1st International Symposium on Wolverine Research and Management

Agenda and Abstracts

June 13-15, 2005
Jokkmokk, Sweden

Swedish University of Agricultural Sciences
Wildlife Conservation Society
The Wolverine Foundation, Inc.
Norweigan Institute for Nature Research

Sponsors

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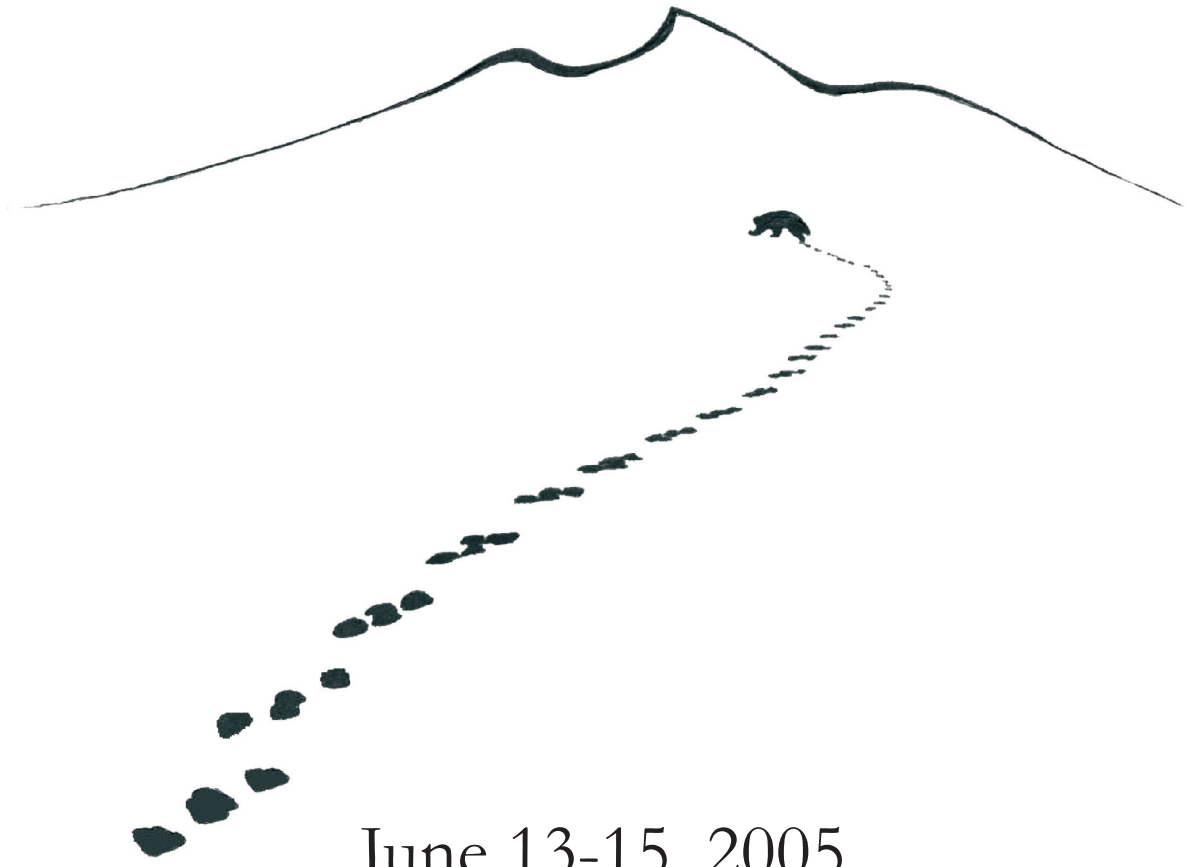

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Contents

Welcome!

We welcome you to the *1st International Symposium on Wolverine Research and Management.* The wolverine is relatively scarce across its circumpolar range, with status ranging from secure to endangered and possibly extinct. There are also conservation and management concerns in most areas where the wolverine occurs. Previously pristine areas within wolverine range are increasingly being opened up to resource extraction and wolverines are living in conflict with sheep and reindeer husbandry. Effective management and conservation plans with a strong scientific basis are therefore essential, but there is still relatively little information on the species in the scientific literature. The last ten years have brought about significant advances in our knowledge about wolverines, from basic ecology to increased understanding of impacts of human disturbance, to the development of increasingly sophisticated monitoring and research tools. To improve wolverine management and conservation, there is a need for collaboration on designing research projects, publishing results, and improving communication among researchers and managers across wolverine range. We are therefore pleased to invite you to the *1st International Symposium on Wolverine Research and Management,* for presentation and discussion of central topics in wolverine biology, management, and conservation.

Sincerely,

The Symposium Organizing Committee

Audrey Magoun *Jens Persson* *Camilla Wikenros*

Roel May *Justina Ray*

Objectives

The overarching aim of the *1st International Symposium on Wolverine Research and Management* is to provide a forum for scientists, managers and stakeholders, to share contemporary scientific information on wolverine ecology, behaviour, and management:

Particular objectives of the symposium are to:

- Provide a forum to assess the current status and distribution of wolverines in the world.
- Identify and present the frontline in current research and knowledge on wolverine biology.
- Facilitate international information exchange on wolverine biology and management to achieve increased efficiency and cooperation in and among current and future research projects.
- Identify current conservation and management issues and the methods to address them.
- Introduce an arena for network building among managers and researchers.
- Provide advice for future research.
- Achieve worldwide focus on the wolverine as an integral part of northern ecosystems, as well as on research, conservation, and management of the species.

Acknowledgements

The *1st International Symposium on Wolverine Research and Management* began as simple discussions several years ago. Finally, it has become reality. This is thanks to several individuals who have committed their time and efforts to make this happen. Clint Long was one of the original catalysts for discussions that led to this international symposium on wolverines. In addition, Clint and Judy Long were instrumental in coordinating the attendance of North American symposium participants and keeping the information flowing on The Wolverine Foundation, Inc. website. We regret that they are not able to attend the symposium after all their hard work, and we thank them for their efforts and their continuing keen interest in the symposium. We are grateful to our webmaster Mona HansErs and to Åke Aronson for the symposium logo. A note of appreciation is extended to Ola Larsson and Mark Kissinger from The County Administrative Board of Norrbotten, as well as c/o Sápmi for organizing the symposium excursion. Finally, our sincerest thanks to everybody, mentioned and unmentioned, from Jokkmokk to Alaska and Siberia, who have assisted with advice and support on the way.

Hosting an international symposium is a costly event and would not become reality without a number of financiers who acknowledged the importance of this meeting. The Scandinavian agencies: Swedish Environmental Protection Agency, Norwegian Directorate for Nature Management, WWF Sweden, and The Research Council of Norway provided early assurance of the main funding of the symposium. Important financial support was also provided by the Wildlife Conservation Society, The Wolverine Foundation Inc., National Park Service (USA), and Ontario Living Legacy Trust. The County Administrative Board of Norrbotten and Municipality of Jokkmokk sponsored the banquet and the ice-breaker, respectively.

Congress Organizers

Organizing Committee

Jens Persson (*Chair*) – Swedish University of Agricultural Sciences, Sweden

Audrey Magoun – The Wolverine Foundation, Inc., USA

Roel May – Norwegian Institute for Nature Research, Norway

Justina Ray – Wildlife Conservation Society Canada

Camilla Wikenros – Swedish University of Agricultural Sciences, Sweden

Scientific Committee

Jens Persson (*Chair*) – Swedish University of Agricultural Sciences, Sweden

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Justina Ray (*Co-chair*) – Wildlife Conservation Society Canada

Kjell Danell – Swedish University of Agricultural Sciences, Sweden

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Vemund Jaren – Norwegian Directorate for Nature Management, Norway

Arild Landa – Norwegian Institute for Nature Research, Norway

Michael Schneider – County Administrative Board of Västerbotten, Sweden

Rosie Woodroffe – University of California, USA

Symposium Schedule

Sunday, June 12 – Excursion and icebreaker

08:00–17:30	Symposium excursion to Kvikkjokk and Mount Snjerak
19:00–22:00	Icebreaker and registration at Ájtte (The Swedish Mountain and Sámi Museum)

Monday, June 13 – Status and distribution

08:00	Registration at Folkets Hus (The Community Hall)
09:00	**Welcome and opening remarks**
	Status and distribution
09:25	Introduction (Chair: *Jeffrey Copeland*)
09:30	Status and distribution of wolverines, *Gulo gulo,* in Sweden – *Ola Larsson*
09:40	Status and distribution of wolverines in Norway – *Jiska van Dijk*
09:50	Status of wolverines in Finland – *Ilpo Kojola*
10:00	The contemporary condition of wolverine populations and numbers in Russia – *Boris Novikov*
10:20	**Break**
10:50	The status of the wolverine population in China – *Minghai Zhang*
11:10	Geographic distribution of the wolverine in the United States: an historical analysis – *Keith Aubry*
11:30	Status and distribution of the wolverine, *Gulo gulo*, in Canada – *Brian Slough*
11:50	Status and recovery of the endangered wolverine in eastern Canada – *Isabelle Schmelzer*
12:00	Discussion
12:30	**Lunch**
	Monitoring methods
13:50	Introduction (Chair: *Henrik Andrén*)
13:55	Monitoring wolverine natal dens in Scandinavia – *Henrik Brøseth*
14:15	A ground-based technique, using tracks in the snow, to estimate wolverine density – *Earl Becker*
14:35	Estimating wolverine population size using quadrat sampling of tracks in snow – *Howard Golden*
14:55	Monitoring populations of rare and elusive animals – *Kevin McKelvey*
15:15	Non-invasive monitoring of wolverines in southern Scandinavia – *Øystein Flagstad*
15:35	**Break**
16:05	The efficacy of using snow tracks in providing genetic data from wolverine and other carnivores – *Todd Ulizio*
16:25	Using genetic analysis to estimate wolverine abundance in northern Canada – *Robert Mulders*
16:45	A Wolverine Information System for Europe (WISE) – *Manuela von Arx*
17:05–18:00	Discussion
19:30-	**Pub evening at Hotel Jokkmokk**

Tuesday, June 14 – Ecology

Ecology

08:30 Introduction (Chair: *Audrey Magoun*)

Research methods

08:35 Anaesthetic and surgical protocols for implantation of intraperitoneal radiotransmitters in free-ranging wolverines (*Gulo gulo*) – *Jon Arnemo*

08:55 Physiological parameters during anaesthesia of free-ranging wolverines (*Gulo gulo*) in Sweden – *Åsa Fahlman*

Behavioural ecology and demography

09:05 Demography – life and death in a wolverine population – *Jens Persson*

09:25 Maternal care in wolverines: early breeding and central-foraging strategies enhance fast growth, survival, and independence of cubs – *Arild Landa*

09:45 Wolverine den and kit rendezvous sites in Glacier National Park, Montana – *Richard Yates*

10:05 **Break**

10:35 Spatial ecology and habitat selection of reproductive wolverine females – *Glenn Mattsing and Per Wedholm*

10:55 Dispersal behaviour of wolverines – *Jens Persson*

11:15 Discussion

Feeding and community ecology

11:35 Introduction (Chair: *Eric Lofroth*)

11:40 Lynx-wolverine interaction: the combined effect of a specialist predator and a generalist predator on a common prey – *Henrik Andrén and Anna Danell*

12:00 Wolverine foraging behaviour during the winter season in the boreal forests of southern Norway – *Jiska van Dijk*

12:20 The effect of intra-guild species on wolverine prey availability and diet – *Line Gustavsen*

12:40 **Lunch**

14:00 Moose (*Alces alces*) mortality caused by wolverines in the forest zone of Krasnoyarsk Territory, Russia – *Vladimir Kozhechkin*

14:30 Wolverine diet in north-western Alaska: the importance of migratory caribou – *Fredrik Dalerum*

14:50 Discussion

Habitat

15:10 Introduction (Chair: *Michael Schneider*)

15:15 Wintering habitat selection and den of wolverine in the Great Khingan mountains, China – *Minghai Zhang*

15:35 Modeling wolverine habitat relationships in central Idaho – *Jeffrey Copeland*

15:55 **Break**

16:25 Identification and conservation of wolverine reproductive den habitat in British Columbia, Canada – *John Krebs*

16:45 Spatio-temporal organisation in wolverines in relation to resource distribution – *Arild Landa*

17:05 Home range characteristics of wolverines in north-western Ontario, Canada – *Neil Dawson*

17:25 Wolverine distribution and movements relative to landscape features in the Pioneer, Flint, and Anaconda/Pintler Mountains of south-western Montana, USA: preliminary results – *Todd Ulizio*

17:45-18:20 Discussion

19:30- **Banquet at Hotel Gästis**

Wednesday, June 15 – Management and conservation

Management and conservation

08:30	Introduction (Chair: *Terje Bø*)
08:35	Conservation and management of the wolverine, *Gulo gulo*, in Canada – *Brian Slough*
09:00	Wolverine conservation and ecology in the United States: studies we can do versus studies we must do – *Jeffrey Copeland*
09:25	Scandinavian wolverines in the east - past and present wolverine management in Sweden – *Susanna Löfgren*
09:45	Management of Scandinavian wolverines in the west - national population goals, regional authority, and legal hunting in Norway– *Morten Kjørstad*
10:05	Discussion
10:35	**Break**

Management and human dimensions

11:05	Introduction (Chair: *Justina Ray)*
11:10	Wolverines and reindeer herding - indigenous participation in the co-management of carnivores – *Lars-Anders Baer*
11:30	Towards a more regional management of the wolverine in Sweden – *Michael Schneider*
11:45	Who are willing to pay for wolverines? Results from a unique national survey – *Jonas Kindberg*
12:00	Cultural relationships of northern trappers with wolverines: a case study from Ontario – *Justina Ray*
12:20	Inuit traditional knowledge of kalvik (wolverine) in Nunavut, Canada – *Vivian Banci*
12:35	Discussion
13:00	**Lunch**

Harvest and development impacts on wolverines

14:15	Introduction (Chair*: Howard Golden)*
14:20	Wolverine habitat use in multiple use landscapes in British Columbia, Canada – *Eric Lofroth*
14:40	Impact of infrastructure on habitat selection of wolverines – *Roel May*
15:00	Wolverines and winter recreation in the Greater Yellowstone Ecosystem – *Robert Inman*
15:20	**Break**
15:50	Population distribution and harvest of wolverines in British Columbia – *Eric Lofroth*
16:10	Wolverine harvest in Alaska: an analysis of spatial and temporal patterns – *Howard Golden*
16:30	Discussion
17:00	*Key note presentation*: The fourth bear cub: perspectives on wolverine research from a bear researcher – *Jon Swenson*
18:00-18:10	**Closing remarks**

Poster Schedule

(Posters will be given special attention in connection with the separate sessions and be posted during the entire symposium.)

