BOREAL WOLVERINE: A FOCAL SPECIES FOR LAND USE PLANNING IN ONTARIO'S NORTHERN BOREAL FOREST

PROJECT REPORT – JULY, 2004

AUDREY MAGOUN, THE WOLVERINE FOUNDATION
NEIL DAWSON, ONTARIO MINISTRY OF NATURAL RESOURCES
JUSTINA RAY, WILDLIFE CONSERVATION SOCIETY CANADA
JEFF BOWMAN, ONTARIO MINISTRY OF NATURAL RESOURCES
CATHERINE LIPSETT-MOORE, ONTARIO MINISTRY OF NATURAL RESOURCES
GEOFF LIPSETT-MOORE, ONTARIO PARKS

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Note: Due to file size constraints, most figures referred to in this report are contained in a separate Appendix, downloadable from http://www.wolverinefoundation.org.

SECTION 1: EXECUTIVE SUMMARY

The lack of knowledge on the ecology of wolverines (*Gulo gulo*) in low-elevation boreal forest systems jeopardizes our ability to conserve populations of this species in Ontario or to attain recovery in eastern Canada. Over a two year period, The Wolverine Foundation, Ontario Ministry of Natural Resources, and Wildlife Conservation Society partnered in a project to further our knowledge of the baseline ecology, broad-scale distribution, and conservation status of wolverine in northern Ontario.

The first months of the project were spent preparing for fieldwork that began in December 2002. All project partners attended a Wolverine Workshop in Monterey, California in November 2002 sponsored by The Wolverine Foundation, where we met with most of the wolverine researchers from North America and Scandinavia and discussed our project and the various research methods that are currently being utilized to study wolverines. A base of field operations was established in Red Lake and 2 years of fieldwork were conducted, which included live-trapping and collaring wolverines, deploying remote camera "traps", and collecting wolverine hair in barbed-wire snares for DNA analysis. Surveys of wolverine tracks in the intensive and extensive study areas were conducted over a 2-year period. Two pilots from Alaska with extensive experience tracking wolverines carried out the surveys in February of 2003 and 2004. In a separately funded but complementary project, we conducted interviews in northern First Nations communities to collect indigenous knowledge regarding wolverine in northern Ontario.

We captured seven different wolverines (four females and three males), all in the second field season. One wolverine, after wearing a satellite collar for a month, was accidentally caught and killed by a trapper. Her collar was removed and placed on another wolverine. Locations from these wolverines indicated that wolverine home ranges in the study area were within the range of or somewhat larger than the sizes reported in the literature for wolverines in other habitat types depending on the methodology used to calculate home range size. The use of ARGOS satellite locations may inflate actual home range size to an unknown extent because of the variable accuracy of many locations, although noticeably inaccurate locations were removed prior to analysis and satellite locations did put the aerial tracking crew in the proper vicinity to begin VHF tracking. We will evaluate the accuracy of the ARGOS data for determining home range size by comparing these locations to the VHF locations. As in other studies, the denning female had the smallest home range, while subadult males had the largest. Daily movements of the wolverines were also similar to that reported in the literature from other studies. While home range polygons of the wolverines included both logged and unlogged areas, nearly all VHF locations were in mature stands of trees or other unlogged habitat types. The ARGOS/VHF collars made it possible to determine that wolverines in the intensive study area are resident animals and that denning occurs in the area.

Over the two field seasons, we obtained 30 wolverine pictures from which at least five wolverines were identified. Using the cameras, we identified at least two additional wolverines in the intensive study area that were not captured in live traps. Identification of individual wolverines using distinctive chest/throat patterns was possible using active

infra-red cameras (TrailMaster), but less successful with passive infra-red cameras (CamTrakker), although overall coat color made it possible to distinguish between at least two unmarked wolverines caught on film by the CamTrakker cameras. Use of active infrared cameras to reliably document wolverine chest patterns requires further testing and refinement of a field protocol for deploying the cameras.

We collected 31 confirmed or possible wolverine hair samples from 63 systematically deployed hair snares in a 2000-km^2 sampling area. Six additional hair samples were obtained at snares deployed opportunistically. We are awaiting the results of DNA analysis on the hair samples. Further testing of the hair sampling techniques is planned in order to refine the sampling protocol.

Over the 2-year period of the extensive surveys, we sampled a total of 372 hexagons (1000 km^2 in size) using 14,200 km of transect lines in northern Ontario. We recorded wolverine tracks present in a significantly higher proportion of hexagons in the forested Boreal Shield portion of the extensive study area (26%) than in the Hudson Plains to the east (16%), with an overall detection rate of 21%. Wolverine presence at the 1000-km^2 scale was correlated with moose and caribou presence in the extensive study area but not with wolf presence. A revised map of wolverine distribution in Ontario based on these surveys will be made available on The Wolverine Foundation website (http://www.wolverinefoundation.org).

We flew two aerial track surveys in the intensive study area (100-km^2 hexagons), one in January 2004 and one in March 2004, during which we detected 18 and 14 sets of wolverine tracks, respectively. At the 100-km^2 scale, we detected tracks in 25 hexagons. Only 3 hexagons had tracks in both surveys. We compared the results of the intensive survey with that of the extensive survey and found that the locations from the intensive survey fell within 11 of the extensive survey hexagons that overlay the intensive study area. Flying more intensively (closer transects) did not improve the rate of detection at the 1000-km^2 scale, but repeated surveys did improve the detection rate. Repeating the intensive survey after a 6-week interval increased the overall number of hexagons with detectable tracks by 53%. Most wolverine tracks were detected in the northwestern and northeastern quadrants of the intensive study area.

Interviews with First Nations trappers were conducted in five northern communities resulting in 94 interviews, each lasting 0.5-2.5 hours in duration. These interviews yielded information on 100 wolverine harvest events and 121 spatially-explicit locations of harvested wolverines since 1990. We were able to match up nearly all of the wolverines harvested with fur harvest returns since 1990. There was no evidence of systematic targeting of wolverines; harvest appeared to be opportunistic in most instances. The number of First Nations trappers in northern Ontario appears to have dropped over the past 20 years in all five communities, probably resulting in a decrease in overall trapping pressure in northern Ontario. The general impression resulting from the interviews was that wolverines have been stable or possibly expanding their range since the 1980's. Wolverines are still harvested close to population centers. Additional interviews are planned for August 2004.

A draft of our preliminary habitat model was developed using logistic regression and resource selection functions to predict occurrence of wolverines across Ontario. Wolverine occurrence was derived from aerial track surveys, trapline data, and opportunistic sightings/roadkills. None of the variables used as predictors appeared to be strongly related to wolverine presence. Wolverines were more likely to be observed near the core Manitoba population, with other variables providing no additional explanatory or predictive power. When just the western half of the study area was considered, beaver density gained some explanatory power in the model as did amount of water on the landscape. Our next step will be to reexamine the variables we used as predictors and determine if there are ways we can incorporate variables likely to be more predictive of wolverine occurrence, for example, a combined prey density index. However, it may not be possible to model wolverine habitat in Ontario using these techniques with currently available GIS data layers.

The success of this project has considerably heightened knowledge and interest in this elusive animal over the period of this grant. Numerous newspaper and magazine articles as well as radio interviews have enlightened the general public's awareness of wolverines in managed forests in Ontario. The information gathered on the distribution and ecology of wolverines in Ontario in just 2 years has established a solid foundation for future work on this species in boreal forests and has formed a basis for preliminary management guidelines in Ontario.

We will be engaged in much more in-depth analyses of data collected during this project for the remainder of 2004 and results will be submitted for publication in scientific journals and will also be presented at the First International Wolverine Symposium in Sweden in June 2005. Many newspaper articles and radio programs have highlighted the project and more are planned. The final report and deliverables as well as other publications resulting from the project will be posted on The Wolverine Foundation website for at least 5 years (www.wolverinefoundation.org). We are also seeking funding to continue field research on wolverines in the intensive study area in winter 2005.

SECTION 2: BACKGROUND, OBJECTIVES, AND STUDY AREA DESCRIPTION

Background - Wolverines (*Gulo gulo*) are considered a Species At Risk in Ontario and in Canada at large. In the past, little if any attention was paid to this wide-ranging carnivore in Ontario because harvests were generally low and wolverines occurred primarily north of current forest management activities. Lowland boreal forests, characteristic of central and eastern Canada, are possibly low quality habitat for wolverines and may carry the lowest density and least resilient populations of this species in the country. As there is considerable question as to whether viable populations still remain in Québec and Labrador, Ontario is currently responsible for the most easterly viable wolverine population in North America. Along with the new proposed Threatened status for wolverines in Ontario, there is a legal requirement that a recovery strategy and action plan be prepared within two years of listing. The major gap in strategy development is the lack of basic ecological data on the species in the Ontario context. This is a critical time in the future of wolverines along the southern portion of wolverine range in Ontario because timber harvest activities currently occur in the Red Lake area and are proposed to proceed further north as part of the Northern Boreal Initiative, a provincial government-led land use planning exercise. Because wolverines have demonstrated sensitivity to human disturbance and development, current activities make this a compelling time to learn more about wolverine ecology in Ontario and the relationships between wolverine habitat use, forest management, protected areas, and other human activities.

