About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species’ persistence in the wild.

What is a recovery strategy?

Under the ESA, a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What’s next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: www.ontario.ca/speciesatrisk
RECOMMENDED CITATION


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Ontario Wolverine Recovery Team

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 DECLARATION

The recovery strategy for the Wolverine has been developed in accordance with the requirements of the Endangered Species Act, 2007 (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

 RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
EXECUTIVE SUMMARY

Wolverine (Gulo gulo) are the largest terrestrial member of the weasel family (Order Carnivora, Family Mustelidae). They are circumpolar in distribution, occupying the boreal and tundra zones of the Northern Hemisphere in Europe, Asia and North America. Wolverine have disappeared from much of their historical range in Ontario and other parts of Canada and the United States. It has been estimated that the range of Wolverine in Ontario has decreased over 50 percent since the mid-1800s. In Ontario, Wolverine are now found primarily in the central and western portions of Ontario’s far north. The decline in Wolverine range and numbers of individuals has been attributed to a number of inter-related factors that include human settlement and land-clearing, forest harvesting, reductions in prey species, Wolverine harvest, landscape fragmentation and climate change.

The Wolverine is listed as threatened on the Species at Risk in Ontario (SARO) List under the Endangered Species Act, 2007 (ESA). Nationally, Ontario Wolverine are part of the Western Population, which was assessed as special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but has no status under the Species at Risk Act (SARA). The national Eastern Population (Quebec and Labrador) is designated as endangered by both COSEWIC and under SARA.

The recovery goal is to ensure self-sustaining Wolverine populations within Ontario’s recovery range. The following recovery objectives have been identified as necessary to attain the recovery goal.

1. Protect and manage Wolverine populations and their associated habitat.
2. Reduce or eliminate known threats to Wolverine populations and their habitat within Ontario’s recovery range.
3. Increase understanding of Wolverine ecology, threats to their habitat and Wolverine survival through inventory, monitoring and research.
4. Integrate Wolverine conservation efforts across provincial, territorial and federal jurisdictions, between ministries and with First Nations and planning processes.
5. Generate support and partnerships for Wolverine conservation by promoting education, awareness and stewardship of Wolverine and boreal forest ecosystems.

A number of recovery approaches have been identified. Three recovery zones are proposed based on differences in Wolverine distribution, ecological conditions, and threats that guide recovery actions. Achievement of the recovery goal should be evaluated by tracking the values of a number of indicators, with provincial range occupancy acting as the overall measure of Wolverine recovery. The recovery team strongly urges the continued involvement of its members and other Wolverine experts in

1 The region encompassed by the combined area of the three proposed recovery zones: Northern, Western, and Eastern.
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the implementation of recovery approaches recommended here, with an emphasis on priority actions outlined below.

The recovery team considers the following actions to be of the highest priority for Wolverine recovery in Ontario.

- Development of provincial policy and guidance to support implementation of section 23.13 (trapping - incidental catch) of Ontario Regulation 242/08 under the ESA to provide security to trappers, and foster cooperation and involvement in Wolverine data collection and population assessment.
- Research into the ecology of Wolverine in lowland boreal forests, with emphasis on den site selection, productivity and survival rates in both undisturbed and modified habitats.
- Building of synergies between Woodland Caribou and Wolverine recovery in the province, by integrating Wolverine recovery considerations with ongoing Woodland Caribou conservation efforts in the province, where appropriate.
- Development of a general habitat description to support implementation of general habitat protection under the ESA or alternatively development of species-specific habitat regulation for Wolverine.
- Establishment and implementation of a survey and monitoring strategy for Wolverine in the context of a formalized adaptive management process.

As a wide-ranging species where individuals require relatively large home ranges, a fundamental goal of Wolverine recovery is to provide for connectivity across the proposed Wolverine recovery range in Ontario and to neighbouring jurisdictions. Also critical to the recovery of Wolverine is the application of management and protection measures at a variety of spatial scales, specifically at the inter-jurisdictional, population, home range, and denning area levels to address several of the objectives in this recovery strategy. Recognizing that functional habitat for Wolverine is provided at the larger landscape scale and that an ecosystem approach will be required to achieve habitat conservation for this broad-ranging species, it is recommended that the entire area captured by the three recovery zones should be prescribed as Wolverine habitat under the ESA. The recovery zones include areas currently occupied by Wolverine, as well as areas where the species is known to be re-occupying at present, and that are key to the objective of promoting connectivity between the nationally defined Western and Eastern Wolverine populations. Areas considered unsuitable such as built-up areas, including communities and a reasonable ‘disturbance’ buffer should be excluded from regulation. However, areas that may be presently unsuitable but have the potential if managed properly (restorative or rehabilitative action), should be included in the habitat regulation.
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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

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The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

**Species Description**

Wolverine (*Gulo gulo*) are the largest terrestrial member of the weasel family (Order *Carnivora*, Family *Mustelidae*) and have a compact and strongly built body resembling a small bear. Adult males weigh 14 to 27.5 kg and females 7 to 14 kg. The head-body length of adults range from 65 to 105 cm and tail length varies from 17 to 26 cm (Hash 1987). Wolverine are well-adapted to life in boreal and tundra habitats as they have long, thick fur and large feet, which allow them to move more easily in deep snow, with a relatively low weight load for their size (Teplov 1955). A keen sense of smell allows a Wolverine to detect carrion over long distances and also beneath one to two metres of snow (Hornocker and Hash 1981). A robust and muscular skull enables the Wolverine to easily consume frozen meat and bones.

Current taxonomy regards both Old and New World animals as conspecifics of *Gulo gulo* (Kurten and Rausch 1959). Banfield (1974) noted two sub-species in Canada, *G. g. luscus* and *G. g. vancouverensis*, the latter occurring only on Vancouver Island. Banci (1982) did not find evidence to support the sub-specific classification of *G.g. vancouverensis*; however, this subspecies is still recognized (Nagorsen 1990 cited in Slough 2007). Wolverine in Ontario belong to the *G. g. luscus* sub-species. Kyle and
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Strobeck (2002) found high levels of gene flow among all sampled northern North American Wolverine populations. However, they observed increasing genetic structure in populations at the southern and eastern edge of the distribution, suggesting that these populations may have been partially fragmented from a formerly panmictic population. Ontario and Manitoba populations were found to be quite similar to one another but relatively distinct from other sampled regions, although the national Eastern Population (Quebec and Labrador) was not sampled (Kyle and Strobeck 2002). A recent analysis of nuclear and mitochondrial genetic diversity suggests that there may be two contemporary genetic populations within the currently recognised national Western Population: the core population in the Canadian territories, western provinces and Alaska, and a peripheral cluster in Manitoba and Ontario (Zigouris et al. 2012).

Wolverine have inspired near mythic tales of their strength, ferocity, and destruction of cabins and food caches (Thompson 1929, Hash 1987, Banci 1994). Such a reputation, while deeply rooted in legends and folklore, has little documented basis. By virtue of their scavenging habits, however, Wolverine can and do have conflicts with humans under certain conditions. The frost-resistant properties of Wolverine pelts have value as fur trim on parkas. In the past, pelts were also in demand for use as rugs or mounts to sell to tourists (Hash 1987).

The Wolverine plays an important role in the cultural beliefs of many First Nations as symbols of strength and determination; they also appear in First Nations mythology and legends in the role of the trickster. The Wolverine plays an important role in the creation story of the Nishnawbe-Aski Nation (Appendix in Loutitt 2009).

By virtue of their tendency to inhabit large areas essentially free of human disturbance, the Wolverine is regarded by many as symbols of wilderness regions. As one of the first species to disappear with the onset of human disturbance, Wolverine can be excellent indicators of ecosystem integrity. They are also likely to be good indicators of changing climates in light of their tie to areas that maintain cold temperatures and persistent snow cover into spring. The ecological role of the Wolverine is as both top predator and scavenger relying on adequate large ungulate densities to maintain viable populations.

Species Biology
Wolverine have developed life history strategies that result in their living at low densities over the landscape (Banci 1994). Their scavenging lifestyle requires them to cover home ranges much larger than similar-sized carnivores. They are opportunist feeders and tend to cache surplus food items (Hash 1987). Wolverine are strong for their size and can drag food items several times their weight over a considerable distance.

Food Habits
The Wolverine has been called a ‘scavenging predator’ (Hash 1987), relying primarily on scavenging during the winter months, but becoming an opportunist omnivore in the summer (Banci 1994). Large mammals, primarily in the form of carrion, are important year-round, although availability generally varies seasonally. Moose (Alces alces) and
Woodland Caribou (*Rangifer tarandus caribou*) are the primary ungulate species in the Wolverine diet in North America (Rausch 1959, Rausch and Pearson 1972, Hornocker and Hash 1981, Gardner 1985, Magoun 1985, Banci 1987, Banci 1994, Lofroth et al. 2007). In Ontario, Wiwchar (2004) found two of three Wolverine stomachs collected in the Red Lake area contained Moose, while the third was empty. Watson (2009) examined the stomach and intestinal contents of 12 Wolverine collected mainly in the Red Lake area and found Moose (three), White-tailed Deer (*Odocoileus virginianus*) (two), Woodland Caribou (one), Striped Skunk (*Mephitis mephitis*) (one) and Ruffed Grouse (*Bonasa umbellus*) (one), while four were empty or contained only Wolverine hair. Collared Wolverine were observed feeding on Woodland Caribou and Moose carcasses during telemetry flights in Ontario (Ontario Boreal Wolverine Project unpub. data).

Under the right conditions Wolverine are able to kill ungulates, although this is generally believed to be a rare circumstance. Limited Wolverine predation on Moose of all sex and age classes has been documented in Russia, Scandinavia (Haglund 1974, Giuliazov 1998, Kozhechkin et al. 2005) and North America (Magoun et al. 2005b). Lofroth et al. (2007) recorded nine predation events by Wolverine on Woodland Caribou; all Woodland Caribou involved appeared to be in poor condition based on bone marrow fat. Gustine et al. (2006) found that Wolverine accounted for 29 percent (5 of 17) of known predation events on Woodland Caribou calves in northern British Columbia, with four of five mortalities occurring when calves were 9 to 15 days of age.