Monday, June 13 – Status and distribution

Status and distribution

- The current distribution of the wolverine – an interactive poster for refining knowledge of the species' world-wide distribution – *Cheryl Copeland*
- Historical changes in wolverine distribution in Ontario, Canada – *Neil Dawson*
- A review of the condition of the wolverine in northern European Russia – *Olga Makarova*
- Using genetic analysis to estimate wolverine abundance in northern Canada – *Robert Mulders*
- Wolverines at the southern limit of distribution in Ontario: preliminary results from 2005 aerial surveys – *Justina Ray*
- Occurrence and distribution of wolverines in Labrador, Canada: an aerial survey to clarify status and focus recovery – *Isabelle Schmelzer*

Monitoring methods

- An assessment of methods for detecting wolverines in boreal forest – *Jeff Bowman*
- Using trapper knowledge to monitor trends of wolverine, *Gulo gulo*, in the Yukon, Canada – *Thomas Jung*
- A method of identifying individual wolverines using remote cameras – *Audrey Magoun*
- An aerial survey technique for monitoring wolverine distribution and relative abundance over large areas – *Audrey Magoun*

Tuesday, June 14 – Ecology

Methods

- Non-invasive monitoring of testosterone, estrogen, progesterone, and corticosterone in wolverines through metabolites in faeces – *Fredrik Dalerum*
- Modified log live-trap for wolverine – *Eric Lofroth*

Behavioural ecology and demography

- Microsatellite markers do not suggest sex-biased dispersal in a solitary carnivore, the wolverine – *Fredrik Dalerum*
- Paternity analysis in Scandinavian wolverines – *Eva Hedmark*
- Territorial behavior of the male and female wolverines in the pre-reproductive period – *Vladimir Kozhechkin*
- Yukon North Slope Wolverine Study, 1993-94 – *Dorothy Cooley*

Feeding and community ecology

- Food habits of wolverine, *Gulo gulo*, in montane ecosystems of British Columbia – *Eric Lofroth*
- Food availability and the viability of North American wolverine populations – *Donald Reid*
- Wolverine predation on moose in North America – *Audrey Magoun*

Wednesday, June 15 – Management and conservation

Management and human dimensions

- Using traditional knowledge to assess the status of species at risk - a case study of wolverine in northern Canada – *Nathan Cardinal*

Oral Abstracts

(In order of Symposium Schedule)

Monday, June 13 – Status and distribution

Status and distribution of wolverines, *Gulo gulo,* in Sweden

Larsson, Ola

The Swedish wolverine population is monitored through annual den inventories. National inventories during the years 2000-2004 have documented between 42 and 70 reproductions annually. The result for 2004 was 70 reproductions and the total number of adult animals is estimated at 380. Population data for the past 9 years (1996-2004) suggest a fairly stable population, with a slight increase in the past 5 years. The wolverine is not subjected to hunting. Official hunting statistics from the 53 years prior to the protection of the species in 1969 show an average annual harvest of 44 wolverines. The Swedish wolverine population has its main distribution in mountains and adjacent boreal forests. Single animals are found throughout the forested landscapes of the boreal region of the country. A small reproducing population became established in the 1990s in the southern boreal region of the country some 80 km from the Baltic Sea coast. The wolverine is currently classified as endangered on the national red list. Sweden has international obligations through the Bern Convention for the conservation of the European wildlife and habitats, the regulation of trade through the European Council Regulation on the protection of species of wild fauna and flora, and the EU habitats directive.

Status and distribution of wolverines in Norway

van Dijk, Jiska, Henrik Brøseth, Arild Landa, Roy Andersen, and Roel May

Until the beginning of the 20th century, the wolverine was distributed throughout most of the forested and mountain areas as far south as the southernmost counties of Norway. The wolverine population, however, became almost extinct due to hunting and predator removal programs until the protective legislation in 1973 and 1982 in southern Norway and northern Norway respectively. In the late 1970's wolverines re-colonized the Snøhetta plateau in south-central Norway and this population was isolated by about 100 to 200 km from the larger population in northern Norway. The population numbers and distribution in both southern and northern Norway increased following their protection in 1973 and 1982, respectively. Today wolverines can be found again in the mountainous areas in south-central Norway and along the Norwegian-Swedish border from Hedmark county and northwards. Although the wolverine has re-colonized the boreal forests in the south-eastern part of Norway during the last decade, faecal DNA data has identified a clear line that still divides the south Norwegian population into two parts, one to the east and north and the other to south and west. Wolverines in Norway are protected and covered by the Bern Convention that was signed by Norway (Bern 1979) with no reservations for the wolverine, although exceptions may be granted when, for instance, serious damage to livestock must be prevented. In 1993 licensed hunting was introduced and today's population numbers are regulated by licensed hunting during the winter season, damage control permits in specific grazing areas and during specific periods in response to high depredation rates on sheep and domestic reindeer, and by taking out family groups during early spring. In 2004 a new large carnivore management policy was implemented with population goals of 19 and 20 yearly reproductions in southern (the county of Nord-Trøndelag and southwards) and northern Norway, respectively. In 2004, 28 reproductions were documented in southern Norway and 19

reproductions in northern Norway under the national large carnivore monitoring program. Based on the numbers of reproductions, the total wolverine population in Norway was estimated at 264 (± 33.4 SE) adult wolverines in 2004 (130 adults in southern Norway and 134 adults in northern Norway).

Status of wolverines in Finland

Kojola, Ilpo

Wolverines have been fully protected in Finland since 1982. According to official estimates, minimum numbers have increased from 60 to 120 after legal protection. Around half of the Finnish wolverines are living within the reindeer management area in the north, where semi-domesticated reindeer obviously form an important part of the diet. In east-central Finland, outside the reindeer management area, wolverines are reproducing within wolf territories and seem to extensively scavenge from wolf-killed moose. In western Finland, there exists a small, introduced subpopulation that is able to reproduce without the presence of semi-domesticated reindeer, wolf, or lynx. We have just started a research project in which nutritional ecology of wolverines within these three areas will be compared. The interaction between wolverine and wolf is one of the main interests in this study and we will use GPS transmitters on both species in east-central Finland. Monitoring methods should be developed, e.g., non-invasive molecular analyses.

The contemporary condition of wolverine populations and numbers in Russia

Novikov, Boris

The last decade of the 20th century was very hard for Russia. The restructuring of the economy and social life in Russia could not but influence the condition of different game populations. The breakdown of industrial links and unemployment forced many people, deprived of their livelihood, to turn to poaching. All this affected the well-being of the game populations, primarily ungulates. Wild reindeer, as a member of a "predator-prey system" (e.g., wolverine-reindeer), suffered serious changes to their numbers during the last decade. The decrease in wild reindeer numbers affected the condition of wolverine populations. The last decade was also very difficult for domestic reindeer breeding, with a loss of almost half of the animals. The domestic reindeer breeding losses had beneficial impacts on wolverine population condition and numbers. During the difficult years of the last decade of the past century and in the beginning of the new millennium, the wolverine had to strive to survive. Our review shows that nowadays the majority of wolverines live in the Russian Far East. Stable preservation of the species is secured by a low density of humans, high density of wild reindeer (especially in the autumn-winter season), and favorable conditions for life in taiga and forest. In the new millennium in contemporary Russia, there are more than 20,000 wolverines. Some decrease in wolverine numbers in the European part of Russia and in western Siberia in the last decade of the 20th century can be explained, but the situation can hardly be mended soon. We present details of wolverine status and distribution in four regions of Russia: European North, western Siberia, eastern Siberia, and the Russian Far East. In summary, at the present time, there are not more than 1,400 wolverines in the European North, an estimated 3,500 in western Siberia, about 10,000 in eastern Siberia in three core areas, and about 7,000 in the Russian Far East.

The status of the wolverine population in China

Zhang, Minghai, Yongqing Wang, and Renzhu Piao

The wolverine is listed as first class national protected wildlife in China. Historically, wolverines were distributed throughout the northern part of the Yellow River. By the early 20th century, wolverines were extinct from whole historical habitats including the Changbai Mountains and Lesser Khingan Mountains, except in the Great Khingan Mountains in northeastern China. At present, the wolverine is only distributed in the Great Khingan Mountains (both Heilongjiang Province and Inner Mongolia Province) and western Altai Mountains (Sinkiang Province) of China. According to a survey in the Great Khingan Mountains from 1996 to 2000, wolverine tracks were found in the following regions: in the east from Sanka (126°40´7E, 50°10' N) on the Amur River bank, straight across the Great Xingan Mountains, to the north along the Eerguna River (120°00' E), then north along the Amur River bank (53°20' N), and down the main mountain ridge southward to Shiwei, Genhe, Taerqi (47°40' N), Wenkutu, Alihe, and Sanka. From the field data, the density and number of wolverines were calculated, using line transect sampling and jackknife method, at 0.00217/km^2 or one wolverine per 461 km^2 and 183±38 individuals distributed in 84,000 km^2. Now the population is tending to decline by an average of 7.93% per year. We recognized that loss of habitat, food declines, and poaching are reasons for population status of the wolverine.

Geographic distribution of the wolverine in the United States: an historical analysis

Aubry, Keith and Kevin McKelvey

We studied the historical and current distribution of wolverines at the southern extent of their range in North America (i.e., the continental U.S.) by searching the literature, museum records, state and federal agency files, and archival material at the Smithsonian Institution for distribution records. We spatially referenced all records that we could confidently locate on a map to an area <36 mi^2 (93.2 km^2). We limited our dataset to records of specimens, photos, and accounts of wolverines being trapped, shot, or treed by dogs; we did not consider visual observations or descriptions of tracks. Records from the Northeast (New England states, New York, and Pennsylvania) were few in number and generally dated from the early to mid-1800s; even fewer records exist from the southern Lake states (Ohio, Indiana, and Illinois). There are no museum specimens from any state east of Wisconsin, and all historical accounts describe the extreme scarcity of wolverines in that region. Wolverine records in the northern Lake States (Michigan, Wisconsin, and Minnesota) are similarly sparse, but include several museum specimens. The primary historical range of wolverines in the U.S. was in high-elevation habitats of the Rocky Mountains in western Montana, northern Idaho, western Wyoming, northern Utah, and western Colorado, the Cascade Range in northern Washington, and the Sierra Nevada in central California. Wolverine records are extremely scarce in southern Washington, Oregon, and northern California. This historical discontinuity in the distribution or abundance of wolverines in the Pacific states appears to be attributable to two primary environmental influences: the spatial extent of alpine and subalpine habitat, and persistent snow cover during the late spring denning period. Wolverines currently occur in northern Washington and Idaho, western Montana, and western Wyoming, but the extreme scarcity of recent verified records in California, Colorado, and Utah suggests that wolverines may be extirpated from those states.

Status and distribution of the wolverine, *Gulo gulo*, in Canada

Slough, Brian

In May 2003 the Committee on the Status of Endangered Wildlife in Canada (http://www.cosewic.gc.ca/index.htm) reassessed the status of wolverine. The eastern wolverine population continues to be Endangered, and the western population remains Special Concern. There are many threats to both habitats and populations, although some threats such as wolf control and ungulate population declines have been mitigated, allowing regional wolverine population growth. The most vulnerable western populations are those of the southern mountains of Alberta and British Columbia, and Ontario-Manitoba where genetic structuring indicates habitat fragmentation as an issue. The Vancouver Island population may be extirpated as there have been no sightings since 1992. A recovery plan is in place for the eastern wolverine population. Provincial and territorial general status rankings for the wolverine are Sensitive for most jurisdictions, Secure in the Northwest Territories, May be at Risk in Alberta and Ontario, and At Risk in Québec and Newfoundland and Labrador. Wolverine historically occurred in all jurisdictions except the island of Newfoundland, Nova Scotia, and Prince Edward Island. They are also absent from most Pacific islands, except Vancouver and Pitt, and are absent from some northwestern Arctic islands. Range reductions began in the mid-19th century when it was extirpated from the eastern boreal forests and from the aspen parklands of the Prairie Provinces. The western wolverine population estimate in late winter is 15,000 to 19,000 wolverines and is likely over 20,000 in the fall, assuming that current harvests are sustainable (2.5 to 8 %). The eastern wolverine population estimate in Québec and Labrador, based on the opinions of wildlife managers, is zero. Recent unconfirmed observations are believed to be extra-limital movements of wolverines dispersing from Nunavut Territory.

Status and recovery of the endangered wolverine in eastern Canada

Schmelzer, Isabelle and Michel Huot

Wolverine populations across Canada were assessed by the Committee on the Status of Wildlife in Canada (COSEWIC) in 1989. At that time, discontinuities in wolverine occurrence across the country led the committee to split the population into "eastern" and "western" units. The eastern population, restricted to Québec and Newfoundland/Labrador, was designated as "Endangered", a status that was reassigned in 2003. Wolverines are currently legally protected under endangered species legislation in both provinces. Historical accounts suggest that wolverines once occurred throughout all of Labrador and northern Québec, though at lower densities than have been observed in western regions. Wolverines became scarce beginning in the late 19th century, concurrent with the collapse of two large migratory caribou herds and increased trapping pressure for furbearers in northern regions. With the exception of two captures in Labrador in 1965 and one in Québec in 1978, no confirmed occurrences have been documented since, though numerous incidental sightings have been reported. Since the 1960s, caribou herds have recovered and trapping for wolverines has ceased, yet the population does not appear to have recovered. Threats that may be constraining recovery include industrial developments such as mining, however, much of the wolverine's historical range remains intact. Prior to 2005, the eastern wolverine population had never been systematically surveyed. Using extensive aerial track transects above the 53rd parallel in Labrador during March 2005 we found no tracks or sightings. This finding suggests that there are no resident animals in Labrador, and any sightings represent extra-limital movements of wolverines from northwestern Ontario or possibly Québec. There are two possible scenarios for the Québec portion of the range: remnant, localized populations occur at very low densities, or there are no resident animals but occasional visits of dispersing animals from Ontario. Either scenario is plausible because Québec is more proximal to a source population, had wolverine pelts traded at fur actions throughout the 1970s, and contains relatively more productive habitat. Regardless, the eastern wolverine population as a whole is probably not viable, and a natural recovery seems unlikely in the near future.