Project Goals and Objectives - The principal goals of this project were to gain a better understanding of the ecology of wolverines inhabiting low elevation boreal and tundra ecosystems of Ontario, and the effects of forest management and increased development on wolverine habitats and populations. The specific objectives of the study were to:

A) Refine our knowledge of wolverine distribution and develop a first-generation spatial habitat model for wolverines in northwestern Ontario;
B) Test the feasibility of using satellite/VHF collars to document home range, movements, habitat selection, and residency status of wolverines in low elevation boreal forests;
C) Develop and test tools for inventory and monitoring of wolverine populations in eastern boreal forest habitats;
D) Develop interim management guidelines and recommendations for maintaining or expanding wolverine populations in northwestern Ontario in areas of timber harvest or potential timber harvest;
E) Establish an action plan for more detailed studies on wolverine ecology, status and distribution, habitat use, and impacts of timber harvest and other activities on wolverines in eastern Canada.

Study Area - The extensive study area (Fig. 1) was divided into 1000-km^2 hexagons (estimated minimum home range size for resident adult male wolverines). In the second field season, we abandoned the stratification scheme for the extensive study area detailed in our May 2003 progress report (based on caribou model, snow depth, and ruggedness) when we realized that this design was prone to classification errors that left out hexagons with features that may be important to wolverines. Instead, we surveyed as much of the area as possible, with nearly 100% coverage in the eastern portion where the eastern limit to wolverine distribution was unknown and we anticipated wolverine occurrence would be low (Fig. 2). Roughly equivalent coverage of Environment Canada's Hudson Plains and Boreal Shield ecozones allowed for comparisons between these very different habitat types. The intensive study area was divided into 100-km^2 hexagons (estimated minimum home range size for adult resident female wolverines) and extended to the Manitoba border to include Woodland Caribou Provincial Park as a control (i.e., unlogged) area (Fig. 3).

The study area was divided into two units: 1) the *intensive study area* (27,900 km^2) was located in the Red Lake/Ear Falls area, where we tested several survey techniques (live-trapping, satellite radio-tracking, aerial surveys, hair snaring, and camera "trapping") in both logged and unlogged habitats; and 2) the *extensive study area* (599,000 km$^{2)}$ extended from latitude 50º north to the Hudson Bay coast and from the border of

Manitoba east to James Bay, where interviews to obtain ecological knowledge from First Nations and broad-scale aerial surveys were conducted to obtain information on the distribution and status of wolverines throughout the rest of the province. Additional figures (Fig D-G) depicting aerial survey routes and sampling designs for live trapping, camera trap, and hair snare deployment can be found in the Appendix.

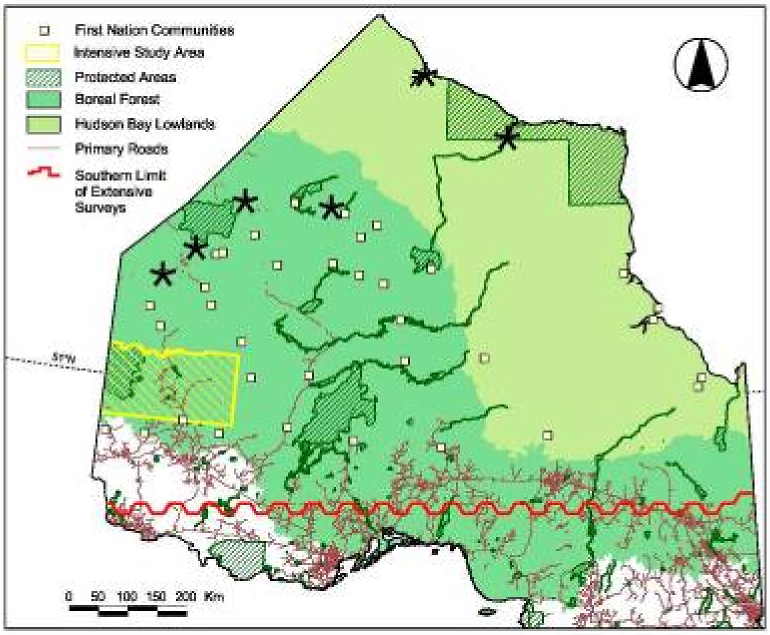

Figure 1. Map of study area, including the extensive survey area (599,000 km2; north of the red line), the intensive survey area (27,900 km2; yellow hatched area), and First Nations communities where interviews have been or will be conducted (asterisks).

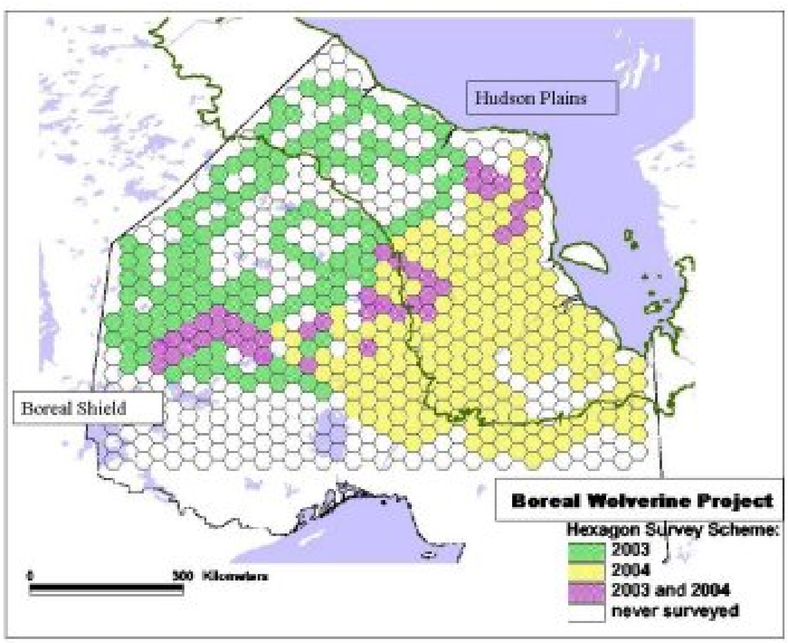

Figure 2. Extensive aerial track survey sampling scheme in Ontario, 2003 and 2004.

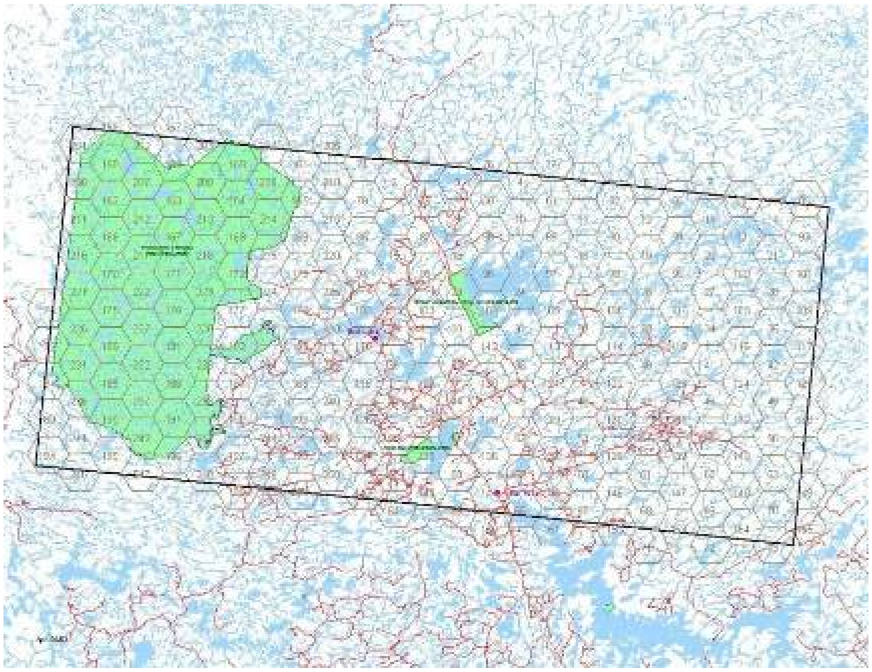

Figure 3. Intensive study area near Red Lake, Ontario.