Banci (1994) suspected that the large number of empty Wolverine stomachs in food habits studies was an indication of the uncertainty in availability of food supplies. When carrion is scarce, small mammals and birds become primary prey for Wolverine. Trappers in Ontario have noted Wolverine actively hunting Beaver lodges and along lakeshores. This activity was confirmed for one radio-collared adult male Wolverine in Ontario during 2004. Wolverine tracks were also commonly associated with Beaver lodges with evidence of Beaver kills on several occasions during aerial surveys in Ontario. Further verification of the importance of Beaver to Ontario Wolverine was acquired through interviews with elders and trappers from northern First Nations communities (Ontario Boreal Wolverine Project unpub. data). The availability of small mammals may be particularly important to females during the denning/rearing periods when energy demands are high and movements are restricted (Landa et al. 1997). Reproductive females have been shown to have different diets in the winter season relative to other age and sex classes (Lofroth et al. 2007, Koskela et al. 2013). Persson (2005) provided evidence that the ability to obtain adequate winter food resources was critical to successful female reproduction in Wolverine.

**Reproduction**

Wolverine have relatively low reproductive potential (Magoun 1985, Copeland 1996, Weaver et al. 1996, Persson 2003). Wolverine breed from May to August, with male Wolverine generally mating with more than one female (Rausch and Pearson 1972). Wolverine have been characterized as having a bet-hedging life history strategy to deal with unpredictable environments (Ferguson & Larivièrè 2002). Births generally coincide
with periods of greater ungulate carrion availability and snow cover, which provides enhanced security cover for kits (Banci 1994). Inman et al. (2012) proposed a two-stage reproductive strategy for female Wolverines to take advantage of their cold, low-productivity niche: the first requires caching enough food (winter-killed ungulates) to fuel the lactation period, while the second involves scavenging and predation of various food sources to fuel the growth of post-weaning cub growth during the brief summer season.

Males are not sexually mature until over two years, while females reach sexual maturity at about 15 months (Banci 1987, Banci and Harestad 1988). Females, however, do not produce litters successfully until they are an average of 3.4 years old (Persson 2003), with a range from 2 to 12 years old (Rauset 2013). Average litter size is two to three kits (Hash 1987). Adult females appear to breed each year but do not necessarily give birth annually (Magoun 1985). The reported proportion of pregnant females varies and appears to be influenced by age with younger Wolverine age classes (two to three year olds) more likely to be pregnant than older age classes (e.g. six years plus) (Rausch and Pearson 1972, Liskop et al. 1981, Banci and Harestad 1988, Persson 2003). While older females are capable of producing larger litters, fewer older females appear to produce litters (Banci 1994). Using 18 years of data from 62 radio-tracked female wolverines in Sweden, Rauset (2013) found that females showed strong age-specific reproduction (large increase between two and three years of age, followed by a slow decline with age); as well as an age-related pattern in reproductive costs, noting that the probability of breeding in successive years peaked at five to six years and was strongly correlated with summer primary production.

Food availability appears to play a critical role in the ability of females to produce young. Rapid growth of kits and the relative availability of winter food appear to place high energetic demands on females and can affect female reproduction in a subsequent year (Banci 1987, Persson 2003, Rauset 2013). Female body condition may be the most critical factor in determining successful births (Banci 1994, Persson 2003, Rauset 2013). As a result, the interval between litters for the average adult female Wolverine is likely two years or more (Weaver et al. 1996, Rauset 2013).

In North America, Magoun (1985) reported a birth rate of 0.6 to 0.7 offspring per adult female per year, while in Sweden Rauset (2013) reported mean number of cubs as 0.84 and a lifetime reproductive span ranging from zero to nine years with zero to six weaned litters per lifetime. Weaver et al. (1996) estimated that the average female Wolverine would have a lifetime production of only two female offspring, and that Wolverine may have lower lifetime productivity than even Grizzly Bears (Ursus arctos horribilus).

Mortality
Wild Wolverine generally have a life expectancy of eight to ten years (Hash 1987). Krebs et al. (2004) summarized causes of mortality and survival rates for radio-collared Wolverine in North America. Of 62 mortalities in 239 radiomarked Wolverine, causes of death included: trapping or hunting (22), road or rail kill (3), predation (11), starvation (18) and unknown causes (8) (Krebs et al. 2004). Human-influenced mortality accounted for 46 percent of deaths in trapped populations and was not detected in
untrapped populations\(^2\) (Krebs et al. 2004). Subadult males made up 11 of the 25 human-caused mortalities. Within trapped populations the most common cause of natural mortality was starvation, followed by predation and unknown causes (Krebs et al. 2004). Deaths due to predation were caused by Gray Wolf (\textit{Canis lupus}), Cougar (\textit{Puma concolor}) and Wolverine. In untrapped populations the number of Wolverine dying from starvation (two), predation (two) and unknown causes (four) were similar (Krebs et al. 2004). Of 14 documented wolf-wolverine interactions discussed in Ballard et al. (2003), eight (57\%) resulted in the death of the Wolverine. Predation on Wolverine by black bear (\textit{Ursus americanus}) has also been documented (Inman et al. 2003). In northern Scandinavia, intraspecific predation was the most common cause of juvenile mortality (Persson et al. 2003).

North American Wolverine survival rates were markedly lower in trapped (less than 0.75 for all age-sex classes) than in untrapped populations (greater than 0.84 for all age-sex classes) (Krebs et al. 2004). Human-caused mortality was determined to be primarily additive to natural mortality for Wolverine. Logistic growth rate estimates suggested that trapped populations would decline (\(\lambda \approx 0.88\)) in the absence of immigration from untrapped populations (\(\lambda \approx 1.06\)).

Squires et al. (2007) reported on sources of mortality for 36 Wolverine in two study areas in western Montana. Of the 14 documented mortalities, 9 (64.3\%) were the result of licensed trapper harvest. The five remaining mortalities were outside the trapping season and included one death from an unknown predator, one death from an avalanche, and three from unknown causes. Annual survival was estimated at 0.80 when harvest was not considered but declined to 0.57 when mortality of harvest was added (Squires et al. 2007). The Glacier National Park area provided some refuge with an annual survival rate of 0.77 and a stable to slightly increasing population (\(\lambda = 1.1\)), relative to the Pioneer Mountain study area where annual survival was 0.51 and \(\lambda = 0.7\), indicating a 30 percent annual decrease during their study. Golden et al. (2007) also outlined the importance of having trapping refugia (areas where no harvest is permitted) and Magoun and Copeland (1998) suggested a system of spatial harvest control to minimize harvest in Wolverine denning areas.

In Ontario, three of seven radio-collared individuals died during the 13 months that radiocollars were active: two were trapped and one succumbed to an unknown predator (Dawson et al. 2010). A fourth radio-collared individual was killed in a vehicle collision in 2009, five years after capture (Dawson et al. 2010). Other documented causes of mortality are biased toward trapper harvest primarily in the area between Fort Severn and the Manitoba border in extreme northwestern Ontario between 1985 and 2004, and shifting eastward between Fort Severn and Peawanuck in recent years. Although a zero quota on non-Aboriginal traplines has been in place since the 2001/2002 trapping season, there were 34 confirmed incidental Wolverine captures as of the end of the 2012/2013 season, primarily in the southern part of the range (OMNR unpub. data). First Nations harvest reported during the 2001/2002 to 2007/2008 periods was 50

\(^2\) Trapped populations include those where targeted and incidental trapping pressure exists.
Wolverine. As of March 2013, 13 known Wolverine deaths in Ontario resulted from vehicle collisions and one from a train collision. Twelve of the 13 road/rail mortalities have occurred since 1990.

1.3 Distribution, Abundance and Population Trends

The Wolverine is circumpolar in distribution, occupying the boreal and tundra zones of the Northern Hemisphere in Europe, Asia and North America as illustrated in Figure 1.

United States
Historically Wolverine occurred throughout Alaska with the exception of the extreme northeastern coastline. There has been no significant change in distribution, with populations in the state generally considered robust. Wolverine range experienced substantive retraction by the mid-1900s in the lower 48 states (Aubry et al. 2007). The species formerly occurred along the western mountain ranges as far south as Arizona and New Mexico, and eastward through the northern states from Washington to Maine (Figure 1). While Figure 1 indicates the presence of Wolverine in portions of California, Colorado, Oregon and Utah, the most current review of Wolverine status in the lower 48 states indicated that small populations continue to persist only in high elevation forest and alpine habitats in Washington, Montana, Idaho, and Wyoming (Aubry et al. 2007). However, lone male Wolverine recently appeared in California (Moriarty et al. 2009) and Colorado (Inman et al. 2009), and three animals have been detected in northeast Oregon (Magoun et al. 2013). Wolverine were believed extirpated from the northeastern and central states by 1900 (de Vos 1964), although verifiable historical records are primarily from the western mountains and Great Lakes region (Aubry et al. 2007). An apparent wild Wolverine was found in Michigan in 2004 and was recorded by trail cameras annually until its death by apparent natural causes in 2010 (MI DNRE 2010). The addition of the Wolverine population in the lower 48 states to the List of Endangered and Threatened Wildlife and Plants was determined to be warranted (Fish and Wildlife Service 2010), and Wolverine was recently proposed by the U.S. Fish and Wildlife Service for listing as a threatened species (Fish and Wildlife Service 2013).

Canada
Historically Wolverine were distributed across Canada, although there are no records of Wolverine occurrence in Prince Edward Island, Nova Scotia, eastern New Brunswick, the island of Newfoundland, and Anticosti Island (Hall and Kelson 1959, Banfield 1974) (Figure 1). Nationally, COSEWIC separated Wolverine into a Western and Eastern population, which primarily reflects patterns in range recession. Ontario Wolverine comprise the easternmost portion of the national Western Population. Based on harvest records, COSEWIC (2003) provided an estimate of 15,000 to 19,000 Wolverine in late winter for the national Western Population under the assumption that current harvest levels were sustainable (2.5 to 8%). The Wolverine population stronghold is in the north and western part of Canada (British Columbia, Yukon, Northwest Territories), with the southern range from Alberta eastward having receded over the past century (Slough 2007).
A component of the national Western population of special concern, Manitoba Wolverine numbers were reported to have seriously declined during the early to mid-1900s (van Zyll de Jong 1972), but were noted to have re-occupied some of their former range in the central portions of Manitoba by the 1980s (Johnson 1990). This range
expansion was attributed to the cessation of predator poisoning programs, an increase in Wolf populations that would provide carcasses for scavenging, and shortened trapping seasons. Johnson (1990) estimated Wolverine in Manitoba to number between 500 and 800 animals. Harvest continued to increase up to the early to mid-1980s, although since that time they have declined, most likely due to reduced trapping effort. Based on known harvest data, Berezanski (2004) suggested the population was stable or increasing. Assuming a sustainable harvest rate of 6 percent, he estimated 1,100 to 1,600 Wolverines in Manitoba.