Monitoring wolverine natal dens in Scandinavia

Brøseth, Henrik, Terje Bø, Robert Franzén, and Roy Andersen

In late winter adult female wolverines dig a natal den as a tunnel through the snow, usually down to boulders and rocks below the snow layer. These are utilized for several months and are relatively detectable by searching for concentrations of tracks in the snow and back-tracking. In addition, the same denning locality tends to be reused for many years. This makes it possible to organize searches for dens and to annually recheck known denning localities. By re-examining "uncertain status" locations after snow melt, it is possible to exclude snow tunnels that were simply day lairs or access tunnels to stored food or carcasses. These counts of natal dens present an intrinsically conservative count because it is possible that some dens were not located. The number of missed dens can be minimized by organizing extensive searches by snow-scooter and using GPS tracking data to identify coverage. The GPS data together with the number of visits at known localities provides an index of the effort that lies behind each year's annual count. In Norway at the national level, Norwegian Institute for Nature Research (NINA) coordinates the monitoring of wolverine natal dens, delegated from the Directorate for Nature Management (DN). Regional coordinators at the State Nature Inspectorate (SNO) organize the monitoring work at the local level, where the fieldwork is done by SNO wardens and SNO local carnivore contacts. In Sweden the monitoring is coordinated by the Swedish Environmental Protection Agency. A functional and secure flow of quality- controlled data is important for practical reasons and to secure confidence in the monitoring. At all three levels (local, regional, and national) of the monitoring system, data flow, and quality control are emphasized. Ensuring the flow of data through the hierarchical system is facilitated by an online database. Once all data for a given season reach the national level, the data are interpreted by scientists who produce an annual report.The national monitoring program for large carnivores in Norway rechecks nearly 200 known denning localities each year. The monitoring effort in 2004 resulted in 720 visits at known denning localities and 74,000 km of searching effort. In 2004 the monitoring program found 47 natal dens in Norway. Based on the numbers of reproductions, the total wolverine population in Norway was estimated at 264 (± 33.4 SE) adult wolverines. Sweden found 70 natal dens in 2004, with an estimated population of 397 (± 48.5 SE) adult wolverines.

A ground-based technique, using tracks in the snow, to estimate wolverine density

Becker, Earl and Howard Golden

The wolverine is a boreal species that naturally occurs at low densities. Consequently, a unique set of problems must be overcome to obtain density estimates. Becker (1991) and Becker *et al.* (2004) developed techniques to obtain scientific estimates of wolverine density by aerially surveying wolverine tracks after a fresh snowfall. A key assumption of these techniques is that wolverine tracks are not missed in surveyed areas. We believe it is likely that this assumption is violated in habitats containing thick canopy cover. If sufficient manpower and access exist in the area of interest, we suggest that a ground or ground–aerial-based survey can be used to obtain scientific estimates of wolverine density. The proposed method requires randomly placed systematic transects and the assumption that the number of wolverines intersecting the transects can be accurately determined. The method will generate an estimate of the distance moved by the wolverine population. An additional requirement is that the study area contains a set of GPS-radiocollared wolverines whose movements can be measured accurately. Such data coupled with ground-truthing will allow us to obtain an estimate of the distance moved by an average wolverine. A density estimate can be obtained with the ratio of these 2 statistics coupled with the size of the study area. This technique requires a recent snowstorm to distinguish fresh wolverine tracks from pre-storm tracks.

Estimating wolverine population size using quadrat sampling of tracks in snow

Golden, Howard, David Henry, Earl Becker, Michael Goldstein, John Morton, Dennis Frost, and Aaron Poe

Wolverines (*Gulo gulo*) function as scavengers and predators throughout their circumboreal range. Their low densities and wide-ranging behavior make their populations difficult to monitor. We report the results of our evaluation of quadrat sampling of tracks in snow to estimate wolverine populations. We conducted aerial surveys in upper Turnagain Arm and the Kenai Mountains (TAKM) in southcentral Alaska and in the Old Crow Flats (OCF) in northern Yukon during March 2004 following procedures for the sample-unit probability estimator (SUPE) developed by Becker *et al.* (1998). This technique uses network sampling of tracks in snow in a stratified random system of quadrats or sample units. We flew the surveys with PA-18 Supercub aircraft after fresh snowfalls of several cm and under clear skies with little wind. In TAKM, we sampled 87 (51%) out of 171 quadrats within a survey area of 4,340 km² at sampling fractions of 66% in the high stratum and 33% in the medium-low stratum. The estimated density was 2.95 (± 0.36) wolverines/1000 km² with a coefficient of variation (CV) of 12.04%. In OCF, we sampled 96 (71%) out of 135 quadrats within a survey area of 3,375 km² at sampling fractions of 72% in the high stratum and 67% in the medium-low stratum. The estimated density was 9.74 (± 0.63) wolverines/1000 km² with a CV of 6.5%. Our results indicated the SUPE technique is an efficient method of obtaining precise estimates of wolverine population size under markedly different population densities and environmental conditions.

Monitoring populations of rare and elusive animals

McKelvey, Kevin, Samuel Cushman, Michael Schwartz, and Leonard Ruggiero

Historically, the "Holy Grail" of monitoring has been statistically reliable population trend data. For rare organisms, however, valid count statistics are generally difficult or impossible to obtain. Additionally, if population trends are stochastic, many years will pass before the shape and magnitude of population changes will be evident. Here we describe an alternative approach for monitoring that does not rely on direct count data but rather on the development of statistically-based habitat relationship models coupled with a suite of genetically-based population health metrics. We provide an example of a genetically based landscape connectivity analysis for black bear (*Ursus americanus*) and discuss potential utility for wolverine (*Gulo gulo*).

Non-invasive monitoring of wolverines in southern Scandinavia

Flagstad, Øystein

The wolverine population in southern Scandinavia was considered functionally extinct in the 1960s, but has partly recovered in recent years. Appropriate conservation and management of this population is highly dependent on reliable estimates of critical population parameters such as population size, population structure, migration rate, and reproductive contribution from immigrants. We report on a large-scale population monitoring project assessing these parameters through genetic tagging of individuals, with faeces as the source of DNA. The project was initiated in 2001, and several hundred faecal samples have been analysed every year since. Dense sampling has unravelled a detailed picture of the population structure in southern Scandinavia, with a remarkably sharp boundary between two genetically distinct sub-populations. The eastern subpopulation is genetically similar to wolverines in northern Scandinavia, whereas the western subpopulation forms a highly differentiated population with slightly reduced levels of genetic variability. Notably, migration seems to be asymmetric, with detectable movement from the north and the east to the west, but not the other way around. There is also some evidence of reproductive contribution from immigrants, which is important for maintenance of genetic

variability in the western subpopulation. Independent yearly estimates of population size suggest that this small and vulnerable subpopulation comprises approximately 70 individuals.

The efficacy of using snow tracks in providing genetic data from wolverine and other carnivores

Ulizio, Todd, John Squires, Daniel Pletscher, Michael Schwartz, James Claar, and Leonard Ruggiero

The wolverine (*Gulo gulo*) is one of the least understood mammals in North America. Concern over the status of the species has culminated in 2 petitions to list the species for protection under the Endangered Species Act. The wolverine's relatively low density, large spatial requirements, and use of often remote habitats have prevented a thorough understanding of its distribution in North America. A survey method is needed that has a high probability of detection, is applicable over large areas of wolverine habitat, and is not prone to "false positives". We tested a rigorous and representative winter snow track survey method to determine if it was effective at detecting wolverine tracks in 4 mountain ranges of southwestern Montana. We investigated the feasibility of following all putative wolverine tracks detected to collect noninvasive genetic samples to provide definitive species identification and more complex demographic data. Snow track surveys detected 614 wolverine tracks in 3 of the 4 mountain ranges. We completed 54 backtracks and collected 169 hairs and 58 scats. Amplification rates of mitochondrial DNA (mtDNA), used for species identification, were 74% and 24% for scats and hairs, respectively. The average distance to collect a sample containing high quality mtDNA for species identification was 1331 m. Genetic analysis confirmed 35 snow tracks (64%) as wolverine. We analyzed nuclear DNA (nDNA) from the same samples to produce individual genotypes. Amplification rates of nDNA from scats and hairs were 52% and 16%, respectively, and produced individual genotypes for 23 of the 54 snow tracks (43%). Our results show that snow tracking is an effective method for determining species ID, while also capable of more complex monitoring using individual genotypes. While tested on wolverines, this method could be applied to other carnivores that live in snowy regions and are active during winter months.

Using genetic analysis to estimate wolverine abundance in northern Canada

Mulders, Robert, John Boulanger, and David Paetkau

This paper presents the results of the first substantive hair trap-based DNA mark-recapture sampling effort for wolverines. In the spring of 2004, 284 bait posts were sampled in 3x3 km cells for 4 sessions in the Daring Lake area of the Northwest Territories, Canada. Bait posts were baited with caribou meat and scent lures. As well, a fish lure was dragged around by snowmobile during bait post setup. One hair sample was genotyped from each post for each session. Results suggested a high degree of attraction to bait posts by wolverines with capture probabilities above 0.5 for both sexes. Males displayed substantial closure violation compared to females. The precision of estimates for females was exceptionally high due to high capture probabilities. Investigation of reduced-effort designs suggests that a 2-session sampling design with moderate densities of bait posts is adequate for estimation of population size for wolverines due to high capture probabilities. A longer-term monitoring effort is recommended to provide a better understanding of wolverine populations in the area. Investigators considering the use of this technique should strongly consider the assumptions of this study before implementing these methods for other studies.

A Wolverine Information System for Europe (WISE)

von Arx, Manuela, Urs Breitenmoser, Christine Breitenmoser-Würsten, Urs Kägi, José Juan Klee, Arild Landa, Jens Persson, Lotta Samuelson, and Ilpo Kojola

Viable populations of wolverines (*Gulo gulo*) require huge range areas, which inevitably result in expansion beyond protected areas into multi-use landscapes. A population normally extends over several countries, requiring international and inter-regional cooperation for its management and conservation. Wolverine conservation faces the challenges that (1) a huge area must be considered, which (2) consists of a patchwork of various land-uses, and (3) extends over several countries with different traditions and management systems. Producing effective action and management plans calls for a standardized and up-to-date assessment of entire populations. The Wolverine Information System for Europe (WISE) provides an easily accessible and readily updated centre of information on the distribution, status, trends, management, and conservation needs of European wolverine populations and serves as a starting point and model for the Action Plan for the Conservation of the Wolverine in Europe (Landa, Lindén & Kojola 2000) and the Eurasian Lynx Online Information System (ELOIS; von Arx *et al.* 2004). The aim of the WISE project is to (1) update the status reports from the range countries (Norway, Sweden, Finland, and Russia) using a standardised approach, (2) recommend management and conservation actions based on a population rather than a country approach, and (3) manage and share information through a readily updated online system. Contacts from the range of countries provide baseline data by means of an extended questionnaire, which follows standards of the IUCN Red List assessment. This information is completed from the scientific literature and is analyzed by country and by (meta-) population. For each country and population, the status is assessed, and conservation needs and knowledge gaps are identified. The WISE will be available as a report, CD-ROM, and through an online web-project, allowing easy access and facilitating the sharing of information among individuals and institutions dealing with wolverine management and conservation.

Tuesday, June 14 – Ecology

Anaesthetic and surgical protocols for implantation of intraperitoneal radiotransmitters in free-ranging wolverines (*Gulo gulo*)

Arnemo, Jon, Åsa Fahlman, Jens Persson, and Peter Segerström

Intraperitoneal radiotransmitters (Telonics®) have been used in free-ranging wolverines (*Gulo gulo*) in the Swedish Wolverine Project for nine years. Since 1998 standard protocols for anaesthetic and surgical procedures have been applied. Capture and anaesthesia: wolverines are captured either by helicopter darting or by darting from the ground after being dug out from day-beds or rendezvous sites. All animals >8 months are darted (Dan-Inject®) with an initial dose of 4 mg medetomidine + 100 mg ketamine per animal. For juveniles and adult females (<12 kg), 3 mg medetomidine + 75 mg ketamine is sufficient. Cubs (<6 kg) are manually restrained, weighed, and immobilized with 0.1 mg/kg of medetomidine + 5 mg/kg of ketamine intramuscularly. Animals that are not down 15 minutes after the intial darting are redarted with a full dose. If the animal is incompletely immobilized, shows signs of spontaneous recovery, or are subjected to a prolonged procedure, additional medetomidine-ketamine (one-third of the initial dose) is given intramuscularly by hand syringe. Atipamezole at 5 mg per mg of medetomidine is administered intramuscularly or subcutaneously for reversal. Surgery: for access to the peritoneal cavity, a ventral midline incision is made using standard surgical procedures. The weight of the implant should be <2% of the animal's body mass. Implants are sterilized (ethylene oxide) or disinfected

(soaking in 10 mg/ml benzalkonium chloride for 24 hours). Implants should be pre-warmed, and in the case of chemically disinfected implants, thoroughly rinsed with sterile saline before being placed aseptically into the peritoneal cavity. The incision is closed in two layers (*Linea alba* and skin) with absorbable sutures. A combination of procaine penicillin and benzathine penicillin (100 mg/kg intramuscularly) is used to minimize the risk of wound infection. For post-operative analgesia, 4 mg/kg of carprofen is administered subcutaneously.

Physiological parameters during anaesthesia of free-ranging wolverines (*Gulo gulo*) in Sweden

Fahlman, Åsa, Jon Arnemo, Jens Persson, Peter Segerström, and Görel Nyman

When immobilising free-ranging wildlife, physiological parameters of the animals are influenced by the capture event as well as the anaesthetic drugs. The aim of this study was to evaluate the pulmonary function and acid-base status in free-ranging wolverines during anaesthesia. The study included 12 wolverines anaesthetised for radio-marking. Adult wolverines (n=9) were darted from a helicopter with a total dose of 4 mg medetomidine[1] and 100 mg ketamine[2]. Juveniles (n=3) were captured by hand, weighed, and injected intramuscularly with 0.1 mg/kg medetomidine[3] and 5-10 mg/kg ketamine. Body weights ranged from 9.1-15.2 kg in adults and 4.8-7.3 kg in juveniles. During anaesthesia, respiratory rate, heart rate, and rectal temperature were recorded. Arterial blood samples were collected between 15-30 min and 45-60 min after drug administration and processed immediately using a portable i-STAT analyzer[4]. Blood samples were analyzed for pH, CO_2, and O_2 tensions, haemoglobin oxygen saturation (SaO_2), and lactate. Data were compared to reference values for domestic mammals since measurements have not yet been reported for wolverines. Respiratory rate and heart rate decreased over time. Eight adults and one juvenile initially had increased rectal temperature (>40.0 ºC), which probably developed in the adults due to physical exertion during the helicopter chase and in the juvenile due to stress from handling. Rectal temperature decreased over time in all animals. Measurements of arterial CO_2 and O_2 tensions indicated an adequate pulmonary function, except in one adult male that had a mild hypoxemia (O_2 tension 63 mmHg, SaO_2 <90 %). Low pH (<7.20) and high lactate levels were measured in two adult females. No mortalities occurred during or within six months after anaesthesia. In conclusion, pulmonary function was adequate, but acid-base disturbances were present during anaesthesia of wolverines with the capture methods and drug combinations used in this study.