<u>SECTION 3: DETAILS ON MEETING PROJECT OBJECTIVES</u>

Specific objectives for the study have been or will be met in the following manner:

Objective A: Refine our knowledge of wolverine distribution and develop a first-generation spatial habitat model for wolverines in northwestern Ontario

<u>Wolverine Distribution</u>

Wolverine distribution was determined using a combination of aerial track surveys (described in section C), First Nation community visits and opportunistic observations and trapping records.

First Nations community visits - The following steps were taken to collect ecological knowledge from residents of six First Nations communities in the heart of wolverine range: a) obtained permission from the Chief and Village Council and scheduled a week-long visit; b) identified an individual from each community who agreed to act as a liaison to help recruit trappers and elders willing to share information about wolverines and translate during interview sessions; c) informed trappers and elders of the goals and objectives of the project and obtained consent for the participation of interested individuals; and d) visited communities and conducted informal interviews. We used a "semi-directive" interview technique, whereby the participant was guided in the discussions by the interviewer, but the direction and scope of the interview was allowed to follow the participant's train of thought. There was no fixed questionnaire, nor was there a time limit for discussions; the interviews were conducted more in the vein of a conversation than a question-answer session. Individual interviews with elders or trappers began by asking them to identify the broad areas where they had the most experience trapping during different periods of their lives. We then established the relative intensities (during certain time periods of the participants' lives) spent trapping and/or hunting to determine the relative amount of time they had spent out in the bush and therefore would have been more likely to encounter wolverines. The interview was also steered towards finding out what participants had been told about wolverines as children and descriptions of their first encounters with the animal. Other information that we obtained during the course of the discussion included extent of trapline damage by wolverines to other furbearer pelts, number of wolverines harvested (if any), method of harvest, motivation behind harvest (for fur or to prevent trapline damage/theft), general attitude towards wolverine, trends in rate of encounter with wolverines since their parents' time, natural history information, precise locations of sightings or harvests, and recounting of legends in which wolverine played a role. During the interviews, we used a 1:250,000 map of the area; most participants felt very comfortable transferring information onto maps. In 2003, community visits to First Nations communities took place January 7-14 (Sachigo Lake), February 5-12 (Sandy Lake), and March 3-10 (Fort Severn). In total, 60 interviews were conducted, ranging from 0.5-2.5 hours in duration. In 2004 visits to two First Nations communities took place January 14-21 (Big Trout Lake) and March 18-25 (Deer Lake), with a visit to Peawanuk scheduled for August 2004. Thirty-four more interviews were conducted, ranging from 0.5-2.5 hours in duration. This brings the total number of interviews to 93, with an additional 15-20 expected in Peawanuk. These interviews yielded information on 100 individual harvest events and 121 spatially-explicit locations since 1990 from all five communities.

An important advantage to conducting interviews on a relatively rare animal such as the wolverine is that, because lifetime harvest rate is generally low (only three of those interviewed reported more than seven harvests), most participants could recall the circumstances of each incident, the location of harvest, and the exact size class and price of their catches. In the five communities we visited, we could identify almost no use for wolverines other than to sell them to the fur auction, the exception being that in very recent years when a capture was considered rare, the trapper or his family kept the pelt, or in a few cases, had the wolverine mounted. We were able to match up almost all the recent harvests for which we collected information during the interviews (n=100) with those from fur harvest returns since 1990. The total numbers of wolverine harvests recorded from the interviews vs. those reported through fur auction returns were similar in all communities except in Fort Severn where the numbers recorded in the interviews were lower than the total harvest. Monitoring fur auction returns likely provides an accurate indication of the extent of wolverine harvest in northern Ontario. In spite of overall negative attitudes towards wolverines, there was no evidence of systematic targeting of this animal, which many consider to be a nuisance. Harvest was opportunistic or in response to real or potential threats to trapping success. The number of First Nations trappers in northern Ontario appears to have dropped over the past 20 years in all five communities, with work and education opportunities, the high costs of fuel and snowmobile maintenance, and relatively low fur prices drawing many residents off the land. This probably translates into a decrease in overall trapping pressure in these areas. The general impression derived from the interviews was that wolverine presence in areas surrounding the five communities we visited in 2003 and 2004 has been stable and possibly expanding since the 1980s. Wolverines are still being regularly encountered or harvested in very close proximity (within 1 km) of population centers. The interviews from the five communities yielded 121 spatially-explicit locations since 1990 (see Fig. H in Appendix).

Opportunistic observations and trapping records - Observations by the public, trappers, and field staff were collected during both seasons and will be considered in future analyses of results.We obtained carcasses of wolverines when possible and took measurements of these specimens and collected samples for DNA analysis. Three wolverines were accidentally trapped in the intensive study area over the two years, one young female in 2003 and a young female (F02) and young male in 2004.

Summary - With previous wolverine locations limited almost entirely to fur harvest reports, and then only at the scale of the trapline, the collection of 116 points from aerial surveys and 121 from First Nations interviews represents a considerable advancement in our knowledge of wolverine distribution in the most remote areas of the province. Whereas locations of wolverine encounters by First Nation community residents tended to cluster around the communities themselves, the results from the aerial surveys indicated a more even distribution across the northwestern Ontario landscape. Although in 2003 the highest density of wolverine locations collected from aerial surveys, including incidental observations not on survey routes, occurred where effort was the greatest (i.e., in the Red Lake/Ear Falls area in the southern part of the study area), this was not the case in 2004, where, as expected, we encountered significant "holes" in wolverine distribution towards the Québec border. Observations from aerial surveys will enable us to extend the current known distribution of wolverine further east than what it has been depicted in range maps from recent decades. At the same time, we have confirmed through interviews with northern trappers that wolverines have been expanding their range eastward over the past ca. 20 years as reported in Dawson (2000). Additional quantitative analyses of presence/absence (i.e., detected/not detected) data are planned; we will be publishing our results on wolverine distribution in Ontario and making a distribution map available on The Wolverine Foundation website.

Development of First Generation and Conceptual Habitat Models

Expert-derived habitat model - Audrey Magoun developed a preliminary conceptual model of wolverine habitat based on past wolverine research and constructed a decision-tree designed to identify habitat features that are likely to be important to wolverines in Ontario (this model is attached as a separate document). This preliminary model was presented to wolverine researchers at the Wolverine Workshop in Monterey, California in November 2002 and comments were solicited from attendees and others. Factors thought to influence wolverine distribution include climate, snow cover, predators and competitors, human activity and development, ungulate carcass availability, small prey for feeding kits in summer, distance to core reproductive habitat, and harvest pressure.

Preliminary Habitat Model - In June 2003, Ontario wolverine project partners met in Thunder Bay with Dr. Jennie Pearce of the Canadian Forest Service to discuss habitat attributes and other limiting factors as inputs into a preliminary wolverine habitat model based on our research experience and information available in the literature. In order to take into account the scale of mobility of wolverines, Pearce et al. (2004) calculated the average condition within a moving 20 and 50-km-radius window centered on each grid cell (1 km resolution) in turn. They used logistic regression and resource selection functions to model the predicted occurrence of wolverine across Ontario. Wolverine occurrences were derived from our aerial surveys (systematic presence/absence), trapline data, and opportunistic sightings/roadkills (both opportunistic, presence only). They used multiple logistic regression to develop three alternate models for wolverine in Ontario – one presence/absence and two use-availability (compared against random points on the landscape). Few variables appeared to be strongly related to wolverine presence. Model results indicated that wolverines were more likely to be observed near the core Manitoba population, with other variables providing no additional explanatory or predictive power. When the study area was reduced to just the western half of the province, the distance-to-Manitoba variable was no longer important, but beaver density gained some explanatory power. The two models run with trapline data and sightings/roadkills yielded similar results, as did the combined model, with distance to Manitoba, beaver density, and amount of water on the landscape the factors with the most explanatory power. The report on the habitat model will be posted on The Wolverine Foundation website.

Summary - The results from the first generation habitat modeling effort did not reveal any explanatory variables for wolverine distribution; distance from Manitoba was the only variable that was statistically significant but we do not know if this is because wolverines are entering Ontario from a source population in Manitoba, thereby increasing the probability of detecting them near the Manitoba border, or because the habitat in the eastern portion of the study area is less suitable for wolverines (or possibly both of these alternatives). Given the wide-ranging nature of the wolverine, its use of different habitat types, and the limited data from northern Ontario with which to build appropriate model layers, it may not be possible to model wolverine habitat in Ontario until more information becomes available, especially on density of prey species.