Forming part of the national endangered Eastern Population, the last confirmed wild specimen in Quebec was trapped during the 1979/1980 season (Moisan 1996). A wolverine was captured in a wolf snare in 2004 near Saint-Côme (Lanaudière region), but a microchip revealed it was an escaped captive animal from southeastern Ontario (I. Thibault, pers. comm. 2011). By 1996, 18 unconfirmed sightings were reported between 1979/1980 and 1995 and occurred mainly in the Lac St Jean region (10 sightings), with small numbers of observations in the northeast along the border with Labrador (4 sightings) and in the Abitibi region of northwestern Quebec (3 sightings) near the Ontario border (Moisan 1996). Since that time, a number of additional unconfirmed wolverine observations have been reported and consolidated in an updated map for Quebec (I. Thibault, pers. comm. 2013). Consequently, Wolverine are considered to be extremely rare or extirpated in Quebec. Similarly, the last verified Wolverine specimens in Labrador were two animals harvested in 1965. Since then there have been more than 40 reports of animals or their tracks at locations throughout Labrador, although none has been verified (Schmelzer 2005). An extensive aerial track survey to clarify the distribution and status of Wolverine in Labrador was conducted in March 2005. No Wolverine tracks or animals were observed on 6,630 km of transects within the 195 to 1000 km² hexagons surveyed (Schmelzer 2005). Results suggest that the national Eastern Population is very rare at best, if present, and that recovery by natural means seem unlikely.

Ontario
Historically, the Wolverine was found throughout all of Ontario (Hall and Kelson 1959) (Figure 1), although Banfield (1974) did not indicate the occurrence of Wolverine in the southwestern part of the province. Banfield (1974) identified the southern extent of their historical range as north of a line running due west from the southwestern tip of Lake Ontario to the southern tip of Lake Huron. The disappearance of Wolverine from southern Ontario appears to have occurred fairly rapidly during the 1800s. What was perhaps the last southern Ontario specimen was an adult of unknown sex killed in Keppel Township, Grey County in 1889 (J. Eger pers. comm. 1998). Trappers in the Quetico Park area of southwestern Ontario estimated that the Wolverine disappeared from that area around 1900 (Cahn 1936), while Peterson and Crichton (1949) felt that Wolverine had disappeared from the Chapleau area in northeastern Ontario between 1885 and 1900. DeVos (1964) reported that while the Wolverine apparently had a wide distribution in the Great Lakes region, they occurred only in low numbers and were apparently extirpated by the early 1900s. By 1950, most of the province’s Wolverine were found north of the Canadian National Railway line. From that point until the
1970s, Wolverine distribution continued to retract westward, with most declines reported in the Hudson Bay and James Bay Lowlands area.

At present, Wolverine are found primarily in the central and western portions of the Ontario’s far north (Figure 2). The modeled core occupied range for Wolverine (based on comprehensive Wolverine aerial surveys undertaken across northern Ontario in 2003 and 2004) roughly corresponds to Wolverine range from 1980 to 2005 based on harvest records. The modeled range (and aerial survey observations) extended northeast to Cape Henrietta Maria where there were no harvest records. Furthermore, detection probabilities did not indicate a higher relative abundance of Wolverine in the northern half of the core range as expected from the distribution of Wolverine harvests from 1980 to 2005. This suggested that the latter was likely reflective of the higher rate of opportunistic encounters with Wolverine in this sparsely forested region (Ontario Boreal Wolverine Project unpub. data).

Wolverine harvest locations since 2005 and occurrences gathered from 2008 to 2012 aerial track surveys (Figure 2) indicate continued range recovery eastward and incorporation of previously identified “peripheral” areas into core range. Figure 3 shows the locations of traplines where Wolverine harvests have occurred between 1980 and 2012, as well as the locations of Wolverine observations reported by OMNR staff, trappers, and the general public from 1980 and 2012.

Both recent aerial surveys and scattered reports by Aboriginal trappers provide evidence that Wolverine in northern Ontario show increasing presence east of the identified peripheral range, which is suggestive of reclamation of the original range from the 1950s (Dawson 2000). Observations of Wolverine in the Fort Severn and Peawanuck areas may be linked to reported increases in the Pen Islands Woodland Caribou herd in the 1980s and 1990s (Abraham and Thompson 1998) and recent changes in Woodland Caribou distribution in the Hudson Bay Lowland (Magoun et al. 2005a, Abraham et al. 2012). While caribou numbers in the traditional Pen Islands calving area have decreased markedly (Abraham et al. 2012) in recent years, there is some evidence for a shift southward from the coast as reflected in observations of large caribou groups north of Big Trout Lake in recent years (OMNR unpub. data). Additionally, an increased concentration of occurrences in the central portion of 2003-4 Wolverine peripheral range has been recently documented suggesting that there has been an increase in numbers to provide a source for this immigration. Due to incomplete knowledge of how distribution or relative abundance patterns of Wolverine in Ontario translate into abundance estimates, no reliable population estimate is available. Slough (2007) published a “rough population estimate”, based on expert opinion, of equal to or fewer than 300 individual Wolverines in Ontario. Radio-telemetry, hair snagging, and aerial survey work since 2002 strongly indicate this number to be an underestimate (Ontario Boreal Wolverine Project, unpub. data).
Figure 2. Wolverine tracks and observations from aerial surveys conducted by Wildlife Conservation Society (WCS) Canada and OMNR in 2003-4, 2009-11 and 2012 depicting increasing frequency of Wolverine occurrences beyond the 2003-4 core and peripheral ranges (modeled from aerial survey occurrence data). Sources: Magoun et al. (2007), Ontario Boreal Wolverine Project, WSC Canada, and OMNR.
Figure 3. Traplines where Wolverine harvest has occurred between 1980 and 2012 (areas in grey represent harvest since 2005) and locations of Wolverine observations or tracks reported by MNR staff, trappers, and members of the public from 1980 to 2012. Source: OMNR

1.4 Habitat Needs

Population Density and Home Range
Wolverine population densities are naturally low relative to other similar-sized carnivores, even under the best conditions. Wolverine densities in North America range from 2.2 (Squires et al. 2006) to 20.8/1000 km$^2$ (Magoun 1985) and average around 4 to 6/1000 km$^2$ (Quick 1953, Banci 1987, Whitman and Ballard 1983, Copeland 1996, Lofroth and Krebs 2007, Fisher et al. 2009). Food availability appears to be a primary factor influencing changes in the distribution of Wolverine (Hornocker and Hash 1981). Regions with higher Wolverine densities tend to be those with the greatest variety and abundance of both prey and habitat types (Banci 1994).

Wolverine home range size varies widely, influenced by both study location and home range estimation techniques. Typically, male home ranges are larger than those of
females, and single females have larger home ranges than females with young. Average home range sizes vary from 73 to 3,513 km² depending on age and sex (Horner and Hash 1981, Gardner 1985, Magoun 1985, Whitman et al. 1986, Banci 1987, Copeland 1996, Mulders 2000, Copeland and Yates 2006, Squires et al. 2006, Inman et al. 2007, Krebs et al. 2007). Winter home range sizes from Ontario are at the high end of reported ranges for North America, with those of males averaging 2,563 km² and females 428 km² (Dawson et al. 2010).

Overlap of adult male and female Wolverine home ranges can be extensive and one male’s home range may cover portions of one to six females’ (Magoun 1985, Banci 1987, Copeland 1996, Krebs and Lewis 2000). There is, however, variation between studies regarding the degree of home range overlap reported within individuals of the same gender. No, or very little overlap of home ranges between adults of the same sex was reported by Squires et al. (2006), Wedholm (2006) and Inman et al. (2007).

Overlap of home ranges between individuals of the same sex was reported by Horner and Hash (1981), Lofroth (2001) and Whitman et al. (1986). Copeland and Yates (2006) reported that resident female home ranges overlapped by 7 percent on average, while male home ranges overlapped by an average of 30 percent. Overlap of adult males with their male offspring was reported on three occasions by Squires et al. (2006). Magoun (1985) reported overlap of adult female home ranges only in winter. Banci and Harestad (1990) also reported spatial overlap of adult females during the winter but noted that the overlap areas were not used at the same time by individual females. Magoun (1985) suggested that adjacent adult females are likely related and therefore more tolerant of spatial overlap between individuals. Aronsson (2009) found high home range fidelity between years for female Wolverine and that when female territories became vacant, replacing females were generally daughters (54%) or granddaughters (15%).

Habitat Use
Throughout their North American range, Wolverine occupy a variety of habitat types. Knowledge about North American Wolverine habitat associations is biased towards mountainous regions, where the majority of studies have occurred. Kelsall (1981) stated that “Habitat is probably best defined in terms of adequate year-round food supplies in large, sparsely inhabited wilderness areas, rather than in terms of particular types of topography or plant assemblages.” Copeland et al. (2010) has recently shown a strong correlation between global Wolverine distribution and persistent spring snow cover, and less strongly to an upper limit of thermoneutrality (average maximum August temperatures equal to or less than 22º C). Spring snow cover (April 24 – May 15) correlated strongly with Wolverine denning locations and year-round movements from studies in Scandinavia and western North America. However, this relationship was weaker in the central and eastern portions of Canada (AB, SK, MB & ON) where distribution correlated with areas having persistent snow through mid-May in only one or two of the seven years. Schwartz et al. (2009) also found that spring snow cover was correlated with gene flow among Wolverine in the northwest United States. Inman et al. (2012) developed a food-based explanation for the relationship with spring snow resulting in a “refrigeration-zone” hypothesis, proposing that Wolverine amass caches of
food over the winter to fuel the costs of lactation from February to April, under the premise that caching in cold microsites inhibits loss of stored food to other scavengers, insects and bacteria.

In Montana, 70 percent of all locations of radio-collared Wolverine occurred within large areas of medium or scattered timber, while areas of young dense timber were used least, and Wolverine were rarely located in recent burn or wet meadow areas (Hornocker and Hash 1981). In south-central Alaska, Whitman et al. (1986) found no specific habitat preference in either summer or winter, but did note avoidance of forest (predominantly spruce *Picea* spp.) in summer (April – October) and tundra in winter (November – March). Copeland (1996) found that Wolverine in Idaho avoided lowland grass/shrub and Ponderosa Pine (*Pinus ponderosa*) cover types. In the Yukon, female Wolverine tended to use habitat in proportion to its availability while males used subalpine coniferous habitats more frequently than other habitat types during the winter (Banci and Harestad 1990). In north-central British Columbia, Lofroth (2001) found few significant patterns of habitat use in home ranges relative to that available within the study area at the landscape scale. He also reported that more than 50 percent of radio-tagged Wolverine locations were in late successional stands and Wolverine used mid-successional stands considerably less often. In the northern Columbia Mountains of British Columbia, Wolverine used late-successional stands most frequently when not using alpine habitats (Krebs and Lewis 2000). Snow-tracking in the boreal forest of northwestern Alberta and northeastern British Columbia indicated that Wolverine were selecting for the densest, older conifer stands for travel and food caching (Wright and Ernst 2004a, 2004b).