[1] Zalopine®, 10mg/ml, Orion Pharma, 02101 Espoo, Finland
[2] Ketalar®, 50 mg/ml, Pfizer AB, P.O. Box 501, SE-183 25 Täby, Sweden
[3] Domitor®, 1 mg/ml, Orion Pharma AB, P.O. Box 334, SE-192 30 Sollentuna, Sweden
[4] i-STAT Portable Clinical Analyzer, Abbott Scandinavia AB, P.O. Box 509, SE-169 29 Solna, Sweden

Demography - life and death in a wolverine population

Persson, Jens, Peter Segerström, and Tom Wiklund

Knowledge about species demography is essential for sound management and conservation. Demographic data is needed for understanding distribution, and estimating sustainable harvest and population viability. In this study, we describe demography of wolverines (*Gulo gulo*) in northern Sweden. Minimum average age at first reproduction was 3.4 yrs. The proportion of adult females (≥ 3 yrs old) reproducing each year was 0.55 (102 female yrs). Average annual birth rate was 0.64 kits per female. The recruitment of juveniles to the age of 1 yr was 0.46 kits (0.26 female kits) per female. Mean litter size was 1.84 (n = 67). Our data suggest that female wolverines have low productivity and low capacity to compensate for increased mortality when compared to other large carnivores. Reproduction incurred costs on female wolverines that

affected reproduction the subsequent year, and reproductive costs appeared to be related to the duration of parental care. Reproduction was higher for food-supplemented females than for non-supplemented females, even though all food-supplemented females had reproduced the preceding year. We suggest that reproduction is limited by winter food availability and that additional food can compensate for reproductive costs. We estimated age-specific survival rates and determined mortality causes in wolverines. Intraspecific predation was the most important cause of juvenile mortality, and illegal killing the most important cause of adult mortality. A sensitivity analysis showed that survival of adult females is the single most important determinant of the growth of wolverine populations and that the reproductive value is highest in 3- to 5-yr-old females. The importance of adult female survival is further emphasized by the patterns of territoriality and dispersal of females. It is necessary for wildlife managers to consider wolverine demographics, especially adult female survival, when developing and implementing conservation policies and harvest regulations.

Maternal care in wolverines: early breeding and central-foraging strategies enhance fast growth, survival, and independence of cubs

Landa, Arild, Roel May, Roy Andersen, Peter Segerström, and Jiska van Dijk

The timing of breeding in most animals is determined by phylogenetic as well as environmental constraints. The ultimate causes for the timing of reproductive seasons are probably cued by availability of food as well as offspring growth and survival. Food-hoarding animals are to some extent released by the constraints imposed by seasonal variation in food availability and consequently some species procreate early in spring. Early breeding (i.e., birth date) should thus favour and enhance the growth and survival of the cubs. Predators especially could benefit by having large and mobile cubs at the time when prey is most abundant and vulnerable. This would give the cubs a long growth season and allow them to be nearly full-grown and ready for the winter season when food becomes scarce. The wolverine *Gulo gulo* is the only northern hemisphere, non-hibernating large carnivore that gives birth early in the spring. However, in solitary animals like the wolverine, this strategy is associated with costs and constraints (i.e., predation risk and nutritional needs). Early reproduction should therefore be related to availability of sufficient food stores in the close vicinity of the den, fast growth, and early independence of the cubs. Activity patterns were recorded by intensive radio-tracking of family groups. In the parturition and weaning period, female wolverines spent most of their time inside their denning areas, with time decreasing over this period. During this period they had mainly a nocturnal activity pattern. Over the following rearing period, the mother-offspring distance increased. By the beginning of September, cubs were nearly full grown and displayed an independent life style. Our results indicate that for successfully raising cubs within one summer season, wolverines are forced to give birth early in the spring, but the observed activity pattern also clearly demonstrates the need to have cached food stores in the close vicinity of the den, especially during the early den period at the infant stage. The mobile rearing period overlapped with the observed timing of mating, which may be related to enhancement of dominant male proximity when cubs are most vulnerable to infanticide.

Wolverine den and kit rendezvous sites in Glacier National Park, Montana

Yates, Richard, Jeffrey Copeland, and Leonard Ruggiero

In addition to natal and maternal den sites, successful wolverine (*Gulo gulo*) reproduction requires refugia for kit security as females forage and/or mate in areas away from their dependent offspring. These refugia, or rendezvous sites, may provide kits with protection from predation and thermal loss. During summer 2004, we followed 2 transmittered kits as they moved within their mother's core home range to various rendezvous sites in the alpine/subalpine ecotone of Glacier National Park, Montana. The 2 male kits were instrumented on 6 May 2004 after locating

them with their mother at a maternal den. Subsequent locations of kits found that the female had cached them in various structures including downed trees, boulder talus, glacial moraine, and broken cliffs. We documented 10 such sites during 5 months (7 May-22 Sept) of monitoring. GIS and LandSat attributes were analyzed for each site and results are presented on aspect, elevation, ground cover, slope, habitat type, fire history, structure type, surface geology, as well as distance to cliffs, trails, roads, and water. A similar analysis was also performed for 2 natal and 3 maternal dens. Photos of den and rendezvous sites are presented. Additional time budget analysis covering 12 hrs (0800-2000) of active transmitter duty for the same 5-month period showed the female's attendance to kits fluctuated on a 3-4 hr cycle.

Spatial ecology and habitat selection of reproductive wolverine females

Mattsing, Glenn, Per Wedholm, Jens Persson, Peter Segerström, and Tom Wiklund

Detailed knowledge of habitat requirements and spatial organization can increase the understanding of a species´ distribution and ecology. For wolverines, only limited information exists on behavioral characteristics such as territoriality and factors involved in selection of den and rendezvous sites. Using GIS, we investigated spatial organization and aspects of habitat selection of wolverine females in northern Sweden. We analyzed spatial patterns of female home range (n = 30) use, den positioning (n = 20), and movements of females with kits. We also analyzed den site (n = 81) and rendezvous site (n = 177) habitat selection. We found that wolverine females had home ranges essentially exclusive from other females. Neighboring females showed little temporal association in overlap areas. Wolverine females showed a tendency for central placing of natal dens within their home ranges, and dens were also located further away from neighboring female's home ranges than expected. On the landscape level, wolverine females showed a preference for alpine heath and meadows, south-western and north-eastern aspects, slopes between 10 – 40 degrees, and elevations between 700 – 800 and 900 – 1000 m. On average, dens were found 40 m above mountain birch tree line (720 m a. s. l.). Weekly distance travelled from a den site was 508 m on average. Females with forest within their home ranges placed den and rendezvous sites at approximately the same elevation. Females without tree cover within their home ranges used rendezvous sites at lower altitudes than the den site. In general, females seemed to be less selective when choosing rendezvous sites compared to den sites.

Dispersal behaviour of wolverines

Persson, Jens, Eva Hedmark, Peter Segerström, and Tom Wiklund

Knowledge about a species' dispersal behaviour is necessary for understanding social dynamics and wolverine distribution and has significant conservation implications. We studied dispersal patterns of wolverines (*Gulo gulo*) in northern Sweden. We monitored 75 wolverines (44 females, 31 males) from the age of 2-4 months to dispersal age. Mean dispersal age did not differ between males and females (11.5 and 12 months, respectively). All males dispersed, while at least 16% of the females were sedentary. All sedentary females occupied their mother's territory when she either died or shifted her territory, and no females dispersed from a territory vacated by their mother. Female dispersal seemed to be explained by the resource competition hypothesis. Both mate competition and inbreeding avoidance hypotheses seem to explain male dispersal pattern. We discuss ecological determinants for observed dispersal patterns. Recorded dispersal distances of radio-marked individuals are likely to be an underestimation, but available data indicate male-biased dispersal distances. Female dispersal may limit recolonization, and frequency of female dispersal seems dependent on the overall survival rate of adult wolverine females in the population.

Lynx – wolverine interaction: the combined effect of a specialist predator and a generalist predator on a common prey

Andrén, Henrik, Jens Persson, and Anna Danell

Eurasian lynx (*Lynx lynx*) and wolverine (*Gulo gulo*) co-exist in the Swedish mountain area. They both prey upon semi-domesticated reindeer, the main prey for both species. We also know that wolverines scavenge on reindeer killed by lynx. A previous study showed that wolverine reproduction is influenced by food availability in winter, especially reindeer carcasses. Thus, there is an intricate interaction between lynx and wolverine, where the wolverine might benefit from the presence of lynx while the lynx might lose carcasses because of the wolverine. The aim of this study is therefore to study the kill rate of lynx and wolverine on reindeer, as well as the use of reindeer carcasses, especially the use of lynx-killed reindeer by wolverine. We have made a model to estimate the combined impact on reindeer by lynx and wolverine. Preliminary analyses of the model indicate that the number of reindeer killed per predator might have a minimum at a certain ratio of lynx and wolverine, because the availability of lynx-killed reindeer decreases the need for wolverines to kill reindeer. We also present data on movements of lynx and wolverine using a new GPS technique. We can identify reindeer killed by lynx by describing the movements of lynx. Lynx often revisit areas where they have killed a reindeer, resulting in clusters of locations. We will describe how frequently wolverines visit these clusters, as well as how soon the wolverines discover these clusters. All these data will be used in the lynx-wolverine model.

Wolverine foraging behaviour during the winter season in the boreal forests of southern Norway

van Dijk, Jiska, Tommy Andersen, Roel May, Arild Landa, Roy Andersen, and Reidar Andersen

The wolverine (*Gulo gulo*) has recently re-colonised the boreal forests in southern Norway after an absence of approximately 100 years, and little knowledge exists on its ecology in forest areas. Interactions and possible co-existence with the other 3 large carnivores – wolf (*Canis lupus*), lynx (*Lynx lynx*), and brown bear (*Ursus arctos*) – were previously only anecdotally described. In this study wolverines were snow tracked for 233 km in two winter seasons to collect information on hunting behaviour, diet, and interactions with other carnivores. The study focused on wolf and lynx interactions as brown bears hibernate in winter. Also, interactions with red fox (*Vulpes vulpes*), pine marten (*Martes martes*), and stoat (*Mustela erminea*) were included in the study. Scavenged moose (*Alces alces*) was found to constitute the main food source (82.6%) for the wolverine. We documented 4 hunting attempts on hare (*Lepus timidus*) and 12 possible hunting attempts on rodents and birds. All hunting attempts were unsuccessful. The wolverines utilized carrion from wolf kills and one red fox kill, remains from human moose harvest, and bait put out for red fox hunting. However, wolverines were not found to follow tracks from other large carnivores to localize food sources. Interactions of wolverine were mainly found at lower altitudes. More wolverine-wolf interactions were recorded in the early winter season, which might indicate that wolverines seek "wolf areas" during the first part of the winter due to easier access to carcasses, even though they still avoid directly following wolf tracks. Our results suggest that, for survival in the boreal forests during the winter season, wolverines are dependent on remains from the kills of others large carnivores, from human harvest, and from natural mortality. We found no evidence for the importance of direct intra-guild interactions for wolverines to localize food, and it seems that wolverines actively avoid close contact with wolves and prefer old carcasses, probably due to the risk of intra-guild predation at fresh wolf kills.

The effect of intra-guild species on wolverine prey availability and diet

Gustavsen, Line, Jiska van Dijk, Arild Landa, Roel May, Roy Andersen, and Reidar Andersen

Although we know that wolverines (*Gulo gulo*) scavenge on kills from other large carnivore species, we do not know to what extent the diet of wolverines is related to the presence of intra-guild species. To identify the wolverine's diet in relation to the availability of food sources in different areas, the diet of wolverines in southern Norway was studied by analyzing prey remains in wolverine faeces, availability of prey (wild ungulates, livestock and small rodents), and presence of intra-guild species (wolf, lynx, and bear). Since 2001 over 800 scats have been collected under the national wolverine monitoring program and for each scat a GPS location was noted. Scats were collected during late winter season. Because only part of these scats had been used for DNA analyses, the remainder of the scats were available for diet analyses. In 2004, 646 scats from 2001 through 2003 were analyzed by estimating volume and percentage occurrence of food items. Through DNA analyses 346 of these scats could be assigned to 144 different wolverine individuals (70 males and 74 females). Reindeer and moose were the main prey remains found in wolverine faeces. Reindeer remains were significantly higher in male scats than in female scats. Moose remains were equally found in male and female scats, which might indicate a scavenging behavior that is equal for both sexes. Only a few scats contained sheep remains, and none in male scats. Small prey (hare, rodent species, and bird species) were significant higher in female scats than in male scats. Although moose remains were found in scats all over southern Norway, significantly more moose remains were found in the area where wolverines coexist with wolves, lynx, and bears. There is a relatively high natural mortality of moose and large amounts of moose remains from human harvest due to an extremely high moose density in this area, but these food resources are not continuous and are only temporally available, especially moose remains from human harvest. We therefore argue that wolverines in this intra-guild setting depend on the more continuous supply of carrion from predator kills, especially from wolves.