While coming up with a useful static habitat model may not be possible, our aerial surveys and modeling suggested possible directions to take in answering two questions concerning wolverine distribution: 1) what limits Ontario distribution eastwards, and 2) what limits wolverine distribution southwards. For the first question, we plan to evaluate whether the eastern limit of Ontario wolverine distribution is related principally to the proximity of source populations further west, or whether there are other factors at play that might limit their continued expansion eastwards. For example, one possibility that wolverine presence was seldom detected in the James Bay Lowland of the Hudson Plains ecozone is that prey densities are too low to sustain breeding populations. The significant result with beaver density in some models was intriguing in light of our growing appreciation, through radio-tracking and interviews, of the importance of this animal in the diet of Ontario wolverines. The fact that beaver, caribou, and moose were considered separately in our initial modeling efforts was problematic and inadequate for providing a proxy variable for food availability. Therefore, our follow-up efforts to the modeling exercise will be to improve the prey availability layers by creating an index that combines beaver, moose, and caribou. The southern limit of wolverine distribution is likely influenced by human-induced disturbance and climatic factors, such as snow depth and number of thawing degree-days during denning (March and April), and it would be difficult to determine the extent to which each might contribute to restricting wolverine range. We are less likely to come up with a definitive answer to this question because of the complexity of the factors involved, but further enhancement of data layers combined with radio-tracking analyses may reveal more clues.

Objective B: Test the feasibility of using satellite/VHF collars to document home range, movements, habitat selection, and residency status of wolverines in low elevation boreal forests

<u>Live-trapping</u>

After using several designs for the log live traps, we developed a trap that was effective, easy to take apart and move, and cost approximately $200 in materials per trap. The trap was made of 4 x 4 timbers and was 32 inches (81 cm) wide and 66 inches (168 cm) long, giving a depth of approximately 24 inches (61 cm) (alternatively, 5 x 6 timbers can be used with one less per side). We used four 3 x 8 floorboards and 6 rows of 4 x 4's for the walls. The roof was made of eight 4 x 4's cut in 66-inch (168 cm) lengths, except for one that was cut to be longer by 4 to 6 inches (10-15 cm); this provided a handhold for lifting the lid. We cut four cross pieces for the lid that were 32 inches (81 cm) long. Three logs approximately 3 feet (1 m) long were cut from the forest, spaced apart on a flat area on the ground, and the floorboards were laid side-by-side across the three logs and nailed to the logs with small spikes that were easy to remove when the trap was disassembled. The walls were pre-fabricated as separate pieces; the 4 x 4's for the long sides were cut in three 58-inch (147 cm) pieces and three 66-inch (168 cm) pieces per side; the 4 x 4's for the front and back sides were cut in three 24-inch (61 cm) pieces and three 32-inch (81 cm) pieces.

The sides were then built by alternating the lengths of the 4 x 4's in an interlocking pattern; the pieces of each side were spiked together as the walls were built up, but the four sides were not spiked together. So that the trap could be disassembled easily, we used lag bolts to join the four walls together once the trap was in place. The roof was built as one piece or in two lengthwise pieces that could be disassembled. Metal hinges were used to hold the door in place. On some traps, an inside false wall at the front of the trap was made with six pieces of 24-inch (61 cm) 4 x 4's to prevent wolverines from chewing out. On other traps, a 24-inch (61 cm) "chew log" was attached to the inside of the front wall just under the lid to give the wolverine an opportunity to chew on a piece of the trap that is easily replaced; most wolverines chewed near the front of the trap where they entered. The trigger mechanism included a cable that runs from an eye hook at the top of the front of the lid up and through another eye hook on a cross piece mounted above the trap on two uprights attached to the sides of the trap and down through an eye hook at the top of the back of the trap, where it dropped down to a panic snap release near the on the back of the trap; a bait cable was connected to the bottom of the panic snap and run through a small hole near the bottom of the trap and into the trap where it is attached to a bait. We will make a detailed description of the trap available on The Wolverine Foundation Website and are planning to submit the design for publication. See Appendix (Fig. I) for photo of live trap design.

Thirteen live traps were deployed by the end of the first field season (December 2002-April 2003). The earliest that traps were activated in the first season was January 31 and the latest April 19. Low visitation by wolverines to the live traps in winter of 2002/2003 led us to expand the trapping area and construct live traps in more remote areas with less human traffic. Sites that were selected in the first field season based on trapper reports of wolverine activity did not result in wolverine captures. Trap placement in the second field season, were based on recommendations by trappers and field personnel experienced in wolverine live-capture studies, combined with observations of wolverine tracks in the field by project personnel. As a result, in the second field season (November 2003 – April 2004), a total of 26 live traps were constructed and operated. The earliest that a trap was operational was December 13 and the latest March 24.

In the first field season, a total of 805 trap nights (TN) of effort occurred. No wolverines were captured; however, 7 marten, 3 red fox, 1 fisher, and 1 raven were captured in the livetraps and released. In the second field season, the 26 livetraps were distributed over two traplines, a line north and west of Trout Lake with 14 live traps and line south and east of Trout Lake with 12 live traps. A total of 1,088 trap nights resulted in 9 captures of 7 different wolverines (2 recaptures). In addition 18 marten, 6 raven, 2 fisher, 2 lynx and 1 red fox were captured and released. On the northwest line, 508 TN of effort occurred, ranging from 1 to 68 TN per site. Wolverine capture rate on the northwest line was 1.18 wolverines per 100 TN. A total of 580 TN of effort occurred on the southeast line, ranging from 10 to 75 TN per site. Wolverine capture rate on the southeast line was 0.52 per 100 TN. For the north and south lines combined, the wolverine capture rate was 0.83 per 100 TN in season two. Combining effort for the two field seasons, the wolverine capture rate was 0.48 per 100 TN.

In season 2 a new wolverine captured every 2-3 weeks (Table 1). Three wolverines were captured in February with 1 recapture, 2 in December, 1 in January with 1 recapture, and 1 in March. The nine captures occurred at seven different sites; the two sites with multiple captures each caught two different animals. The two recaptured animals (M01 and F03) were recaptured at sites different from that of their original capture, in each case at the next closest live trap to the one they were originally captured in. Captured wolverines were immobilized and processed according to approved OMNR Animal Handling Protocols (03-77 and 04-77). Mean weight of the four females was 9.9 kg and for the three males 13.6 kg. Five of the seven animals were subadults.

Table 1. Capture date, body weights and estimated ages[1] for wolverines captured in the intensive study area, 2003-2004.

ID	Capture Date	Weight (kg)	Estimated Age (years)
F01	December 14	9.5	1
F02	December 25	9.7	1
F03	February 7	9.3	1
F04	March 23	10.9	2 – 3
M01	January 15	13.1	2
M02	February 24	12.9	1
M03	February 28	14.7	3 - 4

[1]Ages estimated by tooth wear and teat or testicle size

Radio Telemetry

Audrey Magoun worked with Kevin Lay from Sir Track Wildlife Tracking Systems of New Zealand to improve the design of the standard wolverine radio collar normally used in wolverine research. The new-collar design is rolled leather instead of flat machine belting and minimizes discomfort to the animal and hair damage. The design is now being used in other wolverine study areas, and other manufacturers of telemetry collars for wolverines are experimenting with the rolled collar design. All six ARGOS satellite/VHF collars purchased from SirTrack Wildlife Tracking Systems of New Zealand (see Fig. J in Appendix) were deployed on wolverines between December 14, 2003 and March 23, 2004. As of this writing, collar deployment has ranged from 4-22 weeks per individual wolverine; all VHF collars were still functional on April 8, 2004 when VHF tracking ended and four ARGOS collars were still regularly generating data at the time of this report. A trapper accidentally captured a collared wolverine (F02) in a 330 Conibear trap 1 month after the collar was first deployed. The collar was removed from the dead animal and redeployed on another wolverine (M03) after minor repairs were made to the epoxy coating on the outside of the electronics package. There was no apparent damage to F02 from wearing the collar and no wear on the fur around the neck of the animal.

Radio-tracking most of the collared wolverines using the VHF radio signal began in late February 2004; F02 died on January 25 and was not tracked and F04 was not captured until March 23, so tracking her commenced the next day. We used a PA-18 Supercub to radio-track and attempted to track the wolverines daily or twice daily if weather permitted. On a few occasions, some of the wolverines were tracked three times per day. Average number of VHF locations for the six wolverines was 30 (range 14-38) for the tracking period (February 24-April 3). In addition to the wolverine's exact location, we also recorded habitat type, structures such as blowdown or boulder piles, evidence of feeding or hunting, scent-marking behavior for wolverines seen from the air, den location and use, and other information. VHF locations will also be used to check the accuracy of

ARGOS satellite location and to determine the usefulness of ARGOS collars for determining home range and movements of wolverines in boreal forest landscapes.

ARGOS satellite and VHF telemetry data for each wolverine for the period from capture to April 30, 2004 have been included in this preliminary analysis. Outlier and incorrect locations in the satellite data were removed prior to home range and movement analysis. Table 2 provides a summary of location classes for the satellite locations received for each animal; the results are quite variable depending on the individual collar. Class Z locations are unsuccessful attempts (i.e., non-location) with the satellite unable to provide a coordinate fix. Class Z locations accounted for 34.9 – 75.8% of the locations for each animal.