There are few published data on the relationship between Wolverine and disturbed landscapes and the factors that influence this relationship. Hornocker and Hash (1981) noted that no Wolverine were relocated in clearcuts (age 0 to 15 years) of any size, although tracks were occasionally observed crossing clearcuts; males tended to be found further from active roads, clearcuts and burns than females. In Alberta there was some evidence of avoidance by Wolverine of landscapes within 5,000 meters of regenerating sites (both wildfire and forest harvesting combined) and those with high proportions of mixedwood forests. Individuals were most likely to occur in landscapes with relatively low seismic line densities (Fisher et al. 2009). Krebs et al. (2007) found that in British Columbia males were associated with food-related habitat variables in both summer and winter, such as areas where ungulate carrion and small mammal prey are available. Male winter habitat use was positively associated with Moose winter ranges, valley bottom forests and avalanche terrain. In the Columbia Mountains, male winter habitat use was negatively associated with helicopter skiing areas. Female Wolverine in the same study area showed complex associations with variables related to food, predation risk, and human disturbance during both summer and winter (Krebs et al. 2007). Summer locations of female Wolverine were negatively associated with roaded and recently logged areas. Females had positive associations with Moose winter ranges within rugged landscapes in winter, while in the Columbia Mountains, where winter recreation was widespread, females were negatively associated with helicopter and backcountry skiing (Krebs et al. 2007). Krebs et al. (2007, pg. 2180)
remarked that their work “suggests Wolverine were negatively responding to human disturbance within occupied habitat.”

Initial habitat analyses from collared Wolverine in northwestern Ontario within a managed forest area indicate that although Wolverine frequently used areas in close proximity to clear cuts, track observations within clear cuts were very rare. Only 1 of 99 Wolverine locations obtained during telemetry flights was in a clearcut, and in that instance the animal was within an uncut patch of timber within the cut area (Ontario Boreal Wolverine Project unpub. data).

Krebs and Lewis (2000) found that geographic (e.g., watercourses) and manmade features (e.g., reservoirs and highways) defined Wolverine home range boundaries. Male Wolverine in British Columbia were able to cross large reservoirs and at times crossed major highways during dispersal movements, while females appear not to have crossed reservoirs; only one female crossed the Trans-Canada Highway. Austin (1998) noted that Wolverine avoided areas within 100 m of the Trans-Canada Highway and preferred areas greater than 1100 m from the highway. Wolverine that did approach the highway made repeated approaches and retreats and crossed only three of six times. Mean right-of-way width at crossings (68 m) was significantly shorter than approaches where no crossings occurred (165 m) (Austin 1998). Squires et al. (2006) reported that Wolverine crossings of major roads in their Montana study occurred in areas with the narrowest distance between forest cover on each side of the road, suggesting that width between habitats in road right-of-ways should be important in highway planning. Hornocker and Hash (1981) noted that rivers, reservoirs, highways, valleys or major mountain ranges apparently did not affect movements. Landscape models developed by Rowland et al. (2003) indicated that amount of habitat, road density and human population density were important components in predicting Wolverine occurrence, with areas of high suitable habitat and low road and human population densities having greater Wolverine occurrence. In a north-central British Columbia study, capture frequencies were greater along timbered corridors adjacent to active haul roads and in timbered corridors in general, than at other trap locations (Lofroth 2001). Lofroth (2001) hypothesized that the matrix of cut and uncut stands which resulted from timber harvesting may “funnel” Wolverine into uncut forest areas and as a result, Wolverine may be more sensitive to the need for forest habitat as human activity in an area increases.

In Ontario, road densities were lower in core home range (50% use area, 0.33 km/km$^2$) than overall home range area (95% use area, 0.43 km/km$^2$) (Dawson et al. 2010). Of seven study animals, the two (both females) whose home ranges contained the highest road densities (0.55 and 1.15 km/km$^2$) were both victims of incidental harvest. May et al. (2006) examined the impact of human infrastructure (houses, cabins, settlements, public and private roads) on habitat selection by Wolverine in two areas of Norway and found that Wolverine selected undeveloped areas for home range locations and that human development was a more important factor in home range selection than habitat. They hypothesized that Wolverine distribution may be influenced by direct disturbance or increased risk of human-caused mortality associated with infrastructure. Bowman et
al. (2010) found that both Wolverine and Woodland Caribou were negatively associated with the footprint of human activities in northwestern Ontario. The pattern of Wolverine track distribution in the study suggested that although Wolverine use logged landscapes, there may be a threshold of logging intensity and/or road density at which suitability of boreal forest as Wolverine habitat declines precipitously. This also provides preliminary support for the premise that Wolverine populations require refugia free from human disturbance to ensure their persistence in the broader landscape. Wolverine tend to be concentrated in bog areas and mature conifer stands outside of the main cutover area and avoid deciduous forests (Ontario Boreal Wolverine Project unpub. data; Bowman et al. 2010), while they are more broad in their habitat use patterns in far northern Ontario where the dominant disturbance agent is fire and there are no permanent roads (J. Ray unpub. data).

Denning is critical for survival and Wolverine select den sites, in part, to avoid humans and predators during the denning and kit-rearing period. Magoun and Copeland (1998) described two types of dens: natal and maternal. Natal dens are used during parturition, generally mid-February to mid-March, while maternal dens are used subsequent to natal dens and before weaning, generally from mid-March to the end of April. Den sites have a number of structural features in common that afford protection from extreme weather and predators. Dens were found by Magoun and Copeland (1998) to be complex, extensive snow tunnel systems averaging over 30 m in length and snow depth from the snow surface to the deepest point in the tunnel system was greater than one metre. Females used one to three maternal dens per year. The single Wolverine denning area described in Ontario consisted of three dens within a 300 m radius. The main den consisted of a boulder pile (with the largest boulder being four metres in diameter), and the other two dens consisted of fallen/blown-down trees, all covered with snow (Dawson et al. 2010). The importance of snow-covered fallen trees and boulder piles as denning sites has been documented by other North American Wolverine studies (Magoun and Copeland 1998, Krebs and Lewis 2000, Lofroth 2001, Copeland and Yates 2006). Some den sites may be used repeatedly in subsequent years, increasing the importance of these habitat features (Lee and Niptanatiak 1996, Magoun and Copeland 1998).

Magoun and Copeland (1998) suggested that a critical feature of Wolverine denning habitat was the dependability of snow cover throughout the denning period. This was defined by at least one metre of snow, either evenly distributed or drifted, and present by February and persisting until May. Verified Wolverine reproductive dens were almost always covered by one to five metres of snow. Denning habitat selection by female Wolverine may also be influenced by the suitability of the area as rearing habitat for kits after weaning (Magoun and Copeland 1998); foraging on small mammals and birds is believed to be an important component in the rearing of kits (Magoun 1987, Copeland 1996, Landa et al. 1997).

Wolverine appear to be sensitive to disturbance during the denning period and select denning areas in remote, undeveloped areas (Copeland 1996, Krebs and Lewis 2000, Copeland et al. 2007, Krebs et al. 2007, May 2007). Den abandonment due to human
disturbance has been reported (Myrberet 1968, Copeland 1996). May (2007) noted that for 50 natal dens in southern Norway, the mean distance to the nearest public road was 7.46 km and from the nearest private road (presumably with less traffic) was 3.06 km. Krebs et al. (2007) noted that female Wolverine habitat associations in summer were negatively associated with roaded and recently logged areas. Of 21 dens documented in two British Columbia studies, the closest road access was a minimum of four kilometres away, despite the fact that most of the Wolverine were live-trapped adjacent to logging roads (J.A. Krebs, pers. comm. 2006). Similarly, the Ontario denning site was seven kilometres from the closest active logging road and five kilometres from the nearest human access, a mining trail (Dawson et al. 2010). Rauset (2013) analysed environmental factors predicting the range and frequency of Wolverine reproductions based on 1,442 observations from den monitoring surveys between 2001 and 2011 in Norway and Sweden. They found that Wolverine occupancy was positively related to rugged terrain and productivity and negatively affected by human-dominated habitat. Management policies strongly influenced reproductive success in otherwise similar habitat (Rauset 2013). Rauset (2013) also reported that human settlement and its associated activities may negatively influence Wolverine fitness parameters rather than resulting in absolute avoidance of Wolverine and create sink habitats.

Movement and Dispersal
Snow-tracking has revealed that Wolverine can travel long distances during daily hunting; with distances of 30 to 40 km considered “normal” (Krott 1960, Haglund 1966, Pullianen 1968) and covering distances up to 65 km without rest if pursued (Wilson 1982). Adult males tend to move greater distances and make longer and more direct movements than adult females (Banci 1994). Females with young move less than solitary females and hunting mothers leave their young at rendezvous sites that are visited daily (Magoun 1985). Kits were moved to new rendezvous sites every one to nine days and more frequently (every one to two days) as they grew older (Magoun 1985).

Male Wolverine are capable of large dispersal movements, 378 km over eight months (Gardner et al. 1986) and 874 km in 42 days (Inman et al. 2004). Similar large movements of 185 to 326 km for males have been reported (Copeland 1996, Krebs and Lewis 2000, Mulders 2000). A dispersal distance of 100 km for a juvenile male was documented in the Ontario study (Ontario Boreal Wolverine Project unpub. data). Adult males may influence the dispersal and settlement of juvenile males (Gardner 1985, Banci 1987).

Dispersal distances of juvenile female Wolverine are generally shorter than males, with female residency being established adjacent to, or within, their natal home range (Magoun 1985, Aronsson 2009). Magoun (1985) reported a dispersal of 300 km by a yearling female, while Mulders (2000) reported female movements of 69 to 225 km. Vangen et al. (2001) found similar dispersal distances for males (51 km) and females (60 km), although they cautioned that these were likely underestimates because radio contact was lost to a greater extent with long distance dispersers compared to those that remained in the study area. Flagstad et al. (2004) suggested that males may
disperse up to 500 km and females more than 100 km, based on indirect estimates of dispersal distance inferred from mother-offspring relationships. Genetic evidence collected from a male Wolverine at a camera trap site in northern California revealed a western Rocky Mountain origin, opening the possibility of a lengthy dispersal event across hostile habitats (Moriarty et al. 2009). Support for such movements is provided by the recorded dispersal of a collared male Wolverine from northwestern Wyoming to Colorado, a straight line distance of 541 km, and minimum distance traveled of 942 km (Inman et al. 2009).