Moose (*Alces alces*) mortality caused by wolverines in the forest zone of Krasnoyarsk Territory, Russia

Kozhechkin, Vladimir, Alexander Shishikin, and Igor Tumanov

Analysis of data collected from 1967 to 2001 on moose mortality caused by wolverines during the snow cover period (n=19) showed that most instances of predation occurred in the middle and northern taiga subzones and only one verified incident was recorded in the south of the territory – in the Sayan Mountains. The higher mortality rate of ungulate animals on the left bank of the Yenissey River (n=11) compared to that on the right bank (n=7) could be accounted for by a considerable difference in moose population density, and hence wolverine population density, on the left bank. In the forest zone of this region, we were able to locate the predation area of this species as lying between 58° and 67° N. This is a region of abundant snow cover. It is characteristic for the snow cover to stay in the forest massifs for a lengthy period (240 days and longer) and reach depths of 0.8 to 1.6 m. It is the condition of the snow cover that allows a successful hunt by wolverines. Most of the ungulates (74% of total kills) have been killed by this predator during the period of snow abundance and the formation of a thin crust of ice on the snow, i.e., during the period of January through April; more seldom in November through December (21.0%) and in May (5.3%). During an abundant snow cover period, the main victims of this predator among the moose population (n=17) were the less protected animals: short yearlings (23.5%), both female and male 2-year-olds (17.7%), adult pregnant females (41.1%), and much more seldom adult males (17.7%). Unlike wolves, the wolverine is mainly a *solitary* predator that specializes in hunting for big ungulates. Inhabiting deep snow regions, in the zone that is risky for wintering ungulates (a big plateau north of the Angara River, an eastern tributary of the Yenissey), the wolverine occupies an ecological niche where other big land predators avoid hunting. The efficiency of the wolverine hunt is determined primarily by behavioral and

morphological peculiarities of wolverines. The impact of wolverines on populations of ungulates in the forest zone of the Krasnoyarsk Territory is not significant. Evidently, the selective role of the wolverine is more considerable than the extirpation role.

Wolverine diet in north-western Alaska: the importance of migratory caribou

Dalerum, Fredrik, Kyran Kunkel, Anders Angerbjörn, and Brad Shults

We studied feeding ecology of wolverines (*Gulo gulo*) in relation to seasonal and annual abundance of caribou (*Rangifer tarandus*) within the migratory range of the Western Arctic Caribou Herd, north-western Alaska. We combined analyses of stomach content with analyses of stable carbon and nitrogen isotopes. We predicted that caribou would comprise the greatest component of wolverine diets and that diet composition of wolverines would be affected by annual and seasonal variation in caribou availability. In agreement with this prediction, caribou was the single most important prey, comprising 35-95% mean annual diet (estimated as dry weight of stomach content). Moose was the second most important prey, comprising 0-55% mean annual diet. There was annual variation in diet composition, but no significant relationships between dietary proportions of caribou and either annual variation in caribou presence or caribou mortality, although there were logarithmic relationships indicating a type-two functional response. There were negative relationships between dietary proportions of moose and both caribou presence and caribou mortality. Thus, wolverines seemed to act as specialist feeders on caribou that compensated low caribou availability by increasing the intake of moose. Stable isotope analysis confirmed an annual variation in wolverine diets, and also indicated a seasonal diet shift. This shift appeared to be towards herbivores such as moose, squirrels, and microtine rodents during summer. Stable isotopes did not indicate that wolverines fed on prey that derived their protein from marine sources, such as anadromous fish or migratory waterfowl or geese. Our results indicate that wolverines prefer large ungulates and that this particular wolverine population prefers the seasonally present caribou. Decline in seasonal or annual abundance of caribou likely has important demographic consequences for wolverines in northern Alaska. However, knowledge of availability of alternative prey is fundamental to understanding carnivores' dietary and demographic responses to variations in caribou abundance.

Wintering habitat selection and den of wolverine in the Great Khingan mountains, China

Zhang, Minghai and Yongqing Wang

Winter habitat selection and dens of wolverines were investigated in the Great Khingan Mountains during November 1999 through April 2002. Among the seven habitat types of wolverines in this region, wolverines chose distinct vegetation types, aspects, and slope positions but were indifferent to snow depth, elevation, and slope. The wolverine preferred those habitats where distance from human interference was more than 5 km and horizontal sheltering degree was more than 0.3; habitats beyond these thresholds were strongly avoided. Wolverine dens were classified into two types: those with and those without bedrooms. Considering the use of dens throughout the year, we suggest that wolverines are territorial.

Modeling wolverine habitat relationships in central Idaho

Copeland, Jeffrey, James Peek, Craig Groves, Wayne Melquist, Charles Harris, Clinton Long, Kevin McKelvey, and Greg McDaniels

Specific habitat associations for the North American wolverine (*Gulo gulo*) are not well understood. The development of conservation measures for wolverine necessitates at least a basic knowledge of habitat relationships, which to date, has not been available beyond a general sense. This is likely due to a lack of research within the contiguous U.S. along with inherent difficulties associated with study of the wolverine. We report the findings of an investigation into the associations of wolverine habitat use within a suite of habitat features occurring in central Idaho, USA from 1992 to 1996. We provide a unique methodology for dealing with conventional radio-telemetry error, which provides a vector of habitat probability variables well suited for resource selection analysis within a logistic regression framework. We analyzed the importance of 9 habitat and 3 topographic variables to the presence of 13 radio-instrumented wolverine and developed models for goodness of fit. Wolverine habitat use varied across the extent of the study area, most likely due to dissimilarity in habitat community availability. Elevation was the most dominant variable in all models. Adult wolverine selected strongly for steeper slopes while all wolverine selected generally for northerly aspects. Adult females preferred high elevation whitebark pine and montane park communities while adult males were more closely associated with lower elevation Douglas-fir types, except when associated with lower elevation ponderosa pine. Subadults of both sexes displayed less specific habitat preferences other than an avoidance for lower elevation grass-shrub types, which were avoided across all age, sex, and geographic classes.

Identification and conservation of wolverine reproductive den habitat in British Columbia, Canada

Krebs, John and Eric Lofroth

Wolverines are considered "Special Concern" by COSEWIC and "Blue Listed" by the province of British Columbia (BC). A focal point for conservation of this wide-ranging species has been protection of reproductive den sites and habitat. Developing appropriate measures to protect these habitats has been hampered by lack of understanding of factors influencing selection of den sites at broad and fine scales. Using data from 21 reproductive den sites identified in two BC studies, we examined terrain, snowpack, vegetation, human use, and prey distribution variables in a multivariate analysis to assess their contribution to den site selection at fine and broad scales. Broad scale selection was assessed by comparing habitat attributes within home range size landscapes of ~350 km² to attributes within den landscapes of ~78 km². Fine scale selection was assessed by comparing attributes within den landscapes to those contained within den patches of ~1 km².

Spatio-temporal organisation in wolverines in relation to resource distribution

Landa, Arild, Roel May, Jiska van Dijk, and Roy Andersen

Food habits and distribution of food resources have proven to be important determinants of variation in home range size as well as spatial organization in many carnivore species. By analyzing home range data, index of prey density, and elevation as indirect measures on resource distribution, we tested whether wolverine *Gulo gulo* spacing and habitat use were in accordance with the predictions of the resource distribution hypothesis (RDH). Female wolverines placed their home ranges at lower altitudes, and the proportion of reproducing females increased in years when small rodents were abundant. Furthermore, home range sizes were generally larger in the least productive areas. Both measures for strength of central foraging, spread and dispersion, increased with altitude, indicating poorer food abundance and the need for a wider foraging

search at higher altitudes. Spread of positions in the summer was also affected by individual identity and reproductive status, where females with cubs utilized the smallest home ranges. As a result of strong environmental stochasticity resulting in spatio-temporal variation in food availability, females changed the placement of their home ranges considerably between years (fidelity of only 30 %). During the summer, both home range and core area size could mainly be explained by the reproductive status of the females, which also displayed relaxed territoriality for close kin (yearling female daughters had 60% of their ranges within their mothers' home ranges). These results clearly indicate validity of the RDH for the solitary wolverine. Because wolverines are generalists, scavengers, and highly dependent on cached food stores, we also expected them to relax territoriality when food was abundant and predictable, thus, allowing for a higher degree of overlap between conspecifics of the same gender. Accordingly, the proportion of overlap increased in years with high rodent indices. However, proportions of overlap in summer were affected by individual status and mean altitude available. Although we found no explanation for the observed variation in territoriality over the entire year, summer territoriality was stronger when wolverines used higher and less productive areas.

Home range characteristics of wolverines in north-western Ontario, Canada

Dawson, Neil, Jeff Bowman, Audrey Magoun, and Justina Ray

The first ecological study of wolverines in Ontario was initiated in 2003, the principal goals of which were to gain a better understanding of wolverine ecology in low elevation boreal and tundra ecosystems of Ontario, and of the effects of forest management and increased development on their habitats and populations. Seven wolverines (3M, 4 F) were radio-tagged and monitored for 31 to 279 days. Female 95% MCP home ranges averaged 526 km^2 in size, whereas male home range averaged 1,450 km^2 during the winter (Dec – April) period. Summer and fall data were available for 3 wolverines (2 M, 1 F). Winter and summer home range size and shape were similar between seasons for two animals, however, 50% MCP core areas shifted between the two seasons. A subadult male wandered widely through all seasons. Comparison of satellite versus VHF data for 4 wolverines indicated larger home range estimates when using satellite (Argos) data (F = 7.8 % larger, M = 22.2% larger). Mean daily movements were similar for Argos and VHF data and overall mean daily movements were similar to those reported in other studies. Habitat composition within home ranges of radio-tagged wolverines varied from a juvenile female with 62% of winter range in an 18-year-old burn to two adults that used of mature forest. Mean road density within home ranges was 0.4 km/km^2 and recent clearcuts (0- 20 years old) comprised less than 15% of individual home ranges. Anticipated effects of timber harvests planned within the next 15 years within the study area will also be discussed.

Wolverine distribution and movements relative to landscape features in the Pioneer, Flint, and Anaconda/Pintler Mountains of south-western Montana, USA: preliminary results

Squires, John, Todd Ulizio, and Leonard Ruggiero

Rocky Mountain Research Station, in cooperation with the Western Federal Lands Highway Division of the Federal Highway Administration, initiated research in 2000 to 1) determine the distribution of wolverine, lynx, and other carnivores in the Pioneer Mountain Range and adjacent ranges; 2) determine if environmental correlates such as vegetation structure and composition, elevation, and landscape physiography are useful predictors of how wolverine traverse landscapes, and 3) to document wolverine foraging . From 2000-2002, we conducted snow-track surveys on a representative grid to determine the presence of wolverine in "island" mountain ranges and to collect genetic samples to verify the minimum number of individuals. To study fine-scale movements and to locate foraging sites, we backtracked wolverines for a total of 250 kms. In addition, we collared 13 wolverines (8 males, 5 females) to document broad-scale

movements throughout mountain ranges. However, 6 (4 males, 2 females) of these individuals were killed through recreational trapping. The high mortality of collared individuals has hindered our ability to study broad-scale movements. We will discuss the potential impacts of trapping small populations of wolverine.

Wednesday, June 15 – Management and conservation

Conservation and management of the wolverine, *Gulo gulo*, in Canada

Slough, Brian and Thomas Jung

We review the conservation and management of wolverine, *Gulo gulo*, in Canada. Most of the wolverine's range in Canada is on public or "Crown" lands although increasingly, a proportion of these lands are being transferred to aboriginal groups under land claims. About 6% of the total range, or 10% of the "high" relative density range, is in parks and protected areas in western Canada. The degree of protection varies, with aboriginal trapping permitted in most parks, and outdoor recreation, including backcountry skiing and snowmobiling, unrestricted. Transportation corridors, which are barriers to wolverine movements, bisect many parks. Parks in developed areas run the risk of holding isolated populations. Wolverine populations in parks are not buffered from trapping around their peripheries. Forestry, hydroelectric developments, oil and gas and mineral exploration and development, and transportation corridors continue to alter, remove, or fragment habitats. Habitat fragmentation is currently a threat in southern British Colulmbia, Alberta, and the northern Manitoba-Ontario border area. Wolverines are harvested as furbearers and, in some cases, game animals that may be hunted, in all western jurisdictions. Since 2000, there has been no non-aboriginal harvest of wolverine east of Manitoba. Harvests are managed with variations in season length (including closed seasons), quotas, the use of registered trapping concession systems (a form of limited entry), and trapline management by the trapper. Management incentives are lowest in group trapping areas surrounding many northern communities. Harvests are monitored either through mandatory pelt sealing or by monitoring fur exports. Local use of wolverine pelts is common in northern areas (especially the Northwest Territories and Nunavut Territory), where the reported harvest is underestimated by at least 50%. Large-scale wolf (*Canis lupus*) control programs using poisoning, which killed wolverines in western Canada, were discontinued in the 1970s. Other forms of wolf control such as sterilization and trapping are occasionally used to promote ungulate population recoveries. While temporarily reducing carrion supplies, these programs produce ungulate population recoveries, ultimately to the benefit of wolverines. Several large caribou (*Rangifer tarandus*) herds in Manitoba, Ontario, Québec, and Labrador have increased naturally; and there may be a numerical response by wolverines linked to the recovery of caribou populations.

Wolverine conservation and ecology in the United States: studies we can do versus studies we must do

Ruggiero, Leonard and Jeffrey Copeland

Understandings of wolverine (*Gulo gulo*) distribution, ecology, and patterns of abundance in the United States are limited. These limitations represent a critical problem in the development of a conservation strategy for this potentially threatened or endangered species. Wolverine spatial requirements often exceed 1000 km², thus geographically extensive study areas are required when seeking understandings about population and species persistence. Some of the most critical ecological questions pertain to metapopulation structure, movements relative to extensive ecological gradients, and connectivity among subpopulations. Scientific issues associated with

sampling methods, sample size, and statistical analyses are best addressed in traditional population-level studies. However, such studies cannot address metapopulation issues unless resources are available to adequately sample many subpopulations while also attempting to quantify mechanisms of connectivity. Unfortunately, funding constraints may render such studies infeasible even though the pressing need for reliable understandings at geographically-extensive spatial scales remains. We discuss these issues in a context of current conservation issues in lower 48.

Scandinavian wolverines in the east - past and present wolverine management in Sweden

Löfgren, Susanna

The wolverine population is limited to the alpine region in Sweden and has never inhabited the southern parts. The population is shared with Norway. The wolverine was protected in 1969. In spite of protection, the population did not increase and is still listed as endangered (EN). Reasons for this could be the introduction of snowmobiles and illegal hunting. Before 1969 there was a general hunting for wolverines and the state paid bounties. After protection, permits have been given for controlled hunting in situations with much damage on the reindeer husbandry. In 2001 the Swedish Parliament decided to ensure the long-term survival of Sweden's large carnivores – brown bear, wolverine, lynx, and wolf as well as the golden eagle with a Coherent Predator Policy. Since the long-term survival of the wolverine is not assured, the Parliament has set an interim objective for the wolverine at 90 annual reproductions. The monitoring in 2004 revealed 70 reproductions. The compensation system for large carnivores within the reindeer herding area was initiated 1996. The system compensates the reindeer herders for carnivore presence and not for dead reindeer. Each wolverine reproduction in a given year amounts to more than 20,000 € for reindeer herders. Sweden and Finland are the only countries within the European Union (EU) that have wolverine populations. When Sweden and Finland joined the EU, the wolverine was entered in Annex 2 in the EU habitats directive, which means that it is strictly protected under EU legislation.