Table 2. Summary of satellite locations by Argos Location Class for wolverines collared in the intensive study area, 2003-2004.

			Argos Location Class								
Wolverine	PTT	Dates	1	2	3	0	A	B	Z	% Z	Total
F01	39771	Dec 14 – Apr 30	7	3	0	2	14	25	160	75.8	211
F02	39774	Dec 25 – Jan 25	10	3	0	5	23	38	57	41.9	136
F03	39773	Feb 7 – Apr 30	11	6	6	3	11	37	101	57.7	175
F04	39770	Mar 23 – Apr 30	10	4	1	5	20	40	64	44.4	144
M01	39775	Jan 15 – Apr 30	1	1	1	2	10	22	68	64.8	105
M02	39772	Feb 24 – Apr 30	11	6	6	11	32	52	136	53.5	254
M03	39774	Feb 28 – Apr 30	8	5	5	7	26	48	53	34.9	152

Preliminary home range calculations were made using the 95% Minimum Convex Polygon (MCP) and Kernel estimation techniques using the Animal Movement Extension developed by Hooge and Eichenlaub (1997). Both ARGOS satellite and VHF locations were combined in home range calculations. Table 3 summarizes preliminary home range calculations for the collared animals and Fig. 4 depicts the home range locations. Female home range size averaged 671.6 km^2 (n = 4) using the 95% MCP method. Using the Kernel home range estimator, with 95% and 50% use areas specified, female home range size averaged 736.8 km^2 with an average core area (50% use area) size of 87.8 km^2. Male home range size averaged 3,810 km^2 (n = 3) using the 95% MCP method. Similarly for the Kernel home range estimator, male home range size averaged 3,063 km^2 (95% use area) with an average core area (50% use area) of 342.9 km^2.

A preliminary indication of day-to-day movement was determined by measuring the distance from the last recorded location on the initial day to the first recorded location on the next day using program Path v.3.1 (a.k.a. pathfind.avx) (Jenness 2003). Mean day-to-day distance traveled for females (n = 4) was 7.3 km and 13.8 km for males (n = 3) (Table 4).

Table 3. Summary of preliminary home range calculations for collared wolverines based on combined data from ARGOS satellite and VHF transmitters. Areas in km^2.

Wolverine	95% Minimum Convex Polygon	Kernel Home Range Estimate	
		95% Use Area	50% Use Area
F01	956.5	963.6	133.5
F02	533.7	866.4	149.3
F03	679.6	891.3	46.9
F04	516.6	226.0	21.7
M01	3762.7	1198.0	242.1
M02	5715.3	5269.8	484.5
M03	1955.0	2722	302.1

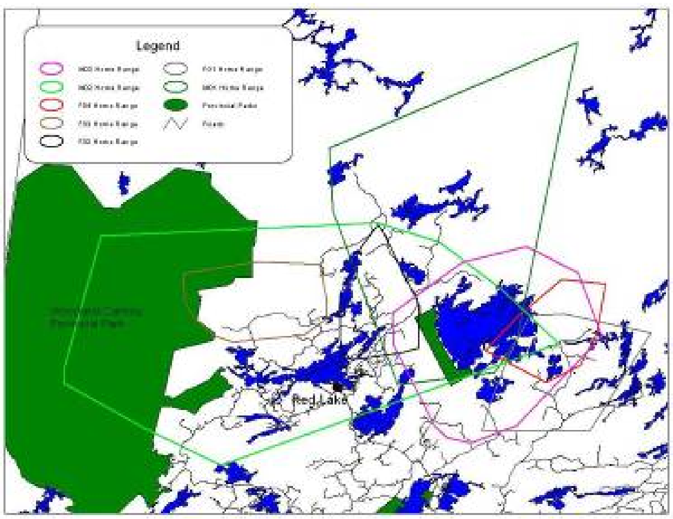

Figure 4. Home ranges of radiocollared wolverines in northwestern Ontario using ARGOS satellite and VHF radio locations.

Table 4. Preliminary summary of collared wolverine movements between consecutive days (last location of day 1 to first location of the day 2; combined data from ARGOS satellite and VHF).

	Distance Category							
Wolverine	0–5 km	5–10 km	10–15 km	15–20 km	>20 km	Range	Mean	N
F01	18	10	5	4	2	0.07 – 27.7	7.68 km	39
F02	8	4	0	1	1	0.36 – 23.0	5.78 km	14
F03	14	7	4	0	2	0.18 – 23.2	6.79 km	27
F04	6	11	7	2	1	0.35 – 25.6	8.91 km	27
M01	16	5	3	0	4	0.00 – 26.6	6.65 km	28
M02	6	4	2	3	11	1.77 – 52.6	17.8 km	26
M03	7	3	4	6	12	0.47 – 46.7	16.9 km	32

M01 undertook what are assumed to be exploratory movements on three occasions. On two occasions he traveled northwest about 85 km before returning to his main area of locations. As of April 7, 2004 he was moving northeast, last recorded roughly 90 km from his main location area. All three exploratory movements were away from the managed forest into areas north of the current northern forest management zone. M02 spent only a short time near his capture site before moving roughly 100 km west to an area in and adjacent to Woodland Caribou Provincial Park where he continues to reside. M03 appeared to travel a circuit around Trout Lake and also made a number of visits to the den site of F04 during April; F04 continued to use the den site after these visits. F01's early activity was concentrated north of Joyce Lake and east of Trout Lake, but she has shifted her activity southwest since March. F02 spent the first week in the general area of her capture before moving south approximately 35 km towards Cochenour where she spent a few weeks before being accidentally killed in a trapper's set. F03 has spent the majority of her time in the same general area in or near Woodland Caribou Provincial Park with no apparent exploratory movements in any specific direction. Over half of her locations were in unlogged habitat, but many locations were in intermediate-aged, regenerating forest following wildfire. F04 is an adult female and her movements in March and April were generally to and from her den site on a daily basis. The den site was on a small hill covered with mature mixed forest. The female was repeatedly located in three different areas on the hill, one in or near a boulder area and the other two under snow-covered fallen trees.

Summary – From a design standpoint, the box that houses the PTT/VHF electronics on the Sir track collar must be modified to reduce damage to the epoxy housing. On a collar that was retrieved after being worn by wolverine F02 for one month, the epoxy had begun to crack and chip off the face of the housing where it was apparently struck against rocks. Both antennae were still intact. A unit of the same type had been worn by a wolverine in Montana for a year and had stopped functioning after 6 months; all of the epoxy had been chipped off the front of the housing and both antennae had been broken or chewed off at the bases. The manufacturer is now modifying the design to protect the housing from damage, but the protection of the antennae is a more difficult problem to correct. Data delivery from the ARGOS satellite collars has been variable and may be due to antennae problems, although failure to transmit may be caused by other problems with the PTT. The VHF units continued to function throughout the tracking period, indicating that the antennae remained intact or, if broken, the radios were still able to transmit a signal to the tracking receiver. Despite the problems with the collars, we would recommend the collars to other researchers studying wolverines in lowland boreal forest because of the amount of information obtained from the collars and the cost effectiveness of the collars compared to VHF radio-tracking for general home range information movements, and residency status for wolverines. On the other hand, collars are not suitable for detailed habitat-use analysis because the accuracy of locations is variable depending on location class and data for portions of each day are unavailable due to battery limitations on duty cycles and low satellite coverage at night in northwestern Ontario. The combination of VHF and ARGOS satellite options available with the Sirtrack collars appreciably improved the quantity and quality of information that we were able to obtain for the collared wolverines. GPS collars may be more appropriate for detailed habitat work but this technology was not sufficiently tested on wolverines in time for this study.

Objective C: Develop and test tools for inventory and monitoring of wolverine populations in eastern boreal forest habitats

Aerial Track Surveys

Extensive aerial track survey - The extensive study area was divided into 1000-km^2 hexagons that approximated home range size for resident adult male wolverines. A transect approximately 34 km long through the center of a hexagon comprised a systematic sampling unit. Flight lines were planned to maximize the number of hexagons sampled given logistical constraints of refueling and stopovers. Surveys were flown during February of both years; tracking conditions were good in 2003 and variable in 2004, with some overcast days. We recorded precise locations of tracks and sightings of wolverine, wolf, and caribou as well as sightings of moose. We recorded tracks of moose, lynx, fisher, marten, snowshoe hare, and flocks of grouse or ptarmigan as well as habitat types and signs of human presence. In 2003, we surveyed 181 hexagons, covering a distance of 6,117 km over a 10-day period (9 survey days), while in 2004, we surveyed 234 hexagons, covering a distance of 8,083 km over 19 days (11 survey days). In 2004, we resurveyed 43 hexagons that had been surveyed in 2003. Effort was almost evenly divided between Boreal Shield (48% of all hexagons) and Hudson Plains (52% of all hexagons) ecozones (Fig. 2). Over the 2-year period, we surveyed a total of 372 hexagons and logged a distance of 14,200 survey kilometers.