Various studies have found that male Wolverine may disperse as either young-of-the-year or subadults (Gardner 1985, Magoun 1985, Banci 1987). Wolverine are known to cross significant natural and artificial landscape barriers such as major highways or reservoirs from dams while undergoing long-distant movements (Inman et al. 2004, 2009). These increased movements by juvenile males, either for exploratory or dispersal purposes, may make them more susceptible than females to trapping and roadkill (Banci 1987, Banci and Proulx 1999).

1.5 Limiting Factors

Low Population Resiliency
As noted previously, Wolverine have relatively low reproductive potential (Magoun 1985, Copeland 1996, Weaver et al. 1996, Persson 2003). Factors such as relatively late age of sexual maturity, high interbirth interval, and low recruitment rate contribute to the low life-time productivity of Wolverine as compared to other large carnivores (Weaver et al. 1996). Food availability appears to play a critical role in the ability of females to produce young and kit survival. This translates into a relative lack of resilience whereby Wolverine populations are slow to recover in the face of higher-than-average mortalities. Since the interval between litters is generally two or more years due to female body condition, food supply and adequate habitat conditions, recruitment of juveniles into the population may be intermittent. In situations where births are unable to keep pace with deaths, the long-term viability of a population will be sensitive to small declines in adult survivorship (Weaver et al. 1996). Banci (1994) hypothesized that due to their lower overall population numbers and relatively lower habitat diversity and prey abundance in eastern North America, that Wolverine in this geography have historically had the lowest level of population resilience among North American populations and have subsequently seen the greatest decline in both numbers and range.

Habitat Specificity
The importance of spring snow cover to successful Wolverine natal denning has been widely reported in the literature (Pulliainen 1968, Banci 1994, Magoun and Copeland 1998, Persson et al. 2003, Aubry et al. 2007, Inman et al. 2007a). Copeland et al. (2010) suggested that Wolverine in fact have an “obligate association” with spring snow cover. This acts as insulation from extreme weather as well as protection from predators. Winters with high snow accumulation and abundant snowpack provide
suitable denning habitat and potentially more winter-killed ungulates for Wolverine to feed on. Although May 15 was used by Copeland et al. (2010) to represent the approximate end of denning, they cautioned that the actual date varies geographically. Snow cover is not consistent from year to year in any given place, and can demonstrate variability across a landscape, particularly at the southern extent of Wolverine distribution and in areas of low topographic relief.

1.6 Threats to Survival and Recovery

The Wolverine is among the least understood of North America’s medium to large-sized carnivores (Ruggerio et al. 1994, Weaver et al. 1996). Although this species has experienced range loss and fragmentation across North America over the past 150 years, particularly at the southern margins (Banci 1994, COSEWIC 2003, Aubry et al. 2007), there is little definitive empirical evidence linking specific factors to Wolverine decline anywhere. Only in the last few decades has basic ecological information on this species been successfully gathered.

In Ontario, Wolverine range recession since 1880 has been documented by Dawson (2000) based on sightings and fur harvest returns. The pattern for Wolverine has been similar to that of Woodland Caribou: both species disappeared from southern Ontario fairly rapidly during the nineteenth century during a period characterized by a large increase in human settlement, logging and railroad construction, and during the early twentieth century, a period of intensive exploitation of wildlife (Dawson 2000, Racey and Armstrong 2000, Schaefer 2003). In addition to this documented correspondence between Wolverine decline and the spread and intensity of the human footprint in Ontario is the fact that Wolverine populations have a low intrinsic ability to recover and repopulate areas from which they have been extirpated (Weaver et al. 1996, COSEWIC 2003).

A discussion of factors that pose the principal threats to Wolverine recovery in Ontario follows. Although an attempt has been made to discuss threats individually, it is recognized that many of these do not act in isolation and that various combinations of factors likely work together, resulting in cumulative impacts and compounded threats. For the same reason, we did not prioritize actions (other than research). Moreover, each threat varies in its intensity across Wolverine range in Ontario, and may be important in some areas while inconsequential elsewhere. In a similar fashion, some threats that are of relatively minor concern today are anticipated to rise in severity in the future.

Climate Change

Although there have been no modeling exercises focused on Wolverine, Colombo et al. (2007) predict rising temperatures and accompanying precipitation changes in northern Ontario under various predicted climate scenarios. As with many furbearers (e.g., Krohn et al. 1995), snow depth and persistence influences Wolverine distribution and abundance. However, predictions are handicapped by the poor ability to model snow
characteristics for future climate scenarios in Ontario (Bowman and Sadowski 2012). Wolverine habitat is expected to be affected by a changing climate in various ways.

**Reduction of spring snow cover and natal denning habitat**
Climate and weather conditions have the potential to affect Wolverine habitat quality. A spatial correlation between spring snow cover and Wolverine occurrences in North America (Aubry et al. 2007) and world-wide (Copeland et al. 2010) has been documented. Brodie and Post (2009) have suggested a link between decreasing snowpack and Wolverine declines, although others have questioned the premise behind these conclusions (Brodie and Post 2010, DeVink et al. 2010, McKelvey et al. 2010,).

Climate change is expected to alter the availability of spring snow cover and recent projections of changes in Wolverine habitat as a result of climate change indicate potentially dramatic declines in Wolverine habitat in the contiguous United States (McKelvey et al. 2011, Peacock 2011). Climate change has the potential to influence future distribution and abundance of Wolverine due to increased variability in snowfall patterns and accumulation, and changes in precipitation falling as rain versus snow. Similar modeling exercises have not been conducted to predict potential impacts on Wolverine in low-elevation boreal habitats in Ontario.

**Alteration of habitat from temperature extremes**
Copeland et al. (2010) suggest that in addition to spring snow cover, Wolverine are also restricted by an upper thermal limit. They modeled Wolverine distribution with a mean August maximum temperature of 22°C and while this was a less effective predictor of Wolverine presence than spring snow cover, the analyses suggested that high summer temperatures may limit the geographic distribution of Wolverines (Copeland et al. 2010).

**Reduction and alteration of Wolverine and prey habitat**
A changing climate will alter the species composition of forested ecosystems and may result in loss of conifer cover and snow conditions which are important to prey species such as Woodland Caribou. A transition to an increased deciduous component may negatively affect Wolverine as Bowman et al. (2010) found a significant negative correlation between Wolverine and deciduous habitat.

**Habitat Loss, Degradation, and Fragmentation**
Habitat loss, degradation and fragmentation constitute important threats to Wolverine in Ontario and Canada, although the nature and mechanisms of their impact remain ill-understood (COSEWIC 2003). Habitat loss follows permanent changes that result in areas with no current or potential value to Wolverine. Habitat degradation implies a reduced, but not total loss of habitat value for Wolverine. Fragmentation of habitat refers to the breaking up of continuous habitat that can serve to isolate populations from one another due to the impermeability of the intervening landscape.
Recovery Strategy for the Wolverine in Ontario

Habitat loss has been most evident in the Wolverine’s historic range and along the southern margins of current range\(^3\) (van Zyll de Jong 1975, Dawson 2000). This loss is attributed to the permanent conversion of once suitable habitat to areas now heavily interspersed with human infrastructure (urban centers, settlement and associated linear corridors). Remaining potential habitat at the southern edge of Wolverine range exists in small patches surrounded by areas characterized by high Wolverine mortality that may not sustain populations. Habitat loss is a potentially increasing threat in current Wolverine range if resource development activities that move northward permanently alter the environment.

Activities such as forestry, mineral development and exploration, and development of linear corridors influence Wolverine ecology through the degradation, fragmentation, and effective loss of Wolverine habitat (Banci 1994, Krebs et al. 2004, Aubry et al. 2007, Slough 2007). Degraded habitats can theoretically increase in quality and become suitable in the future if given the opportunity to recover. While the exact impacts of forest management on Wolverine are not completely understood, evidence suggests that there is a threshold of human access (road density) and habitat removal or degradation at which Wolverine will cease to use or occupy an area which overcomes any benefits brought about by forest management-induced increases in prey levels. Losses or displacements can have a significant impact on local populations and impede the natural recovery of populations at the periphery of current range (Aubry et al. 2007, Krebs et al. 2007).

It is anticipated that mining will supplant forestry as the principal resource development activity in Ontario’s Far North in the coming decades. This is already apparent with respect to the significant interest in the “Ring of Fire” mineral exploration area where plans are currently underway to develop mining operations for the extraction of chromite and other minerals. The impacts of mineral development of this scale on Wolverine are largely unknown. Future impacts may range from displacement of individuals from areas subjected to sustained disturbance from helicopters during exploration activity, to habitat loss or fragmentation due to infrastructure and accompanying road networks, and the accumulation of these impacts. It is unknown at this time whether the regulatory environment for mineral exploration and mining activities, which does not currently emphasize biodiversity protection, will be able to mitigate this threat for Wolverine. In addition, the enhanced potential for conflicts tend to arise when Wolverine are attracted to the human domestic waste sources at these developments. For example, a number of Wolverine mortalities, relocations, and other incidents have been documented at the two operating diamond mines in Northwest Territories (COSEWIC in prep).

Wolverine populations in Ontario and Manitoba currently show signs of genetic isolation from Wolverine in alternate jurisdictions (Kyle and Strobeck 2002, Zigouris et al. 2012.), perhaps underlining the enhanced vulnerability of their status as peripheral populations.

\(^3\) Wolverine distribution as determined by detection probabilities calculated from the Ontario Boreal Wolverine Project aerial track surveys conducted in 2003 and 2004 and aerial efforts completed in 2009 and 2010 (see Figure 2).
Although the factors causing this genetic isolation are not known, major transportation and transmission corridors may impede Wolverine movements, ultimately affecting gene flow and population persistence (COSEWIC 2003). Increasing road development within Wolverine range may result in higher incidences of Wolverine-vehicular collisions, particularly for young dispersing males (Krebs et al. 2004). As noted in the Species Biology section, a number of Wolverine have been killed in vehicle collisions in Ontario.

Human activities, such as recreation, tourism, research activities, and vehicle or air traffic, have been correlated with the displacement of Wolverine from areas of suitable habitat (Krebs et al. 2007). At present, some of these activities are not as prevalent in the Ontario Wolverine range as they are in mountainous areas of western North America.

Declines in prey species due to natural or anthropogenic causes can result in reduced Wolverine fitness, reproduction and recruitment (Persson 2005, Lofroth and Krebs 2007). Woodland Caribou, Moose and American Beaver are important food sources for Wolverine (Ontario Boreal Wolverine Project unpub. data). Woodland Caribou populations tend to decrease in areas of young deciduous forest that follow forest harvesting or fire, while Moose and White-tailed Deer populations tend to increase in these areas (Fisher and Wilkinson 2005, Courtois et al. 2007, Vors et al. 2007, Wittmer et al. 2007, Bowman et al. 2010). Although areas recently disturbed by natural or human-induced means may have increased prey biomass relative to undisturbed mature forest, the relative availability of ungulates and other prey to Wolverine is unclear due a number of confounding effects such as access, trapping, and increased predator (Wolf and Black Bear) populations. Thus it is not simply prey numbers that should be looked at but rather the landscape context in which that prey biomass exists. Wolverine using these areas may be susceptible to increased mortality due to greater trapping effort or vehicle collisions as a result of enhanced access.