Management of Scandinavian wolverines in the west - national population goals, regional authority, and legal hunting in Norway

Kjørstad, Morten

Management of wolverine and the other three large carnivore species in Norway has been debated three times by the Norwegian Parliament since 1991, and Parliament has produced three white papers. The last white paper was produced in 2004 and gives the framework and goals for current management in Norway. The management policy is to establish sustainable management for all four large carnivore species in Norway. Within this main goal, one objective is to reduce conflicts with other societal interests, especially to reduce the number of livestock and semi-domestic reindeer killed by large carnivores. There are approximately 2.1 million unguarded, free-ranging, domestic sheep distributed throughout Norway, and depredation is widespread. Each year approximately 30,000 domestic sheep killed by large carnivores and golden eagles are compensated. Wolverines do most of the damage; in recent years, wolverines killed 40-50 % of compensated sheep. In addition, 10,000 – 15,000 of 180,000 semi-domestic reindeer are compensated as depredation cases each year. Wolverines also do most of the damage on semi-domestic reindeer. The total budget for carnivore management in 2004 was 125 million Nkr (19.2 million USD/14.9 million EURO). Budgets go mainly to compensation and preventative measures. The management of large carnivores is based on two main strategies: 1) area zonation and 2) removal of carnivores causing excessive damage. With these main strategies as a foundation, the Parliament has established exact national goals for yearly reproduction for

wolverine and the other large carnivore species. Furthermore, the Parliament has divided Norway into eight geographic regions for management of large carnivores, and the national goals are distributed among these regions. For each region, committees composed of regional politicians have management authority for the species. The committee makes decisions regarding use of money on preventative measures, quota for licensed hunting, geographic area for hunting inside the region, number of hunters allowed, and so on. The licensed hunting period for wolverine is September 10 to February 15. About 30 individuals are shot on these licenses every season.

Wolverines and reindeer herding - indigenous participation in the co-management of carnivores

Baer, Lars-Anders

There is an old saying among reindeer herders in Sápmi that says that "reindeer are the property of the wind" because the reindeer always walk into the wind. Now in the new millennium, reindeer and herders globally have literally to challenge many new and difficult "winds". One of these new "winds" or trends is nature conservation, especially in relation to carnivores. Reindeer, wild or domesticated, are an important part of the food chain for many carnivores. Earlier, the indigenous hunters and herders balanced this relationship between reindeer and carnivores. This relation can be seen in indigenous cultural and spiritual tradition all around the Arctic. That's why the indigenous territory often is the last refuge for these carnivores. The integration of these indigenous territories into different nation states and the market economy have created new threats for the traditional indigenous economies and biological diversity, which include the future of large carnivores. The indigenous Sámi reindeer herders in Sweden are facing this problem daily. The Swedish government demands that, on the one hand, the reindeer economy follow the capitalistic market economy and, on the other hand, be mainly responsible for feeding threatened carnivores, without fair compensation and excluded from governmental management of the carnivores. In Sweden, there are about 20,000 – 30,000 reindeer killed by carnivores yearly, mostly by lynx and wolverine. This is compensated by the Swedish government. In 2005, the compensation reached 47 million Swedish kronor (about 5.1 million EURO). The demand from the Sámi reindeer herders and the Sámi Parliament is that, besides fair compensation, the reindeer herders and the Sámi people's representative bodies are included in carnivore management systems and organizations.

Towards a more regional management of the wolverine in Sweden

Schneider, Michael

According to a decision by the Swedish Parliament, a viable wolverine population shall exist in the country. The species shall be allowed to recolonize areas where it formerly occurred. This national policy establishes the framework for wolverine management in Sweden. The County Administration in Västerbotten has developed a regional management plan for the wolverine, taking into account specific regional circumstances such as the level of economic losses inflicted, the amount of wolverine habitat available, and human attitudes. We had to decide on how large the wolverine population should be in the County, how wolverines should be distributed, and which methods should be used to reach these goals. The wolverine population in Västerbotten is currently in a restoration phase. The population has to increase to reach a favourable condition. Regional management objectives for the wolverine include a more even distribution of individuals, an overall larger population, and the recolonization of vacant habitat. The level of damage inflicted by wolverines is currently relatively high and should be thoroughly surveyed. Until today, a lack of basic information on wolverine biology and habitat requirements has resulted in little management beyond administrative protection. Background surveillance of the wolverine population consists of a yearly survey of all known denning sites, snow tracking, and faecal sampling. Attitude surveys are conducted every fifth year. We are currently considering the

use of remote camera surveys to determine the reproductive status of dens and to prevent the illegal killing of family groups. Human attitudes are the most important habitat variable for wolverines in the County. The wolverine population has not increased very much since the species was protected in 1969, presumably because of illegal harvesting. The monitoring of the species is straightforward, as the well-developed survey system for big predators provides most of the information needed. The management and conservation of the species, on the other hand, are more complicated, due to huge geographical areas that have to be dealt with, illegal killing that has to be stopped, and political conservation priorities that favour the reindeer herding culture.

Who are willing to pay for wolverines? Results from a unique national survey

Ericsson, Göran, Jonas Kindberg, and Göran Bostedt

Of the four large carnivores in Sweden, wolverines are supposed to be the most unknown. The vast majority of wolverines appear along the fairly narrow mountain range bordering Sweden-Norway. Moreover, wolverines live where the human population density is extremely low and thus very few people come in contact with wolverines. We tested, in a national mail survey to 11,000 people, whether people where more or less interested in promoting conservation efforts for wolverines compared to wolves, brown bears, and Eurasian lynx. In the six regions where wolverines have been documented, we oversampled to capture local attitudes. We furthermore applied a set of multiple-choice items to estimate the average willingness to pay for reaching the national goal set by the Swedish government for the wolverine population. Of the sample representing Swedes living outside the wolverine areas, 57% responded to the survey, in contrast to 63-69% in the six wolverine regions. In several of the local townships in which wolverines are present, the response rate was higher. Our results confirmed - at a national level - the prediction that wolverines are less favored by the Swedish population than are the other three large carnivores. In some local townships the relative attitudes towards wolverines were lower than the national and regional values. Nevertheless, a substantial proportion of the respondents were willing to pay for activities to reach the national goal. We explore this finding in more detail relating our findings to experience, knowledge about carnivores, and socio-demographic data on the aggregate level of townships.

Cultural relationships of northern trappers with wolverines: a case study from Ontario

Ray, Justina, Neil Dawson, Audrey Magoun, and Jeff Bowman

Much of the documented knowledge concerning wolverine in Ontario was, until recently, limited to harvest information. In 2003 and 2004, as part of the Ontario Boreal Wolverine Project, we interviewed 115 elders and trappers in six northern First Nations communities to obtain information on harvest, historical distributions, relative abundance, and cultural relationships. This effort had the broader aim of refining our knowledge of broad-scale distribution and conservation status of wolverine in northern Ontario. Of additional interest were: to test whether wolverine harvest rate as gleaned from fur auction returns was reflective of actual harvest (i.e., whether there were any important local uses for wolverines) and to gather relevant ecological information from indigenous knowledge. Interviews yielded information on 100 wolverine harvest events and 121 spatially-explicit locations of harvested wolverines since 1990. The general negative attitude toward wolverines appeared to result more from stories and legends passed down through the generations than from personal experience. In spite of such attitudes, there was no evidence of systematic targeting of this animal. Harvest was opportunistic or in response to real or potential threats to trapping success. Only a handful of interviewees had deliberately set traps to capture wolverines for sale on the fur market. Wolverines are still being regularly encountered or harvested in very close proximity (within 1 km) of population centers. Results

from this study are discussed in a comparative light with those from other jurisdictions in North America, particularly those where wolverine fur has more local value. This effort to collect indigenous knowledge in northern Ontario on wolverines highlights some of the important variability across a species' range that has bearing on the utility and potential value of "traditional knowledge" in species recovery planning.

Inuit traditional knowledge of kalvik (wolverine) in Nunavut, Canada

Banci, Vivian, Chris Hanks, and Rose Spicker

The Naonayaotit Traditional Knowledge Project (NTKP) is a GIS database of the knowledge of the Copper Inuit of Nunavut. It was developed as a tool to provide Inuit with the means of effectively responding to land-use applications within their area of historical and current use using their own traditional knowledge (TK). TK is based on the observations of a group of related individuals over time about specific landscapes, cultural perspectives, animal populations, and climatic conditions. It can be thought of as an evolving "how to" manual for the use of specific places. TK is invaluable in understanding and managing wide-ranging, low-density species such as wolverine, especially since it has evolved over a time period that no biological study can hope to match. To use TK, however, it must first be systematically collected and organized into a usable format. Detailed information on wildlife, habitat, and land use was collected during structured interviews of 51 Inuit consultants. Their knowledge covered an area of use that exceeded 700,000 km^2 over the span of a century. The NTKP provides a regional perspective and a historical and current framework for understanding wolverine biology in a vast wilderness area that is logistically difficult and prohibitively expensive to work in. Prior to the fur trade, wolverine had minimal importance to Inuit. However, after snow-machines and rifles were introduced, Inuit became consummate wolverine hunters for the fur trade and for their own use. Survival in the harshest of environments meant that to be successful Inuit hunters needed to be keen observers. Consultants described wolverine distribution, abundance, important habitats, prey, and hunting behaviour, including the ability of some individuals to kill caribou. Trends in wolverine numbers over time were discussed. Some consultants acknowledged the negative impact that hunting by snow-machine had had on wolverine abundance, especially near communities.

Wolverine habitat use in multiple use landscapes in British Columbia, Canada

Krebs, John, Eric Lofroth, and Ian Parfitt

Identifying factors and scales at which wildlife select habitat is important in developing conservation strategies for wide-ranging carnivores. Wolverines are considered "vulnerable" in British Columbia and have been proposed for listing under the Endangered Species Act in the continental United States. Unfortunately, there is little published material on wolverine habitat selection to guide conservation strategies. We used telemetry data from 32 resident adult wolverines tracked over 6 years in two separate studies in British Columbia, Canada to assess habitat selection at landscape, stand, and patch spatial scales. The 7,000-km^2 Revelstoke study area included a variety of land uses including national park land, forest harvesting tenures, two large hydro-electric reservoirs, helicopter skiing operations, snowmobiling, and a major transportation corridor. The 8,900-km^2 Omineca study area included considerable forest harvesting, a major hydroelectric reservoir, and limited snowmobiling. We used movement rates to define analysis scales. Habitat variables considered in the analysis included vegetation, terrain, snowpack, prey distribution, and human use characteristics.

Impact of infrastructure on habitat selection of wolverines

May, Roel, Arild Landa, Jiska van Dijk, John Linell, and Roy Andersen

Compared to the other northern large carnivores, wolverines (*Gulo gulo*) are thought to be the most sensitive species with regard to habitat changes and human disturbance. Nowadays, wolverines in Scandinavia are found in remote high alpine areas, and we investigated whether human development through presence of infrastructure has relegated them to these areas. We analyzed wolverine habitat selection and the impact of infrastructure in two study areas in Norway using compositional analysis. We found that alpine tundra with low human development was important for wolverines to locate their home ranges. Human development formed a more important factor for home range location than did habitat, because habitat selectivity was much higher in undeveloped habitats relative to developed habitats. Within their home ranges, wolverines used alpine shrub land and forest, irrespective of human development. The sympatric distribution of wolverines with wild and semi-domestic reindeer indicates that wolverines are vulnerable to indirect loss of habitat. However, we hypothesize that wolverine distribution is also partly influenced by direct disturbance or higher risk of human-caused mortality associated with infrastructure, rather than solely by abundance of prey. Increased human development and activity in once remote areas may thus cause reduced ability of wolverines to perform their daily activities unimpeded, making the habitat less optimal or causing wolverines to avoid the disturbed area. Our results suggest that the potential exists for further wolverine recovery in forest ecosystems with low levels of infrastructure development.

Wolverines and winter recreation in the Greater Yellowstone Ecosystem

Inman, Robert

We briefly review the variety of interactions between wildlife and outdoor recreationists that may have impacts at the population level, and then focus on a case study with wolverines. The Greater Yellowstone Ecosystem (GYE) is a destination area for snowmobile, ski, and heli-ski recreation, and land managers believe that trends in backcountry use are increasing rapidly. Snowmobile use within Yellowstone National Park (YNP) has been debated at the highest political levels in the US. Debate over use on national forest lands surrounding YNP has been less intense even though use forest lands is not limited to roads and overlaps with wolverine habitat to a much greater degree. We captured and monitored 26 wolverines at 2 study sites in GYE from 2001-2005. Wolverine parturition occurred primarily during February (range = 30 Jan - 23 Feb, n = 5) and coincided with peak volume of snowmobile use in the backcountry. Natal den sites (n=3) occurred at 2,423 - 2,597 m on north slopes and were all associated with avalanche debris. We will present data on Euclidean distance analysis and compositional analysis of 881 winter (1 Dec-15 Apr) locations of 18 wolverines (10♀, 8♂) in relation to snowmobile activity.

Population distribution and harvest of wolverines in British Columbia

Lofroth, Eric, Mike Badry, and Ian Adams

Wolverines are found throughout most of the ecologically diverse province of British Columbia, Canada. Wolverines have been commercially harvested for their fur in British Columbia for at least two centuries. In spite of this, reliable estimates of regional and provincial populations and explicit sustainable harvest strategies have never been developed. We use new and existing data from ecological mapping, two recent studies of wolverine habitat ecology, and statistically-based estimates of wolverine density to develop ecoregional estimates of wolverine populations in British Columbia. We present a spatially-based analysis of nineteen years of wolverine harvest data and evaluate this in light of currently available survivorship and reproductive data. We

review the results and potential application of these analyses to conservation and management of wolverine populations in British Columbia.