Although the weather conditions were less favorable in 2004 than in 2003, we were able to satisfactorily complete almost all of the planned survey routes. Because information gathered from harvests and sighting reports indicated that wolverines were likely to be at lower densities (if present at all) in the eastern half of northern Ontario, we increased survey effort in that part of the survey area to increase our chances of documenting the easternmost distribution of wolverines in the region. 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; Table 5); wolverine presence was not nearly as evident in the eastern part of the study area, particularly in the James Bay Lowland ecoregion. Nevertheless, we recorded 11 new sets of wolverine tracks during the 2004 survey, extending the eastern known range of the wolverine in North America. In 2004, about 5% of 234 sampled hexagons had detectable wolverine tracks, in contrast to 2003 when 39% of 181 surveyed hexagons yielded wolverine tracks. The detection rate for wolverine for both years combined was 21% (Fig. 5).

Wolverine presence at the 1000-km^2 scale was correlated with moose and caribou presence in the extensive study area (Spearman's R=0.101, p=0.05 [moose]; R=0.106, p=0.04 [caribou]), but not with wolf presence. Like wolverines, wolves were significantly (26% vs. 16%; X^2=5.76, p=0.02; Table 5) more likely to be present in the Boreal Shield forest than in the Hudson Plains, but wolves had a different distribution pattern from wolverine, tending to be fewer in the northern Hudson Plains (Hudson Bay Lowland) and more frequent in the eastern part of the Hudson Plains (James Bay Lowland). Both caribou and moose were equally likely to be detected in the Hudson Plains and the Boreal Shield hexagons. Figures depicting aerial survey results for wolves, moose, and caribou can be found in the Appendix (Figs. M-O).

Table 5. Number of hexagons in the extensive study area in which four principal species were detected in the Boreal Shield forest vs. the Hudson Plains.

Ecoregion	Wolverine	Caribou	Wolf	Moose
Boreal Shield (n=177)	46 (26%)**	59 (33%)	46 (26%)**	149 (84%)
Hudson Plains (n=195)	32 (16.4%)	58 (30%)	31 (16%)	157 (81%)
Total (n=372)	78 (21%)	117 (31%)	76 (20%)	306 (82%)

** significant (Chi-Sq) difference in occurrence between the two ecozones

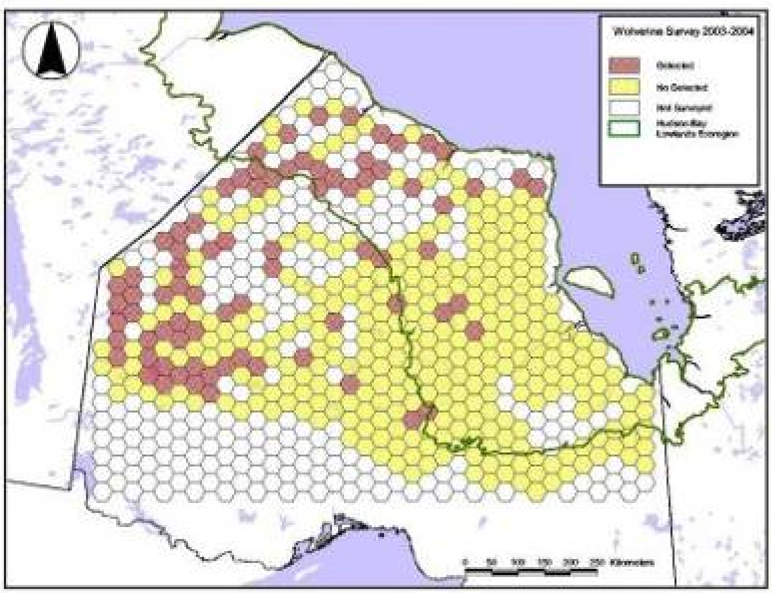

Figure 5. Distribution of hexagons with wolverine tracks detected during extensive aerial track surveys in February 2003 and 2004 in northern Ontario.

Intensive aerial track survey. The intensive study area was divided into 100-km^2 hexagons and flight lines were drawn through the centers of 118 hexagons, using the same methodology as the extensive track surveys (Fig. E in Appendix). The intensive survey was conducted in January 2004 and repeated in March 2004. We flew 2,109 km during the first survey and 2,358 km during the second. Portions of the first survey were missed due to some minor mechanical problems with the aircraft that prevented us from flying for half a day. We recorded the exact location of each wolverine, wolf, and caribou track and visual observations of moose. We also recorded the habitat types along the survey routes. Tracking conditions were good for both surveys.

Between the two intensive area surveys, 32 sets of wolverine tracks were detected, 18 in Survey 1 and 14 in Survey 2. We compared the results between the two intensive aerial track surveys, and also between the intensive surveys and the extensive survey for those extensive survey hexagons that overlapped the intensive study area. Tracks in the intensive surveys were detected in 25 hexagons; there were 17 hexagons with tracks in Survey 1 and 11 in Survey 2 (despite fewer hexagons flown in Survey 2) (Fig 6). Only three hexagons had tracks in both intensive surveys. Therefore, repeating the January 2004 survey in March 2004 after a 6-week interval increased the number of hexagons with detected tracks by 53%. No tracks were detected in the hexagons that were missed during Survey 1 when we flew these hexagons in Survey 2.

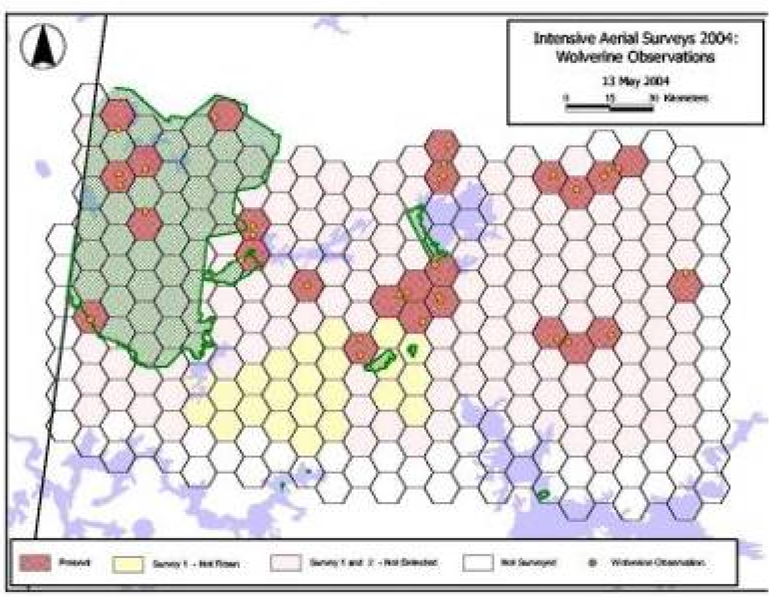

Figure 6. Distribution of hexagons with wolverine tracks detected during aerial track surveys in January and March 2004 in the intensive study area.

The wolverine tracks detected in the intensive surveys fell within 11 of the extensive survey hexagons that overlapped the intensive study area (Fig. Q in Appendix). Of these 11 hexagons, only 4 had wolverine tracks detected in the extensive survey and 4 had tracks in the extensive survey but not in the intensive surveys. Flying more intensively (transects 10 km apart rather than 34 km apart) did not improve detection of tracks at the 1000-km^2 scale. Tracks were detected in 8 and 7 of the 1000-km^2 hexagons in Survey 1 and Survey 2, respectively, when transects were flown 10 km apart compared to 8 in the extensive survey when flown 34 km apart. Repeated surveys did, however, improve detection at the 1000-km^2 scale; tracks were detected in 11 of the 1000-km^2 hexagons when results of both intensive surveys were combined and in 15 hexagons if all three surveys were combined.