**Increased Predator/Competitor Encounter Rates**

Interspecific interactions are among the least understood aspects of Wolverine biology. As Moose and White-tailed Deer populations increase in logged areas, so do wolf populations (Bergerud 1974, Schwartz and Franzmann 1989, Bowman et al., 2010). Wolverine may benefit from low to moderate increases in wolf densities in some areas due to increased access to carrion. However, the trade-off to increased wolf populations and increased carrion from wolf kills could be an increase in predation risk, since Wolves (Boles 1977, Krebs et al. 2004) and Black Bears (Inman et al. 2007b) have been identified as predators of Wolverine. Recent studies in Norway (van Dijk et al. 2008) suggest spatial separation between Wolverine and wolves. While Wolverine appear to depend on wolves for carrion in the winter they do not use wolf trails to find carcasses, suggesting an avoidance of direct confrontation with wolves. Although unsubstantiated by data at this time, it is possible that increased predator populations following habitat changes may ultimately have a negative impact on Wolverine through competition or predation once wolves reach relatively high densities.

**Targeted and Incidental Trapping**
By virtue of their low reproductive rates, limited range and distribution, and large home ranges, Wolverine has a low resilience to trapping pressure. As such, overexploitation can lead to local extirpation with replacement of removed animals a slow process, if it occurs at all (Banci and Proulx 1999). In populations outside Ontario, the consequences of overexploitation have been clearly demonstrated. In Scandinavia, Wolverine was nearly extirpated as a result of uncontrolled harvest prior to their legal protection (Landa et al. 1997). In a recent synthesis of survival and mortality data from 12 North American radio-telemetry studies, Krebs et al. (2004) found that survival was much lower in trapped than untrapped Wolverine populations and that immigration from untrapped areas is often required to sustain Wolverine in trapped areas. Because Wolverine can travel great distances and are attracted to bait due to their scavenging habits, they can be more susceptible to trapping than many other furbearing species (Hornocker and Hash 1981). Lofroth and Ott (2007) assessed the sustainability of Wolverine harvest (trapping and hunting) in British Columbia over the 1985 to 2004 period and concluded that harvests were likely to have been unsustainable in 15 of the 71 population units occupied by Wolverine. An additional 5 of the remaining 56 population units were deemed to be marginally sustainable and of potential management concern.

In Ontario, prior to the elimination of the trapping season for Wolverine in 2009, generally between 5 and 15 Wolverine were harvested annually, (OMNR unpub. data). This number was stable since at least the 1980s (Dawson 2000). Most traplines where Wolverine have been harvested have had very low total numbers (one to two) removed over the past 28 years, and the vast majority of traplines have had either no reported harvest or long periods of time between harvest. Five traplines accounted for 40 percent of the Wolverine harvest: all are among the largest traplines (by area) and are concentrated in northwestern Ontario. For Ontario at large, there is nothing to suggest that current reported Wolverine harvest levels pose a threat to the overall survival or recovery of the species in the province. The spatial pattern and intensity of harvest is indicative of a very light overall harvest level spanning a vast geographic area. Indications of an expanding range and possibly increasing population numbers in Ontario suggest that current mortality rates from harvest or any other means are not occurring at rates that would negatively influence Wolverine recovery in the province, with the possible exception of areas along the southern and eastern edges of Wolverine range.

Particular conditions within localized areas do, however, make Wolverine more susceptible to overharvest. For example, Wolverine appear to be more commonly harvested where trappers have road access and forests have been harvested (OMNR unpub. data). Likewise, removal of any individuals through trapping may be harmful to populations that are at low levels (e.g., northeastern Ontario where Wolverine have been absent until recently).

A zero quota for trapping Wolverine was placed on non-Aboriginal trapping licenses during the 2001/2002 trapping season in Ontario. Since that time an average of 2.6 Wolverine per year have been incidentally harvested in Gray Wolf, Canada Lynx (Lynx
canadensis), American Marten (Martes americana) or River Otter (Lontra canadensis) trap sets (OMNR unpub. data). This harvest is primarily concentrated at the southern extent of current Wolverine range and may serve as an impediment to the establishment of sustainable Wolverine populations in this area and a barrier to further expansion into previously occupied range. Forest harvesting and mineral exploration have altered the age, structure and composition of the forest and increased human access into the southern portions of current Wolverine range. This may predispose Wolverine to increased trapping mortality through ease of trapper access and a reduction in mature forest habitat that may be ‘funneling’ remaining animals into more concentrated areas of remaining habitat, as hypothesized by Lofroth (2001). Of more immediate concern to Wolverine recovery, however, is the lack of information about Wolverine mortality in Ontario as a result of incidental trapping. Although sub-section 14(d) of Ontario Regulation 242/08 previously mandated reporting of incidentally caught Wolverine within seven days of knowledge of the event, it is difficult to establish whether this requirement was adhered to. Similar challenges will continue to persist under the revised regulation (section 23.19 trapping – incidental harvest, under O. Reg. 242/08).

Although sale may be restricted provincially, there are unconfirmed reports that Wolverine trapped in Ontario have been sold in alternate jurisdictions such as Manitoba. Prior to the elimination of the Wolverine harvest season in 2009, Wolverine were occasionally sold in Manitoba due to the proximity of fur buyers. Fur market prices may also influence harvest of Wolverine as the effort expended on trapping generally mimics the market environment (i.e., as pelt prices increase, so does effort, which increases the probability of incidental Wolverine harvest and vice versa). However, from more than 125 interviews with trappers in northwestern Ontario, Ray et al. (2005) found that the majority of Wolverine harvests have been motivated by opportunistic encounters, accidents (incidental harvest), or real or perceived threats to trapper success, rather than the value of the fur itself. All are likely to increase as human development moves northward, thereby providing enhanced access into the core of current Wolverine range in Ontario.

Wolverine – Human Interactions and Human Attitudes
A great deal of folklore surrounds the Wolverine, which has led to a negative reputation influencing people’s attitudes towards recovery. Its reputation as a thief or pest to the trapline and food caches has been passed down through generations and does a great deal to shape current attitudes, regardless of personal experience. Members of the general public likewise perceive this animal to be a ferocious and blood-thirsty creature, even though there has never been a documented attack of a human by a Wolverine. Conservation measures and recovery efforts may be hindered by these attitudes.

As well, increased human access and activity in previously undeveloped areas of the north increase the likelihood for Wolverine-human interactions. This is most likely to occur through attraction of Wolverine to camp kitchens or waste disposal sites, potentially resulting in harm, harassment or targeted killing of Wolverine that may be attributed to misconceptions of this animal.
Cumulative Impacts of Multiple Threats
Threats to Wolverine rarely act in isolation. Cumulative impacts from many activities (direct and indirect) can have a large influence on an area’s ability to support a viable population. Cumulative effects from multiple resource management activities are seldom adequately addressed in planning or in development and implementation of mitigation strategies. A lack of integrated land use and resource development planning at appropriate scales and lack of examination of cumulative impacts within Wolverine range could likely exacerbate the above-described threats to Wolverine.

Caution must be exercised due to uncertainties associated with the direct and indirect effects of forestry and other resource extraction activities on Wolverine. As with other mustelids for which the cumulative effects of trapping and forest harvesting have been demonstrated (Thompson and Colgan 1987, Thompson 1994), as well as northern carnivores at the southern periphery of their range (Carroll 2007), high mortality rates of animals from already-compromised habitats is likely to be of greater detriment to Wolverine than trapping alone (Banci and Proulx 1999, Krebs et al. 2004).

1.7 Knowledge Gaps

Additional research on Wolverine in Ontario is necessary in order to make effective management decisions to ensure the Wolverine recovery goal and objectives are achieved in the face of increasing development activities within Wolverine range (see sections 2.1 and 2.2).

Scientific knowledge of Wolverine ecology in Ontario is profoundly limited because most current Wolverine range has been generally coincident with those regions of little interest for resource development (although this situation is changing rapidly). It is only in the last decade that an initial understanding has been gained of Wolverine ecology in Ontario. Some initial effort has been made to gather traditional knowledge from several hundred trappers and elders (e.g., Whitefeather Forest Initiative, Ontario Boreal Wolverine Project unpub. data, Ray 2004), but this must be augmented and incorporated into the knowledge base that will inform recovery actions on an ongoing basis. The limited knowledge of the mechanisms that drive population decline serves as an impediment for formulating actions to ensure Wolverine conservation in the face of projected land use changes.

The following list of knowledge gaps focuses on those topics for which there is a practical application that will benefit Wolverine recovery efforts. The recovery team has elected not to prioritize them, leaving that instead for a future exercise to be done in the context of recovery implementation and formalization of an adaptive management process.

Wolverine Distribution and Abundance
Surveying and monitoring techniques
Recovery Strategy for the Wolverine in Ontario

There is general knowledge of broad distribution patterns of Wolverine in the province but information that could effectively support land use or resource management planning is not available at the necessary resolution (e.g., den surveys, baseline population health estimates such as recruitment rates, or provincial population size estimates with known confidence intervals). Traditionally, fur-trapping records and incidental observations have been the sole means of monitoring Wolverine distribution and relative abundance in the province. However, under the current regulatory framework where non-Aboriginal individuals, fur dealers and fur auction houses cannot purchase, possess or sell Wolverine harvested in Ontario, there is no mechanism for tracking current Wolverine harvest by First Nations, eliminating this as a mechanism to track future Wolverine distribution and relative abundance in the province. An effective and efficient Wolverine survey and monitoring protocol using aerial surveys of tracks in snow has recently been developed for the purposes of evaluating extent of distribution and area of occupancy via hierarchical spatial modeling (Magoun et al. 2007). Further testing of this monitoring protocol and its ability to detect changes in Wolverine occupancy and relative abundance at the southern extent of current range and range-wide is warranted. There are currently no reliable population-level estimates for Wolverine in Ontario. While important advances have been made recently on deriving population estimates of Wolverine at smaller scales (< 10,000 km²; Magoun et al. 2010; Royle et al. 2010), the low densities, large home range sizes, long-distance movements and logistical constraints mean that it is not presently considered feasible to generate such a population estimate across the entire Wolverine range in northern Ontario.

