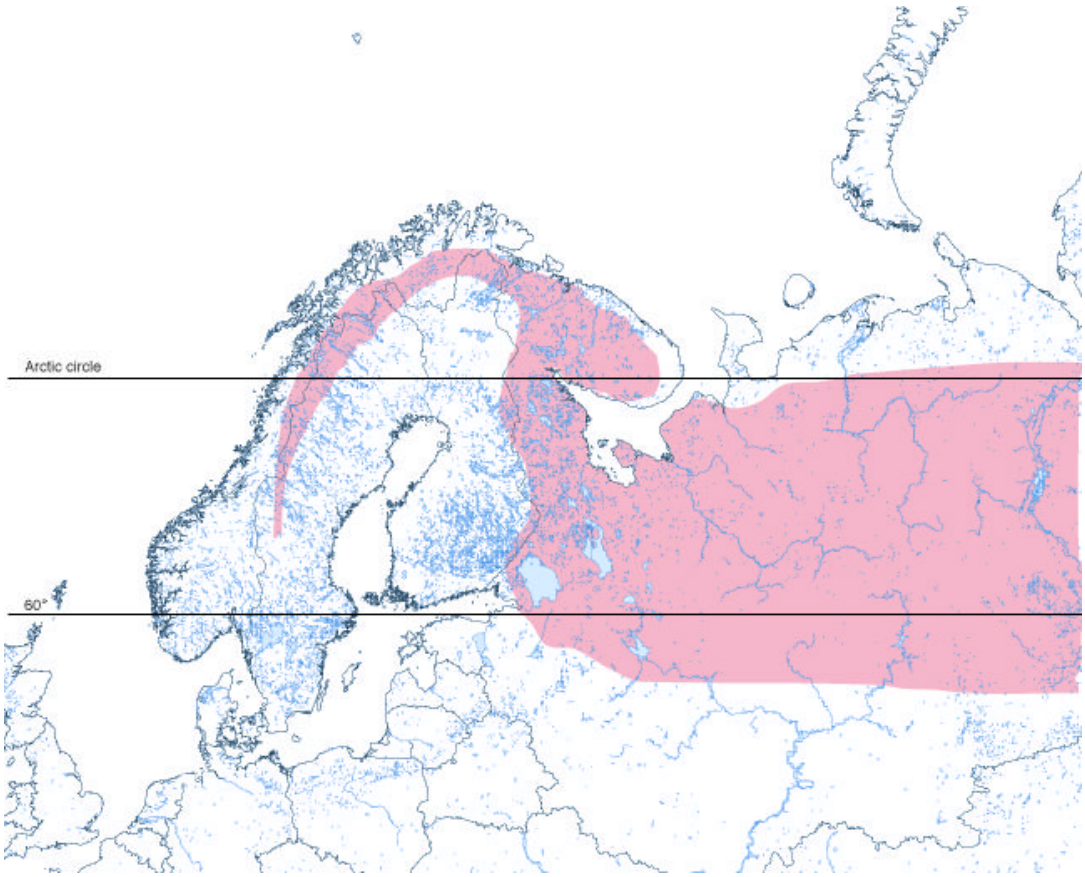

Figure 3. Present distribution of wolverines in Europe.