<u>Remote Cameras</u>

We used 18 TrailMaster 1500 units and 18 CamTrakker units during the 2002-03. TrailMaster cameras were set up with a hanging bait positioned over the end of a run pole that was situated approximately 2.5 meters in front of the camera, with the upper end of the pole pointed towards the camera to encourage the wolverine to look up at the bait. Ideally, photos would show the distinctive color pattern on the throat and chest of wolverines, which facilitates discriminating among individuals. CamTrakkers were set perpendicular to the direction the animals were likely to use to approach the bait in order to capture a side view of animals. Low visitation by wolverines at our detection devices (camera traps and hair snares) in the winter of 2002/2003 resulted in a reevaluation of placement of the devices. Whereas placement was dictated by our apriori stratification scheme during the first field season, in the second year we made two major improvements to our camera trapping design: 1) focused efforts in a 2,000-km^2 portion of the intensive study area where we knew wolverines were active (as opposed to diffuse effort over the entire 27,900 km^2), and 2) selected sites for camera placement within 100-km^2 hexagon sampling units where wolverines were most likely to visit, rather than random placement within a stratification scheme (Fig. 7). Detection devices were deployed in 20 contiguous 100-km^2 hexagons in the intensive study area that were within or close to known or suspected wolverine home ranges. This design, together with the added advantage of having 2 years of baiting within portions of the sampling area, resulted in higher visitation rates to the sampling sites. The success of cameras and hair snares as detection devices for wolverines in the boreal forest is expected to improve with repeated baiting within the same area, giving resident animals a better opportunity to find the sampling sites over time. During the 2003-04 field season, 24 cameras (20 TrailMasters and 4 CamTrakkers) were deployed systematically in the 2,000-km^2 sampling grid; a number of other cameras were deployed opportunistically throughout the study, for example, at some live traps. Camera deployment began at the end of February 2004, and most camera stations remained active until mid April. Cameras were visited periodically to check batteries, change film, or freshen bait.

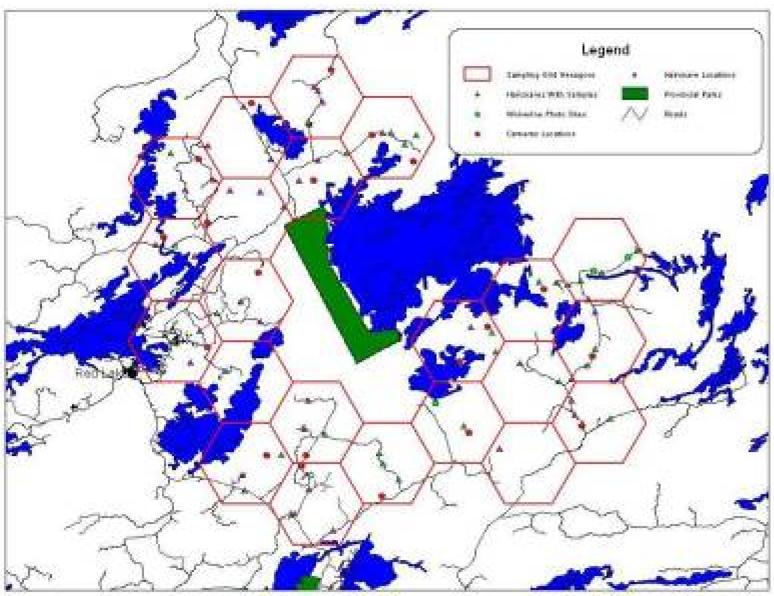

Figure 7. Systematic survey grid (100 km^2 hexagons) and locations of cameras and hair snares.

In our first field season, sites were selected for camera placement based on pre-stratification described previously. A total of 36 cameras were deployed in the intensive study area, 18 TrailMaster 1500 units and 18 CamTrakker units. Most cameras were established between January 20 and February 14, 2003 and were visited approximately every 2 weeks to check battery and film status. Cameras were retrieved from the field between March 26 and April 22, 2003. A total of 308 photos of identifiable wildlife were taken: 168 at CamTrakker sites and 140 at TrailMaster 1500 sites. Some technical difficulties were experienced with each type of system. A few CamTrakkers did not perform in the intense cold, while a few TrailMaster 1500 units had cables chewed by snowshoe hares. One photo of a wolverine was taken and eleven additional species (marten, fisher, red fox, wolf, moose, red squirrel, gray jay, raven, chickadee, great gray owl) were photographed.

In our second field season, a total of 335 photographs of identifiable wildlife were taken during the systematic and opportunistic camera deployments in our intensive study area during 2004. These deployments captured photographs of 13 different species, including marten, fisher, wolverine, ermine, wolf, lynx, red squirrel, red fox, moose, raven, gray jay, bald eagle, and rough-legged hawk. In total, 29 wolverine pictures were taken; seven were of two different marked animals and 22 were of unmarked animals. Of the marked animal photos, five were F01 and two are believed to be F04. The systematic camera stations resulted in 246 photos of 11 species, including 10 wolverine pictures in 2 of our 20 sampling hexagons (Fig. 7). The opportunistic camera deployments captured 89 pictures of 6 different species, including 19 wolverine pictures. Four photos taken by a TrailMaster camera at site TM-03 provided a view of the chest/throat pattern, three of F01 and one of an unmarked wolverine. Two to four different unmarked wolverines were captured on film. Sample camera trap photos can be found in the Appendix (Figs. R-T).

Summary - The effectiveness of the cameras at documenting individual wolverines using the chest/throat pattern requires an active infrared camera system, such as the TrailMaster, in order to reliably photograph wolverines in the proper position. Care must be taken to position all components of the camera trap site correctly in order to capture the identifying pattern on the chest/throat. Difficulties with positioning some components of the system (e.g., run pole, camera units, or bait) at some camera trap sites probably resulted in failure to photograph wolverines at these sites or to obtain definitive chest patterns. To improve the chances for photographing definitive chest patterns, we recommend the following set-up: the run pole should be a minimum of 6 inches in diameter; the camera should be between 6-10 feet (2-3 m) from the end of the run pole and the height of the run pole above ground level where it attaches to the vertical support tree should be 38-46 inches (97-117 cm) so the wolverine must walk up the run pole to reach the raised end; the length of the upper end of the run pole where it extends beyond the support tree should be 24-36 inches (61-91 cm) to entice the wolverine to go to the end of the run pole to investigate the bait rather than climb the support tree; the bait should hang down to about 18 inches above the end of the run pole and about 4 inches (10 cm) out away from the end of the run pole. The infrared beam should be positioned 8-12 inches (20-30 cm) above the run pole at least 12 inches (30 cm) back from the end of the run pole; there should be at least another 12 inches (30 cm) from the beam to the vertical support tree. If possible, the bait should hang from a cable run between two trees rather than from a branch on the support tree to discourage the wolverine (or marten and fisher) from climbing the tree and climbing out to the bait. We will carry out further testing of this monitoring technique with captive wolverines during June 2004 and develop a protocol for setting up the components of the system that will provide consistent and useful results. As mentioned above, the protocol will be made available in a manual on inventory and monitoring wolverines in the boreal forest to be published after further testing of these techniques over the next year.

DNA Hair Snares

In the first field season, hair snares were set up at 19 camera trap locations, and 17 additional hair snares were placed in areas where fresh wolverine tracks were observed. Hair snares were set and checked regularly from February 28 to March 9, 2003 at camera sites and between March 5 and 15, 2003 in areas where fresh wolverine tracks were located. No hair was collected at any of the hair snares. In 2004, we changed the snare design to more closely match the snare type that is being used successfully in the Northwest Territories by Robert Mulder. We deployed hair snares in the same sampling grid that was used for camera traps, but at different locations (Fig. 7). Hair snares consisted of barbed-wire coils approximately 3 m long mounted on baited trees (Fig. U in Appendix). Selected trees were of similar diameter (about 15-30 cm dbh) and had no limbs on the main trunk below a height of about 3 m. Barbed-wire was wrapped and nailed into place from the base of a tree to about 2 m up the trunk. At this height, a large meat bait was wired onto the tree. We deployed 3 hair snares in 17 of 20 hexagons selected within the sampling grid, and 4 hair snares in the remaining 3 hexagons, for a total of 63 snares. Some snares also were set opportunistically in the intensive study area, for example, at most live traps. Snares were set beginning at the end of February 2004, checked periodically for the presence and freshness of bait and the presence of hair, and taken down by mid April 2004.

Hair in the snares was removed during each visit, placed in an envelope with the date and site information, and kept dry until the end of the field season. Hair samples from the snares in the intensive study area and from live-captured wolverines, as well as tissue samples obtained opportunistically (e.g., road kill, fur harvest), have been sent to the Natural Resources DNA Profiling & Forensic Centre (NRDPFC) at Trent University. Dr. Chris Kyle, a researcher at the NRDPFC, has agreed to collaborate with the Boreal Wolverine Project to process and analyze DNA from the hair and tissue samples. The samples will be analyzed using both mitochondrial DNA and nuclear microsatellite molecular markers. A fragment of the control region of mitochondrial DNA will be sequenced to get a relative sense of the phylogenetic distinctiveness of Ontario wolverines relative to animals from other portions of their North American range (see Cegelski et al. submitted). Nuclear microsatellite markers will be run to assess the levels of genetic variation within Ontario wolverines and the levels of gene flow relative to other North American populations (see Cegelski et al. submitted; Kyle and Strobeck 2001, 2002). It is also hoped that the number of microsatellite loci used in this analysis will be able to elucidate interrelationships between the Ontario animals (e.g., parent-offspring or siblings), if any exist, in this sample subset.