Genetic diversity within Wolverine populations
The genetic profile of Wolverine is not understood well enough to assess, predict or manage the genetic connectivity of this species across Ontario, neither between recovery zones (see section 2.2) nor neighbouring jurisdictions. Studies based on nuclear DNA loci have demonstrated little structuring among Wolverine sampled across northern Canada, suggesting a single, panmictic population (Wilson et al. 2000, Kyle and Strobeck 2001, 2002). However, studies examining mitochondrial DNA (mtDNA) have shown considerable genetic structuring among Wolverine samples from these same regions as well as other areas of North America (Wilson et al. 2000, Chappell et al. 2004, Tomasik and Cook 2005, Cegelski et al. 2006). These findings are consistent with male-biased dispersal but emphasize the importance of female philopatry and successful dispersal of females between populations to maintain genetic diversity (Chappell et al. 2004, Tomasik and Cook 2005, Cegelski et al. 2006). At present, samples from approximately 70 Ontario Wolverine have been collected, most from a relatively small area near Red Lake and Ear Falls (Zigouris et. al. 2012). It will be necessary to acquire as many Wolverine hairs and tissue samples from as wide an area in the province as possible for both nuclear and mtDNA genetic analyses to determine levels of genetic structuring within Ontario Wolverine populations.

Habitat and Habitat Management

Habitat selection
It is presumed that Wolverine habitat needs are met at a variety of spatial scales, yet the specific contribution (mechanism, relative importance) of physical and biological
factors to habitat suitability at each scale is not known. It is therefore difficult to translate these needs into specific habitat or population management prescriptions. Moreover, Wolverine habitat information collected in North America has been traditionally biased towards western mountainous regions. While data gathered thus far by the Ontario Wolverine Project has contributed valuable information on the distribution patterns and general habitat associations of Wolverine in the province, further research is needed at the following forest management planning scales.

- **Landscape**: It is important to resolve the uncertainty about the extent to which different landscape-scale habitat attributes, resulting from both natural and anthropogenic disturbances (e.g., number, size, shape and placement of timber harvest blocks, other anthropogenic disturbances, fires or blowdown; percentage composition of various habitat seral stages; linear corridor density and placement) may be important for predicting Wolverine use. This information will contribute to an evaluation of the ability of forest management or other guidelines and regulations (currently existing and in development) to maintain Wolverine habitat at the landscape scale under landscape change by any agent. It will also help to understand cumulative impacts on Wolverine and provide information relevant to land use planning. Specific information is needed to develop recommendations for road density and human footprint thresholds, spatial and temporal scales for harvesting, and habitat required for stable, viable Wolverine populations. Moreover, every effort must be made to evaluate the hypothesis that landscapes created through implementation of direction for Caribou will provide appropriate habitat for Wolverine.

- **Stand**: Studies of the habitat needs and human activity disturbance thresholds of Wolverine at the stand/site scale (specifically, conservation of natal and maternal denning features) are necessary to support the development and refinement of habitat management best practices and area of concern prescriptions. While these scales are management constructs specific to forestry, insight derived from these research activities are expected to be helpful for managing other resource management activities that affect Wolverine habitat at multiple scales.

It is unknown to what extent the distribution and abundance of boreal forest landscape features in relation to human developments and activities accounts for the overall distribution of Wolverine across the landscape. An analysis of current Wolverine distribution in Ontario in relation to current and projected land-use activities at several spatial scales will assist in identifying potential locations and sizes of refugia and travel corridors for Wolverine and the point at which habitats and populations become fragmented or isolated.

*Movement patterns*

Wolverine have large home ranges and move widely across the boreal forest landscape; however, it is unknown which factors or interactions between factors
encourage or impede this movement, expand or contract home ranges, or support successful dispersal of juveniles across the landscape. It is also unknown to what extent these factors contribute to population status such that they could be managed to support achievement of the recovery goal.

- More details on Wolverine movement patterns in and around disturbed (both natural e.g., fire and anthropogenic e.g., timber harvest) and roaded areas is needed to understand how Wolverine react to changes in land use patterns and adjust their movements and home ranges to accommodate various types of disturbance (forestry, mining, power development, fire etc.).

- Resident adult Wolverine occasionally make long-distance movements beyond the boundaries of their home range (Banci 1994). Future research efforts should therefore attempt to document these movements, noting their frequency of occurrence, sex of animals involved, and what factors may be influencing these patterns (e.g., habitat, food availability, or presence of other Wolverine).

- Dispersal of young female Wolverine has been suggested as the primary factor limiting the re-colonization of habitats (Banci 1994). Detailed information on the movements and habitat use of dispersing females is needed to determine and identify the appropriate composition and location of potential dispersal or travel corridors within and between recovery zones.

- Collaboration with Quebec to evaluate dispersal of Wolverine in the Eastern Recovery Zone towards the Quebec border would be helpful to determine the likelihood of re-colonizing the Quebec territory.

**Home range size and movements of reproductive females**
The minimum size and composition of a landscape capable of supporting a minimum viable population of Wolverine in Ontario is not known. Although the general distribution of Wolverine across the province is now understood, there is no knowledge of how many populations occur in the province, or whether they are viable (or reliant on rescue from Manitoba). There would be no way to predict the relative change in viability resulting from specific changes in human activities or habitat quality. The location and size of home ranges for reproductive females are probably influenced by a combination of food, predation risk and human disturbance factors, while home ranges of adult males are influenced by the location and number of reproductive females and food-related habitat variables (Sandell 1989, Krebs et al. 2007). Information on home range sizes for reproductive females will help determine the minimal amount of suitable habitat needed (i.e., thresholds) to support viable Wolverine populations: information that is useful for land use planning. Additionally, information on the movements of reproductive females and their centres of activity will aid in the identification and availability of important food items.

**Den site characteristics and availability**
Presently, there is no method for predicting den site locations or denning/maternal areas for Wolverine in lowland boreal forests.

- Limited information currently exists on Wolverine den site characteristics in Ontario. It is presumed that den site selection is a significant factor in survival and recruitment of kits. The need for reproductive females to protect kits from predators requires that certain types of den structures be present in their home ranges. Information on den site characteristics and distribution of these structures on the landscape will help to define habitat features necessary for Wolverine recovery in Ontario, and understand the extent to which they may be limiting. Of particular interest are not only the structures themselves, but also other characteristics that might influence the selection of the site as a den [e.g., forest cover type, aspect and slope, distance to water, distance to active and inactive roads or trails, food availability (Section 1.2) etc.] and the relative importance of these factors. Such knowledge will aid in the evaluation of the “denning potential” of areas planned for resource development.

- The role of den selection in predator avoidance remains uncertain. Knowledge of how the distribution and abundance of predators such as Wolves and Black Bears, may affect the location and types of natal and maternal dens and rendezvous sites used by Wolverine is needed.

- The impact of climate change on Wolverine denning habitat is uncertain but potentially significant. Factors such as a potential decrease in snow cover and persistence during the denning period, the potential impact of more frequent thick snow crusts on access to denning habitat, and survival of small mammals in the sub-nivean layer is required. Methods need to be developed to model snow depth, including under various scenarios of climate change (Bowman and Sadowski 2012).

Population dynamics
Reliable predictive models of Wolverine population dynamics are absent for Ontario, as are the values to calibrate significant parameters of such a model. These models are very important for addressing uncertainties as they relate to population-level responses to human and natural disturbance, including harvest levels. They are required to make predictions on the outcomes of management actions and allow for the explicit testing of any predictions that derive from them.

- Population modeling would assist in understanding the dynamics of Wolverine populations and allow the evaluation of the sustainability of populations and potential for future sustainable fur harvests, as well as the design of conservation measures such as trapping refugia. Field studies are needed to build a database of Wolverine population attributes (see 2 - 4 below) and to parameterize the models.
• Field investigations are required to determine female pregnancy rates, sex ratios at birth, and sex-specific recruitment rates to derive a better understanding of how reproductive success and female condition vary with environmental factors, such as the availability of food and natal dens.

• Information on the causes and extent of adult and juvenile Wolverine mortality in managed and natural landscapes will assist in parameterizing models and developing strategies for managing mortality.

• The ultimate application of population and habitat modeling will be for researchers to put forward robust recommendations on the size of area or number of animals required for a sustainable population, and the identification of potential refugia.

*Relative importance of ungulates and small prey as direct or secondary food sources*
Based on Wolverine research from other regions and anecdotal evidence from Ontario, it is assumed that carcasses of caribou and moose are important foods for Wolverine in lowland boreal forest in Ontario, particularly in winter. Information from the Ontario Boreal Wolverine Project also indicates that American Beaver may be an important source of food, even in winter. However, there is no information on the relative importance of these items in the Wolverine diet, how the availability of various food items affects Wolverine distribution and abundance on the landscape, and how these may be affected by changes in landscape pattern or composition as a result of resource development.

*Cumulative impacts of anthropogenic disturbance on the distribution of Wolverine*
As described in section 1.4, preliminary results from the Ontario Boreal Wolverine Project have indicated that as forest management and other human disturbances (particularly road networks) expand on the landscape, Wolverine probability of occupancy tends to decrease. However, more information is needed to understand the mechanism of distributional shifts (e.g., direct responses to habitat changes produced by forest management activities) and to cumulative effects of human disturbance on the landscape (e.g., enhanced opportunities for additive mortality through encounter with traps or roads).

*First Nation knowledge, perspectives and practices*
Traditional knowledge from communities within Ontario Wolverine range would strengthen the overall information base with respect to any or all of the knowledge gaps listed above. Of particular relevance to Wolverine recovery would be the collection of knowledge regarding: (1) cultural, spiritual, ecological and socio-economic significance of Wolverine, (2) traditional ecological and local knowledge of wolverine populations and management, and (3) Aboriginal harvesting practices.
1.8 Recovery Actions Completed or Underway

Legislation and Policy
The Wolverine was provincially designated as a threatened species on the Species at Risk in Ontario List (OMNR 2004) in April 2004. On June 30, 2008 the ESA came into effect providing protection to individual Wolverine (i.e., killing, harm, harassment, etc.). Effective June 30, 2013, Wolverine habitat is protected under the general habitat protection provisions (i.e., damage or destruction) of the ESA. Activities that are likely to adversely affect Wolverine and/or their habitat may require authorization under the ESA or may be eligible to register for one or more regulations under the amended O. Reg. 242/08 to avoid a contravention under the Act.

The Wolverine is classified as a furbearing mammal by Ontario Regulation 669/98 under the Fish and Wildlife Conservation Act. In recognition of declining numbers, all non-Aboriginal trapping licenses have been assigned a zero quota for Wolverine since the 2001/2002 trapping season. Additionally, in 2009 the season for Wolverine was closed.