Wolverine harvest in Alaska: an analysis of spatial and temporal patterns

Golden, Howard, Aaron Christ, and Elizabeth Solomon

Wolverines (*Gulo gulo*) occupy nearly all areas of Alaska, and their abundance across the state is comparable with healthy populations in other areas of North America (Hash 1987). Wolverines are harvested in Alaska as furbearers under trapping regulations, and as big game under hunting regulations. Trapping seasons range from November through April with no bag limit in most areas of the state. Hunting seasons range from September through March, with a statewide bag limit of 1 wolverine. Since 1972, annual harvests in Alaska ranged between 397 and 984. Wolverine resiliency to harvest is low relative to other furbearers (Banci and Proulx 1999), and human-caused mortality may be additive to natural mortality in most circumstances where wolverine harvest occurs (Krebs *et al.* 2004). Therefore, it is important to understand the patterns and dynamics of that harvest for application in management models to ensure populations are not over harvested. In this paper, we report the results of our analysis of wolverine harvests in Alaska using spatial and temporal measures. We also discuss the potential effects of the current harvest system on wolverine populations as Alaska's human population continues to expand.

Key note presentation

The fourth bear cub: perspectives on wolverine research from a bear researcher

Swenson, Jon

Poster Abstracts

(In alphabetical order of first author.)

An assessment of methods for detecting wolverines in boreal forest

Bowman, Jeff, Neil Dawson, Audrey Magoun, and Justina Ray

Wolverines occur at low population densities in the boreal forest of Ontario, Canada. The species is of conservation concern in the province, which suggests that their population status should be monitored. However, monitoring wolverines is difficult due to their low densities and large movement ranges. These difficulties are exacerbated in boreal forest due to uncertainties about wolverine ecology in this environment. We describe 3 techniques employed during winter 2004 to detect the presence and to measure the abundance of wolverines in a 2000-km^2 study area near Red Lake, Ontario: hair snares, camera traps, and live traps. The study was divided into 100-km^2 hexagons and a minimum of 3 hair snares and 1 camera were placed in each hexagon. In total, 63 hair snares and 24 cameras were deployed. Hair snares consisted of barbed wire coiled around live trees and nailed in place, and a bait (food lure) was attached to the tree above the wire. Camera traps consisted of hanging baits that wolverines could access by run poles, thereby tripping the remote camera trigger. Twenty-six log cabin live traps were used to capture wolverines for a concurrent telemetry study. We obtained 31 confirmed or probable wolverine hair samples from the hair snares. A total of 246 pictures were taken with the remote cameras of 11 different species; 10 of these pictures were of wolverines. An additional 19 pictures of wolverines were taken at opportunistically deployed cameras. In 1088 trap nights, we had 9 captures of 7 different wolverines in the study area. The camera results suggested that there was at least 1 wolverine in the area that was not captured. We provide recommendations for monitoring wolverines in boreal forest.

Using traditional knowledge to assess the status of species at risk - a case study of wolverine in northern Canada

Cardinal, Nathan

A wolverine Aboriginal Traditional Knowledge (ATK) study was conducted across northern Canada as a case study to develop a formal process regarding the incorporation of ATK into the Committee on the Status of Endangered Wildlife in Canada's (COSEWIC) species assessment process. COSEWIC's current species assessment process is largely scientifically based, but the new Species at Risk Act now requires COSEWIC to use the "best available knowledge", which includes scientific, community, and Aboriginal traditional knowledge. However, there are currently few procedures or guidelines with regards to gathering ATK or integrating it into the COSEWIC species assessment process. A wolverine ATK study was designed to act as a case study to show what kind of information ATK could contribute to the COSEWIC species assessment process, and how it could be incorporated. While rarely used, ATK has the potential to contribute pertinent knowledge for determining a species' status. The wolverine (*Gulo gulo*) is one such species that could benefit from the inclusion of ATK into its assessment. Because of a number of biological and geographic factors, little scientific information is readily available for the wolverine in northern Canada. Northern biologists and Aboriginal People indicate that those Aboriginals who have lived in close proximity to the wolverine for many years have likely accumulated a large body of knowledge regarding the wolverine populations in their respective areas, largely through their own hunting and trapping experiences with wolverine. Interviews were conducted with 30 Aboriginal wolverine experts across northern Canada to better assess the status of wolverine in northern Canada. The ATK study provided relevant information regarding the distribution, threats, and relative abundance of wolverine in northern Canada. The information gathered about wolverines was congruent with present scientific knowledge,

provided finer-scaled information, and also provided new information on wolverine in the North. The study highlighted potential population-source areas and threats to wolverine, issues important to improving the conservation and management of wolverine in northern Canada. In addition, based on insights from the case study, a number of recommendations were developed regarding how to integrate ATK into the COSEWIC species assessment process.

Yukon North Slope Wolverine Study, 1993-94

Cooley, Dorothy

A study was done on a harvested population of wolverines on the Yukon North Slope in 1993-94. Objectives of this study were to gather baseline data describing Yukon North Slope wolverines, estimate the wolverine population size in the northern Richardson Mountain area using a probability sampling survey technique (Becker and Gardner 1992), and, by extrapolation from home range sizes, estimate population growth by comparing surveys at the beginning and end of the study and by recording birth and death rates and documenting distribution, seasonal movements, and habitat use from collared animals, and food habits using harvested wolverines. Fourteen wolverines (10 males and 4 females) were snow tracked and captured; 13 of these were fitted with radio collars. Cementum aging showed that all 4 females were mature, however, no kits were ever seen with the single lactating female. Telemetry flights were scheduled every 2 weeks. The largest number of locations recorded per animal throughout the yearlong study was 15. Despite the low number of locations, we calculated home range size for 4 males (mean 507 km2) and 2 females (259 km2). Aerial population density estimate surveys were attempted in March 1993 and in March 1994. Both attempts were abandoned due to deteriorating weather. Few harvested wolverine carcasses were submitted, due to reduced hunting/trapping efforts by local people and, therefore, this portion of the study was discontinued. Blood samples were taken from 5 males and 3 females. The samples were tested for canine distemper, infectious canine hepatitis, Aleutian disease, and 2 types of *Leptospira*. All tests were negative except canine distemper. Four males tested positive for canine distemper (one male's test was inconclusive). All 3 females were negative. Samples from a concurrent wolf study also showed a high incidence of canine distemper, suggesting a recent local outbreak.

The current distribution of the wolverine – an interactive poster for refining knowledge of the species' world-wide distribution

Copeland, Cheryl, Clinton Long, and Jeffrey Copeland

The distribution of the wolverine is a matter of vital importance as we consider management objectives and direct research. Distribution was a key issue in petitions to list the wolverine under the US Endangered Species Act in 1995 and 2000 and is a central criterion in defining the status of a species under the IUCN Red List. We offer an interactive poster as an effort to refine the current distribution of the wolverine in Eurasia and North America. The poster provides maps depicting distribution polygons derived from the literature and from the collective judgment of participants at the November 2002 Wolverine Workshop held in Monterey, California. Attendees of the *1st International Symposium on Wolverine Research and Management* are encouraged to critique these maps and contribute information to refine existing boundaries. We provide handouts of the maps upon which participants can illustrate boundaries and provide details regarding data source and quality. The resulting information will be combined to create new distribution maps, which will denote the involvement of each contributor and will be made available via the internet.

Microsatellite markers do not suggest sex biased dispersal in a solitary carnivore, the wolverine

Dalerum, Fredrik, Janet Loxterman, Brad Shults, Kyran Kunkel, and Joseph Cook

Sex-biased dispersal is common among vertebrates. In polygynous mammals, dispersal is generally expected to be male biased, with males dispersing earlier, more frequently, and over larger distances than females. Although this pattern has been suggested for most solitary carnivores, direct or genetic data to support or contradict these predictions are surprisingly sparse. In this study we used microsatellite markers scored on harvested wolverines (*Gulo gulo*) from a population in the Brooks Range, Alaska to test the prediction of male-biased dispersal in this solitary carnivore. Our data suggest that females disperse later than males, but we did not find any evidence for sex differences in either frequency or range of dispersal. These findings partly support previous studies on wolverines, but contradict the assumption that wolverine females in this population inherit part of their mother's range, a strategy that has been suggested for wolverines and been shown to be common in some other solitary carnivores. We suggest that dispersal in this wolverine population primarily is driven by resource competition. We further suggest that males are forced to leave their natal territory by their mother, while females voluntarily disperse due to competition for local resources.

Non-invasive monitoring of testosterone, estrogen, progesterone, and corticosterone in wolverines through metabolites in faeces

Dalerum, Fredrik, Sarah Hall, and Scott Creel

Due to the elusive nature of wild wolverines, data on the physiological status of wild animals are difficult to collect. Non-invasive monitoring of hormone levels through metabolites in faeces is a seductive, non-invasive technique that is used in a wide range of species. The technique is particularly advantageous for solitary species, since direct contact with the study animals is not necessary. However, these techniques need to be validated, to verify their technical and biological relevance. This requires longitudinal samples from known individuals, which is difficult to get from wild populations. It is thus advantageous to use captive animals to develop and test these tools. We used samples from captive wolverines to validate assays for monitoring reproductive and stress hormones in wolverines through metabolites in faeces. We validated commercially available EIA kits provided by R&D Systems, Inc. (Minneapolis, MN) for testosterone and progesterone, and commercially available double antibody RIA kits provided by ICN Pharmaceuticals (Costa Mesa, CA) for estrogen and corticosterone. Serial dilutions of faecal hormone extract yielded antibody bindings parallel to the standard curve for all assays. Recovery of hormone ranged from 67% (corticosterone) to 88% (progesterone). Sex hormones generally followed predictable patterns during onset of mating season, ovulation, and gestation, indicating the assays' biological relevance. Injections of synthetic AcTH (adrenocorticotrophic hormone) generated an increased release of corticosterone, which indicated the biological validity of the corticosterone assay. We suggest that these techniques could be used to monitor reproductive status and endocrine stress responses of wild wolverines when traditional samples for endocrine analyses, such as blood, are difficult to collect.

Historical changes in wolverine distribution in Ontario, Canada

Dawson, Neil, Justina Ray, Audrey Magoun, and Jeff Bowman

Harvest and historical sighting information on wolverine were compiled for a status report, as part of a species assessment for wolverine in Ontario. The wolverine was historically found throughout the province of Ontario. However, distribution receded rapidly during the mid- to

late-1800s, apparently due to increasing human settlement, logging, railroad construction, and a general decline in populations of moose, white-tailed deer, and woodland caribou. By 1950, occupied wolverine range was essentially restricted to the area north of the Canadian National Railway line (latitude 50º 15'N). Range recession continued until the early to mid 1970s. Beginning in the late 1970s and early 1980s, harvest reports indicate wolverines began to re-colonize the Fort Severn area of far north-western Ontario (latitude 56º 00'N). Results of the first aerial track surveys and interviews in First Nation communities in 2003 and 2004 indicate that wolverines have continued to slowly re-colonize portions of its former range along the Hudson Bay coast through the 1990s and the early 2000s. Expansion over the last 20 years appears to track an increase in the Pen Island caribou herd in the Fort Severn area and recent changes in caribou numbers and distribution along the Hudson Bay Coast and may be further facilitated by a decrease in trapping effort and therefore harvest pressure in unroaded areas.

Paternity analysis in Scandinavian wolverines

Hedmark, Eva, Jens Persson, Peter Segerström, and Arild Landa

Knowledge of the wolverine breeding system is still rather limited and this is especially true for males. The proportion of males contributing to reproduction is not known and studies require genetic analysis since it is otherwise impossible to know which male fathered a litter. We analysed 20 microsatellite loci and performed paternity tests for 147 wolverine offspring with known mothers. Samples were collected during several years in two Scandinavian populations. Mothers and offspring were all represented by tissue samples and potential fathers were represented by either tissue or faecal DNA. Paternity tests were performed using a method that compares the likelihoods of the potential fathers calculated from allele frequencies. The feasibility of assigning fathers was high when a large proportion of the male population was sampled. When 70-80 % of the male population was sampled, about 60 % of the offspring could be allocated a father at a high significance level and in agreement with geographical data. Some males appeared to be very successful and accounted for most or all paternities within a specific area. We found no evidence of multiple paternity.

Using trapper knowledge to monitor trends of wolverine, *Gulo gulo*, in the Yukon, Canada

Jung, Thomas, Brian Slough, Helen Slama, Barney Smith, and Harvey Jessup

Monitoring wolverine, *Gulo gulo*, population abundance and trends is notoriously difficult. Traditional monitoring methods applied to wolverine often lack precision because animals are normally distributed in exceedingly low densities and they or their sign are rarely seen. Intensive methods to monitor populations are too expensive to be applied at the temporal and spatial scales necessary to reliably inform managers of noteworthy changes in status. We applied data collected by trappers in the Yukon, through annual questionnaires, to estimate broad population trends of wolverines across a broad area of the Yukon (ca. 400,000 km^2) over a long time span (1978 – 2001). Trappers also reported on abundance of other furbearers and their prey, and correlations of these data and wolverine abundance were performed. Between 106 and 252 trappers reported per year, generally one-third of all Yukon trappers per year. Preliminary results indicate that wolverine populations have largely remained stable over time, according to trappers; no population cycles were evident. However, wolverine abundance was positively correlated to that of snowshoe hare. We provide detailed preliminary results of these data and discuss the utility and caveats of using information derived from trappers to monitor wolverine population trends and explore ecological hypotheses.

Territorial behavior of the male and female wolverines in the pre-reproductive period

Kozhechkin, Vladimir

A settled way of life and protection of an individual area of habitat are typical features for wolverines of the Sayan Mountains ridges. The size of a territory controlled by an individual wolverine is variable and depends upon the amount and availability of food. Wolverine movements normally increase in February-March. With abundance of forage at the beginning of winter, the aggressiveness of wolverines is not very high, however, it increases towards the end of winter regardless of the condition of the forage base, because of behavior related to the establishment and protection of individual territories. In the pre-spring period, redistribution of individual areas occurs among those that survived the winter season, and new pairs are formed. It is during this period that wolverine tracks can be observed in pairs and groups of three animals. There are instances of joint use of a territory of up to 90,000 hectares by an adult female and male. Several wolverines roaming together (two or three individuals at a time) is part of a behavioral pattern that results, in the long run, in formation of pairs and a certain territory distribution structure. However, territoriality does not exclude a possibility of conflicts when wolverines of the same gender meet, or when another male joins a pair that is in the process of formation. Most frequently the territorial conflicts occur in the pre-spring period. Studying tracks and compacted spots (with diameters of 0.5 to 1.5 meters) during this time period reveals drops of blood and saliva, tufts of fur, and odorous greenish liquid emitted from circumanal glands. This period should be considered active preparation for the heat period, which wolverines have in summer. The time when couples are formed is impacted to a large extent by the forage base. Under favorable conditions, pairs start forming in February-March, and in certain years even in December, right after the current litter becomes independent. In scarce forage years, pair formation shifts to a later period. Thus, with the exception of joint use of a large prey item by several wolverines, the wolverine's tendency to form groups is most vividly manifested in the spring-summer period, which is related to the reproductive cycle of the species.