From the 63 systematically deployed hair snares within our intensive study area, we collected 31 confirmed or possible wolverine hair samples in 13 of the 20 sampling hexagons. Of these, 10 samples were confirmed to be wolverines based on field evidence. These 10 samples were obtained at 8 different hair snares in 7 different hexagons. The remaining 21 possible wolverine samples will be identified by genetic analysis. Six additional hair samples were obtained from the opportunistically deployed hair snares. Thus, we obtained a total of 37 possible wolverine hair samples in our intensive field study during 2004. We are awaiting DNA analysis to determine how many different wolverines are represented in the samples.

Summary - We recommend further testing of the hair snare technique for monitoring wolverines in boreal forest habitats. Visitation rates at snare sites may be affected by many factors such as wolverine density, habitat characteristics (i.e., vegetation density and wind patterns), food abundance, contact with humans in other contexts, baits and scents, and wolverine travel patterns and factors that influence them (i.e., snowmachine trails, bait drags, roads, active logging areas, etc.). After our failure to snag hair samples in the first field season, we changed the snare design and the sampling sites. In the second field season, we established hair snare sites in areas where we knew wolverines were active and prebaited some of the sites before the sampling period. With these changes, we improved visitation to our sampling sites. Nevertheless, wolverines still did not visit some sites and others were visited but wolverines did not take the bait; at other sites, wolverines removed bait but no hair was left on the barbs. We believe it is possible to improve this technique for monitoring wolverines in boreal forest by improving our ability to attract wolverines to sampling sites, entice the wolverines to climb the trees for the bait, and consistently snag hair on the snagging devices.

Compared to open tundra habitats, we suspect that wolverines in boreal forest are less likely to detect bait sites within a 1-month sampling period because visual and olfactory attractants to the bait sites are less effective in forested habitats. To improve chances that wolverines will find hair snares in boreal forest, we recommend prebaiting the sites for at least 2 months before sampling, or extending the sampling period over at least a 3-month period, depending on resources and research objectives. A large, securely-fastened meat bait in a burlap bag should be hung high in a tree; the burlap bags will discourage birds from rapidly removing the meat and securing the bait high in a tree will keep it from being eaten by carnivores such as wolves, coyotes, and foxes. Removal of bait by marten and fisher may still be problematic. A separate, non-edible scent station placed above the bait (using a long-lasting, long-distance scent lure) will attract wolverines even if the meat bait is removed. Because wolverines follow other carnivores, including other wolverines, to food sources, the longer the bait is available the more likely that multiple wolverines will locate it. Resident wolverines are likely to repeatedly visit the site. Sampling in multiple years may be necessary for low-density wolverine populations or in areas that have discontinuous wolverine home ranges.

As far as we know, barbed-wire has proven to be the most effective means of snagging wolverine hair at bait sites, but the efficacy of barbed-wire as a snare in this study appeared to vary and could have been affected by a number of factors: the size of the trees selected for snares, type of wire/barbs, placement on the tree (e.g., distance of barbs from the tree, attachment points, looseness and stiffness of the wire, ability of the wolverines to learn to avoid the barbs or use the wire to aid in climbing, molt pattern of individual wolverines, and wind at the site strong enough to remove hair from barbs).

Using captive wolverines and field trials with wild wolverines, w plan to test different barb and wire types (or other snag devices), determine optimum tree size and barb placement, and test lures that are most effective in enticing wolverines to climb the snare trees. A protocol will be developed for using hair snares for wolverines in boreal forest habitats and will be published in a manual on inventory and monitoring techniques. The techniques will also be available on The Wolverine Foundation website, from Neil Dawson, OMNR in Thunder Bay, and from The WCS Canada office in Toronto.

Conclusions - The aerial track surveys were used successfully for documenting the distribution and occurrence of wolverines in Ontario and will be useful as inventorying and monitoring techniques in the future. Both remote cameras and hair snares documented wolverine presence in the study area and exceeded our expectations as a potential tool for yielding relative abundance or even density estimates in the boreal forest; however, further development of these tools is necessary to improve their efficacy and cost efficiency as monitoring tools and to design a sampling protocol. Results of DNA analysis in June will allow us to compare the results between the cameras and the hair snares. Additional testing of these techniques is planned on a captive population of wolverines in June 2004. We have also applied for additional funding to field test the improved designs next winter within the intensive study area. Following further testing, we will prepare a manual on the monitoring techniques that will provide a detailed protocol for using these techniques in boreal forest settings.

Objective D: Develop interim management guidelines and recommendations for maintaining or expanding wolverine populations in northwestern Ontario in areas of timber harvest or potential timber harvest

Satellite/VHF data from seven radiocollared wolverines in the intensive study area are currently being analyzed and will provide information on the size and location of wolverine home ranges in relation to current and proposed logging areas and roads within the intensive study area. While logged areas were included within home range polygons, only one VHF location of a wolverine was documented in a cutover area; all other locations were in mature timber or other unlogged habitats. While it is possible that use of logged areas by wolverines occurred either at night (radio and satellite locations were not available at night) or on such a short timeframe that we were not able to document wolverines in logged areas using the ARGOS/VHF equipment, there is also a possibility that wolverines are avoiding logged areas. We are investigating the feasibility of using GPS collars, which can be programmed to provide data at night, or intensive ground tracking to more fully investigate wolverine movements and activity in relation to logged areas and roads. This information will help address the potential effects of proposed northward expansion of logging on wolverines in Ontario. An on-the-ground visit to the natal den site at the end of June 2004 provided some measurements of forest structures likely to be important for wolverine dens in boreal forest habitat. As originally proposed, interim management guidelines and recommendations will be available at the end of September 2004 and will be posted on The Wolverine Foundation website and available from Neil Dawson, OMNR and these guidelines and recommendations will be modified as additional information becomes available.

Objective E: Establish an action plan for more detailed studies on wolverine ecology, status and distribution, habitat use, and impacts of timber harvest and other activities on wolverines in eastern Canada

The Boreal Wolverine project is the first field study of wolverines in eastern North America and the first to use radiotelemetry in boreal forest habitats. Nearly all the information resulting from this 2-year study is new and has appreciably expanded our knowledge of wolverines in boreal forests, especially at the interface of wilderness and human-modified forests. However, results from this study should be considered background information for a more fully developed research program aimed at understanding the limiting factors that affect or could potentially affect wolverines in boreal ecosystems. Such a research program is unarguably an expensive undertaking and should involve cooperative funding by interested parties, be targeted at objectives that directly deal with management and conservation concerns on a broad scale, and take advantage of expertise and knowledge accumulated from wolverine research projects in other ecosystems. We will prepare an action plan for more detailed studies on wolverines in eastern Canada by the end of October 2004 and bring this plan up for discussion at the First International Wolverine Symposium in Sweden in June 2005, to be incorporated into or help inform a proposed IUCN Action Plan for wolverines. The action plan for wolverine and published papers that result from the Boreal Wolverine Project will be one of the few sources of information on wolverines in boreal forest habitats. We plan to post the action plan on The Wolverine Foundation website.

SECTION 5: ACKNOWLEDGMENTS

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SECTION 6: LITERATURE CITED

Cegelski, C. C., L. P. Waits, and N. J. Anderson. 2003. Assessing population structure and gene flow in Montana wolverines (Gulo gulo) using assignment-based approaches. Molecular Ecology 12: 2907-2918.

Cegelski, C. C., L. P. Waits, N. J. Anderson, C. J. Kyle, and C. Strobeck. (submitted). Genetic diversity and population structure of wolverine (Gulo gulo) populations at the southern edge of their current distribution in North America.

Dawson, N. 2000. Report on the status of the wolverine (Gulo gulo) in Ontario. Ont. Min. Nat. Res.Unpublished Rept. 39 pp.

Hooge, P. N. and B. Eichenlaub. 1997. Animal movement extension to arcview. Ver. 1.1. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA.

Jenness, J. 2003. Path with Distances and Bearings v. 3.1. Jeness Enterprises, Flagstaff, AZ, USA.

Kyle, C. J. and C. Strobeck. 2001. Genetic structure of North American wolverine (*Gulo gulo*) populations. Molecular Ecology 10: 337-347.

Kyle, C. J. and C. Strobeck. 2002. Connectivity of peripheral and core populations of North American wolverines. Journal of Mammalogy 83: 1141-1150.

Pearce, J. and G. Eccles. 2004. Characterizing wolverine distribution in Ontario, Canada. Unpublished manuscript. Great Lakes Forestry Centre, Canadian Forest Service, Sault Ste. Marie, Ontario.