Food habits of wolverine, *Gulo gulo*, in montane ecosystems of British Columbia

Lofroth, Eric, John Krebs, David Lewis, and William Harrower

The objective of this study was to examine food habits of wolverine (*Gulo gulo luscus* Linnaeus, 1758) as part of two companion studies of wolverine ecology. We examined the seasonal food habits of wolverines in sub-boreal and interior wet-belt montane environments in British Columbia. Understanding of foraging ecology for a wide-ranging carnivore such as wolverines is important, particularly because reproduction has been demonstrated to be closely linked to food abundance. We studied food habits of wolverines by identifying the contents of scats collected at foraging sites and maternal dens, and stomachs from carcasses provided by trappers. Wolverine diet is shown to vary regionally and seasonally. Regional variation is related to differences in prey availability between study areas. Within the winter season, diet choices by reproductive females are different than other sex and age classes. Caribou (*Rangifer tarandus* Linnaeus 1758), hoary marmots (*Marmota caligata* Eschscholtz 1829), and porcupines (*Erithizon dorsatum* Linnaeus 1758) are present in significantly higher frequencies in the diet of reproductive females. Dependence of reproductive female wolverine on a species of current conservation concern (caribou) and a species that may be affected by issues related to climate change (hoary marmots) may present conservation issues for wolverines in the future.

Modified log live-trap for wolverine

Lofroth, Eric, John Krebs, Richard Klafki, and David Lewis

Over the course of 2 Canadian field studies, researchers developed and modified live-traps used to capture and contain wolverines for radio-tagging studies. We describe a modified version of a log live-trap (Copeland *et al.* 1995). We developed a portable wooden live-trap that can be deployed during winter trapping seasons. Using data from >200 captures and >10,000 trap-nights, we report capture rates by season, trap type, and trap location, and discuss maintenance, repair, and trap limitations.

A method of identifying individual wolverines using remote cameras

Magoun, Audrey, Neil Dawson, Richard Klafki, Jeff Bowman, and Justina Ray

We used passive and active infrared cameras to record the presence of wolverines in boreal forest in northern Ontario. To individually identify wolverines that visited the camera sites, we positioned the cameras and bait so that photographs of wolverines would capture the distinctive coloration pattern on the chest and throat of the wolverines. This pattern is unique to each wolverine and becomes evident around the time kits begin to develop their dark pelage at about 6 weeks of age. In order to determine the most effective way to capture photographs that would clearly show this pattern, we tested two cameras using captive wolverines: TrailMaster 1500 and DeerCam DC-200. A third camera type, CamTrakker, was not tested on captive wolverines because of its previous poor performance under field situations. Our tests indicated that a large percentage of photos, using both the TrailMaster and the DeerCam, provided sufficient detail of the chest pattern to individually identify wolverines that climbed the run pole to investigate the bait. We present details of the design for setting up the bait and cameras and examples of photographs taken during the tests and in the field.

An aerial survey technique for monitoring wolverine distribution and relative abundance over large areas

Magoun, Audrey, Justina Ray, Neil Dawson, and Jeff Bowman

Northern Ontario is a vast, largely unroaded region of boreal forest, taiga, and tundra. In the past, information on wolverine occurrence was obtained through harvest statistics and incidental observations of wolverines or their tracks. Regions with low human populations were underrepresented in this database. We developed a technique for systematically surveying a 599,000-km^2 area of northern Ontario to determine wolverine distribution and relative abundance. The aerial track survey required two PA-18 Supercubs and trained observers. We divided the area into 1000-km^2 hexagons and flew transects that passed through the centers of the hexagons. The pilots, who were experienced trackers, were instructed to fly over areas where wolverine tracks would most likely be detected, such as rivers, lakes, and beaver flowages in boreal forest or scattered stands of spruce or willow in taiga and tundra areas. We conducted the survey during February over a 2-year period. We recorded locations of tracks and sightings of wolverine as well as other wildlife species. Over the 2-year period, we surveyed a total of 372 hexagons and logged a distance of 14,200 survey kilometers. Effort was almost evenly divided between Boreal Shield (48% of all hexagons) and Hudson Plains (52% of all hexagons) ecozones. We detected wolverine tracks in 21% of the surveyed hexagons. We recorded wolverine presence in a significantly higher proportion of hexagons in the more heavily forested Boreal Shield ecozone than in the Hudson Plains to the east (26% vs. 16%; $X^2=5.14$, $p=0.02$). The program WINBUGS was used to map the probability of occurrence for wolverines across the survey area. The survey documented a broader distribution of wolverines than was previously known and indicated that wolverines were most abundant in the western portion of the survey area.

Wolverine predation on moose in North America

Magoun, Audrey, Geoff Carroll, John Krebs, Eric Lofroth, and Patrick Valkenburg

There are published accounts of wolverines killing moose in Scandinavia and Russia, but no cases of moose predation by wolverines have been documented for North America. We provide details and photographs of three instances of suspected moose predation by wolverines that occurred in Alaska and British Columbia. Tracks and fresh blood in the snow as well as wounds on the moose indicated that wolverines were responsible for the death of the moose. In one instance, a wolverine was observed attacking the moose, which had blood on its head and shoulders, but the actual kill was not observed; the moose was found dead the next day and the wolverine was feeding on the head. Subsequent visits to the kill site revealed 3 different wolverines and 5 red foxes feeding on the carcass. The carcass was still being visted daily by these species 11 days after the kill, at which time approximately 30% if the carcass remained. In at least two cases, deep snow probably contributed to the wolverines' ability to kill the moose, which were both subadults and in average winter condition based on bone marrow. One adult moose was in poor winter condition with only 8% bone marrow fat; this moose was killed by a radio-tagged, 6-yr-old female wolverine that was known to have also killed at least 3 caribou over a 4-yr period.

A review of the condition of the wolverine in northern European Russia

Makarova, Olga

In the beginning of the last century the wolverine was probably a rather common animal in the northern areas of Europe. In Russia the southern border of distribution of wolverine reached the Leningrad region and even Estonia. In the northern regions the number of species was the highest, gradually decreasing to the south. On the Kola Peninsula the wolverine was rather numerous up to 1960's. Records of fur stocking affirm this. In the period from 1946 to 1966, several tens of animals were annually extracted and hunters delivered 37-40 skins on average. In the same years according to the data from the management of the hunting facilities, 300-500 animals lived in Murmansk area. In the 1980's only 200 individuals were estimated, at a density of 0.01-0.02 per 1,000 hectares. Because of the sharp reduction of wolverine numbers, prohibition on hunting was introduced in 1986, but the population continued to decline and by the end of 20th century, the population hardly exceeded 100 individuals. During the last years, the inventory numbers became a little bit higher. Management personnel regularly make winter inventories. However, inventories do not occur over the whole of the species' habitat and, therefore, a full inventory of the animal is not possible. The wolverine is more often noted in northeast and southeast areas where domestic deer are basically concentrated. According to the winter inventory in 2003, the highest numbers were found in these areas: 0.43 and 0.45 tracks per 10 km of survey route. Much more seldom, the wolverine was found in other areas of the Murmansk region; in Pechenga and Kovdor municipalities, it was not registered at all. According to our opinion, the winter inventory by tracking does not always give a true assessment of a population. The number of routes should be considerably more. However, it is possible that the situation became better in recent years, and the number of wolverine in the Kola Peninsula population has exceeded 200 animals. According to the calculations for 2004, the number of wolverines in the Murmansk area was 330. Nevertheless, the population has not yet reached a level similar to that of the middle of the last century, therefore, the wolverine is included in a list of rare species of the region and in the Red book for the Murmansk region. The wolverine is included in a group of species subjected to "biological supervision", a rather vulnerable group within the northern biocoenosis. Species with the designation "biological supervision" require special attention to their status. A similar situation exists in Karelia. Up to the end of the 1960's and 1970's, the wolverine was common, and in northern areas of Karelia even numerous. The average number was approximately the same as in the Kola Peninsula, up to 500 animals. The density of the population noticeably decreased from the north to the south, 0.34 to 0.20 to 0.10 tracks per 10 km. During the following years, the number of wolverines declined, and during the last years of

20th century, did not exceed 200-300 individuals. The wolverine is also included in the Red book of Karelia. In the beginning of the 21st century, the situation is improved somewhat. In 2003 according to the winter inventory, the number of tracks was 0.11 per 10 km of route for Karelia as a whole, but higher numbers were noted in the northern areas of Karelia: in the region of Kostomuksha tracks reached 0.38, in the Kalevaliskii region 0.27, and in the Louhskii region adjoining the Murmansk region, 0.22. In southern Karelia -in Priladozhie - a wolverine is seldom seen and not each year. In the Leningrad region, the wolverine population was never high relative to other areas and obviously was higher in northern communities. In a more favourable period at the end of the 1960's and in the beginning of the 1970's, about 20 animals lived here, basically on the Karelian isthmus. The wolverine is included in the Red book of the Leningrad region.

Using genetic analysis to estimate wolverine abundance in northern Canada

Mulders, Robert, John Boulanger, and David Paetkau

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Wolverines at the southern limit of distribution in Ontario: preliminary results from 2005 aerial surveys

Ray, Justina, Audrey Magoun, Neil Dawson, and Jeff Bowman

Wolverines have been classified as threatened in Ontario, with most of their range occurring in unroaded, undisturbed areas north of the 50th parallel. With active planning underway for logging and other development activities to move northward, information is needed to guide recovery and land use planning. For example, factors that influence distribution and abundance of wolverines in lowland boreal forest are little known. In order to develop specific recommendations for wolverine management guidelines (particularly in relation to forestry activities), we conducted aerial track surveys in a 60,000-km^2 study area in northwestern Ontario from January through March, 2005. This poster describes the rationale and scope of the study and preliminary results. Our study area spanned a wide gradient of human disturbance to investigate the relationship between patterns of wolverine track distribution and the distribution and disturbance levels of forest habitat produced by logging activities and roads. The study area was divided into 100-km^2 hexagons, and transects that passed through the centers of the hexagons determined the flight routes of the survey aircraft (PA-18 Supercub). The area was surveyed multiple times with each hexagon examined for tracks 1-6 times. We surveyed a total of 585 hexagons, with 38% surveyed once, 41% twice, 16.8% three times, 3% four times, and 1% 5-6 times. We recorded the location of tracks and sightings of wolverines, wolves, caribou, fisher, and moose. In the case of wolverines, we recorded 231 locations, with sign of this species present in 148 hexagons (25.3%) and mostly concentrated in the northern half of the study area. The rather abrupt cessation of tracks in the southern portion of our study area may be due to any number of causes, including roads or other anthropogenic factors, food availability, climatic factors, forest cover types, wolf numbers, and other potential predators and competitors. We also consider the possibility that wolverines are currently expanding their range in Ontario and that our study area captured the fringe of an expanding wolverine population. We discuss how we plan to examine the relationship of wolverine track distribution to these factors.

Food availability and the viability of North American wolverine populations

Reid, Donald

Wolverine population viability will vary with food availability, though human harvest and disturbance are also proximate limiting factors. I argue that food availability needs more attention, especially with regard to energetic demands of females. Reproductive females experience about 30% increment to maintenance energy during pregnancy, and 150-300% increment during lactation and post-weaning food provisioning. Litter growth rates are among the highest recorded for mustelids. Satisfying increased energy demands will require a relatively predictable food supply in space and time compared to carrion scavenged from other predators. In North American cordilleran and tundra regions, where wolverine populations are most robust, the timing of peak lactation, habitat use, and the dietary data indicate that females satisfy energy needs largely with terrestrial sciurids (*Marmota* and *Spermophilus* spp.). The exceptions are the arctic archipelago and Ungava Peninsula, where wolverine populations have historically been low and perhaps ephemeral, and terrestrial sciurids are absent. In these tundra areas, alternative but less predictable prey would include highly mobile caribou (*Rangifer tarandus*), patchily productive arctic hare (*Lepus arcticus*), and periodically irruptive arvicolid rodents (*Dicrostonyx*, *Microtus*, *Lemmus*). In boreal forests, where wolverine populations are less abundant and more variable in productivity, female energy demands may depend on snowshoe hares (*Lepus americanus*), though only periodically, and semi-aquatic mammals (*Castor canadensis* and *Ondatra zibethicus*), though only patchily. For wolverine conservation, I suggest that reintroduction to tundra habitats lacking terrestrial sciurids may be a wasted effort, that the impact of climate change on terrestrial sciurids needs to be monitored, and that habitat suitability models need to prominently include terrestrial sciurid abundance and productivity.

Occurrence and distribution of wolverines in Labrador, Canada: an aerial survey to clarify status and focus recovery

Schmelzer, Isabelle, Allan McNeill, Gerry Yetman, Audrey Magoun, and Justina Ray

We report on a large-scale systematic aerial survey of wolverines in Labrador. The survey was undertaken due to a shared desire between the Labrador Inuit and Newfoundland and Labrador wildlife biologists to learn more about the ecology and broad-scale distribution of wolverines in Labrador. Trapping records and historical accounts indicate that wolverines once occurred throughout Labrador. However, beginning in the mid 19th century, and following the collapse of large caribou herds, they became scarce. Since then caribou herds have recovered, and numerous accounts of sightings and/or tracks have been reported. Uncertainty regarding current conservation status, and of the Eastern wolverine population as whole, constrains the ability to choose biologically-appropriate recovery measures. For example, whether the recovery goal of a self-sustaining population of 100 wolverines could best be achieved via a reintroduction, a supplementation of existing animals, or through a natural recovery is unknown. The study area was divided into a tessellation of 1000-km² hexagons and a total of 236 hexagons, covering 7600 km, were surveyed during March of 2005. The surveys were conducted using two PA-18 Supercubs by pilot/observers experienced in tracking wolverines from the air, and by Inuit wildlife technicians familiar with the landscape, wildlife, and weather. Information on presence of caribou, moose, wolves, beaver, and other species were recorded, as were signs of human activity (snowmobile tracks, dwellings). Habitat types within hexagons were described and photographed in an effort to depict course-scale habitat characteristics. The survey was part of a larger recovery program, including complementary activities such as hair snagging and camera trapping, and an ongoing stewardship program that facilitates sharing of local and scientific knowledge. Results will assist in establishing recovery priorities at both regional and national levels, and in refining non-invasive monitoring techniques that will be used to assess the success of future recovery efforts.

Abstracts Author Index

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