Research
A general lack of knowledge and attention to Wolverine in Ontario has been attributed to the Wolverine’s occupancy of areas north of current forest management activities, and historically low populations and harvest rates (Dawson 2000). Recently, interest levels in Wolverine have increased due to increasing development pressures (forestry, mining, power development) within its current range. Recent and ongoing provincial Wolverine research efforts are summarized below.

- **2001 and 2002 - Initial camera “trapping” surveys** were conducted by the OMNR in the Red Lake area to document Wolverine presence at the southern limit of their current range.

  - The principal goals of this project were to gain a better understanding of the ecology of Wolverines in Ontario, refine existing knowledge of Wolverine distribution, develop and test tools for inventory and monitoring of Wolverine populations, and gather initial knowledge on the effects of forest management and increased development on Wolverine habitats and populations.
  - The study area was divided into two units: (1) the intensive study area (27,900 km²) was located in the Red Lake/Ear Falls area, where several survey techniques (live-trapping, satellite radio-tracking, aerial surveys, hair snaring, and camera “trapping”) were tested in both logged and unlogged habitats; and (2) the extensive study area (599,000 km²) extended from latitude 50° north to the Hudson Bay coast and from the border of Manitoba east to James Bay, where
interviews with First Nations community members were conducted to seek information on the distribution and status of Wolverine throughout the rest of the province. This area was also the focus of broad-scale aerial surveys to obtain the same information.

- During the third season of fieldwork, the intensive study area was extended around Red Lake to the north (unlogged), south (intensively logged), and east (minimally logged) and track surveys were carried out 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 (Bowman et al. 2010, Dawson et al. 2010).

- The survey methodology developed for Wolverine in remote, inaccessible regions has been published (Magoun et al. 2007). This paper formed the basis for a surveying and monitoring techniques manual for Wolverine, recently published jointly by WCS Canada and OMNR (Koen et al. 2008).

- **2006-2007 - Trapper Survey at the Southern Limit of Wolverine Distribution in Ontario**
  - This project was a joint effort of WCS Canada, Ontario Fur Managers Federation, and OMNR, which aimed to collect objective information from trappers relating to individual attitudes towards Wolverine, incidental harvest circumstances, and quantification of trap damage from Wolverine.
  - Insights from this study were incorporated into the development of the Wolverine chapter of the Fur Harvest, Fur Management and Conservation Course manual (see below).

- **2006-2010 – Red Lake District Non-invasive Survey**
  - These camera surveys, conducted by OMNR in partnership with local trappers, built on non-invasive survey work in 2003 and 2004 of the Ontario Boreal Wolverine Project in the Red Lake/Ear Falls area.
  - Trappers were involved with the location and checking of the camera and hair traps on a regular basis.

- **2008-2012– Aerial Surveys**
  - This project has been led by WCS Canada in collaboration with several First Nations and OMNR.
  - Deploying the methodology of Magoun et al. (2007), its principal goals have been to conduct intensive aerial surveys for Wolverine (and other large mammals) within several traditional areas of northern Ontario First Nations, in caribou collaring study areas in and around Pickle Lake, Hearst and Nakina, and across the Far North.
  - This ongoing work has provided new information on Wolverine habitat use in undeveloped areas and relative abundance of this species at the edge of its core range and in relation to other large mammal
species throughout northern Ontario.

- **2009 – 2012 – Far North Aerial Wildlife Surveys**
  - Funded by the Far North Branch (OMNR) as part of the Information Knowledge Management Strategy, aerial track surveys were conducted across the far North planning area from 2009 – 2012.
  - These surveys documented continued range re-colonization to the east by Wolverine (Figure 2, Bergelund et al. 2013).

- **2009 – Wolverine Food Habits Study**
  - The stomach and intestinal contents of 12 incidentally harvested Wolverine, primarily from the Red Lake area, were examined as part of a fourth year honours thesis project at Lakehead University (Watson 2009).

- **2009-2011 – Wolverine Genetics Project**
  - Genetic analysis of historical and recent Wolverine samples from Ontario was conducted with funding from the Far North Branch by the Trent University Natural resources DNA Profiling Lab.
  - Over 60 samples have been analyzed and a final report is pending.

**Habitat Management**

Habitat classification schemes and habitat models do not currently exist for Wolverine. The Draft Forest Management Guide for Boreal Landscapes (OMNR 2013) is intended to address the general habitat requirements for area-demanding species such as Wolverine by applying the coarse filter in forest management. Landscape-level Woodland Caribou direction is included in the draft boreal landscape guide and Wolverine conservation may therefore be addressed indirectly if cumulative impacts can be adequately managed at appropriate scales. Wolverine and Woodland Caribou exhibit similarities that make it advantageous to consider both species together in management decisions, although this hypothesis requires testing.

Standards and guidelines for addressing specific habitat concerns, such as Wolverine denning sites, are contained in the Forest Management Guide for the Conservation of Biodiversity at the Stand and Site Scales (OMNR 2010). A standard four kilometre radius area of concern (AOC) centred on the den site and development of a den site management plan are requirements under this guide. Guidelines include, to the extent possible, incorporation of these local site features into larger blocks of unharvested and unroaded forest on the landscape.

**Communications and Outreach Initiatives**

An awareness poster and reporting postcards seeking information on Wolverine sightings were prepared and distributed by the OMNR in 2001 in an effort to increase OMNR staff and public awareness of Wolverine and improve understanding of this species’ provincial distribution. While relatively few Wolverine observations are received annually (1-2 per year on average), overall levels of media coverage and
positive reaction from the public to news articles and public presentations give some collective indication that the program has helped to increase public awareness of Wolverine in Ontario.

Several informative articles about the Ontario Boreal Wolverine Project appeared during the duration of the project in local newspapers and publications. A mailing list of interested individuals and organizations was created for distribution of project updates. Additionally, preliminary results have been shared with other jurisdictions and Wolverine experts through presentations at conferences and workshops.

An article entitled ‘Why is the Wolverine a threatened species in Ontario?’ (Ray and Dawson 2006) was published in the Ontario Fur Managers Federation publication to enhance awareness of the status of Wolverine in Ontario and recent activities being undertaken in the province. Several presentations and workshops have also been held since 2004 in Red Lake/Ear Falls and in select First Nations communities on the subject of Wolverine ecology, conservation and management.

The Ontario Fur Managers Federation (OFMF), in partnership with WCS Canada and OMNR prepared a special section of the Fur Harvest, Fur Management and Conservation Course manual devoted to Wolverine. This included general information on Wolverine identification (e.g. tracks), practices for avoidance of incidental capture and trap damage, as well as a review of provincial legislation, regulation and policy and associated trapper responsibilities (i.e. reporting). In 2010, a Fact Sheet was developed by OFMF in partnership with OMNR devoted to best management practices for avoiding incidental harvest of this species and Wolverine damage to traps. This document was published as a brochure for distribution and appeared in the Ontario Fur Manager’s Federation magazine (summer 2011, Volume 16, Number 2).

Data Management
The development of a provincial Wolverine database to house all Wolverine observations and research data is underway by OMNR. Once populated, the database will aid in land use planning for proposed resource management activities, and recovery planning initiatives. The database will track observations, aerial survey efforts, collaring projects, remote camera and hair-snare surveys, DNA projects and reported mortality events resulting from harvest, and vehicle or train collisions.
2.0 RECOVERY

2.1 Recovery Goal

The recovery goal is to ensure self-sustaining\(^4\) Wolverine populations within Ontario’s recovery range.

Ontario currently has the most easterly Wolverine populations in North America, given the questionable status of Wolverine in Quebec and Labrador. Thus, Ontario Wolverine are strategically important for both the maintenance of the national Western Population and the recovery of the national Eastern Population. This recovery strategy focuses on the attainment of Wolverine range occupancy across the province and enhancement of connectivity to adjacent populations. Its goals and objectives aspire to achieve self-sustaining populations at levels that would allow genetic exchange with the national Western Population and support emigration to the Eastern Population. If successful, Ontario Wolverine would attain levels able to withstand future commercial harvest.

2.2 Protection and Recovery Objectives

Table 1. Protection and recovery objectives

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<thead>
<tr>
<th>No.</th>
<th>Protection or Recovery Objective</th>
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<tr>
<td>1</td>
<td>Protect and manage Wolverine populations and their associated habitat.</td>
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<tr>
<td>2</td>
<td>Reduce or eliminate known threats to Wolverine populations and their habitat within Ontario’s recovery range.</td>
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<tr>
<td>3</td>
<td>Increase understanding of Wolverine ecology, threats to their habitat and Wolverine survival through inventory, monitoring and research.</td>
</tr>
<tr>
<td>4</td>
<td>Integrate Wolverine conservation efforts across provincial, territorial and federal jurisdictions, between ministries and with First Nations and planning processes.</td>
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<tr>
<td>5</td>
<td>Generate support and partnerships for Wolverine conservation by promoting education, awareness and stewardship of Wolverine and boreal forest ecosystems.</td>
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Recovery Zone Delineation

Historically Wolverine were distributed throughout the province (Figure 1). However, it is recommended that recovery efforts are focused within the three defined recovery zones in the northern half of Ontario (Figure 4). This “recovery range” includes both areas currently occupied by Wolverine, as well as those where the species is known to be re-occupying at present, and that are key to the objective of promoting connectivity between the nationally defined Western and Eastern Wolverine populations. Together, all recovery zones facilitate this future connection: both the Northern and Western

\(^4\) Self-sustaining – a population that has a high (90%) probability of persistence and is capable of sustaining itself while under the influence of stressors and in the absence of mitigative intervention.
recovery zones form a core area for gene flow and dispersal in a north-south direction and eastward to re-populate the Eastern recovery zone. This will provide an essential long-term link to Quebec and the nationally endangered Eastern Population of Wolverine. As well, while the proposed recovery range defines the primary geography within which recovery activities should be undertaken, it should not preclude undertaking of activities outside these boundaries (e.g. southward) where warranted.

Individual recovery zones were delineated on the basis of a number of criteria (described below) that inform the geographic context for Wolverine recovery efforts, which is variable throughout the recovery range. As such, some recovery approaches are not relevant to all zones (Table 2). For those approaches that are, this zonation will inform their implementation, whereby activities can be tailored to the geographic context of Wolverine recovery in Ontario.

The following criteria were considered during the delineation of proposed recovery zones for Wolverine in Ontario: current Wolverine distribution (based on 2003 and 2004; aerial surveys supplemented with 2008 – 2011 survey results), historical Wolverine range [specifically, estimated 1955 range from Dawson (2000)], Ontario Ecoregion boundaries (Crins 2002), and the southern boundary of the zone of continuous Woodland Caribou distribution identified in the Caribou Conservation Plan (OMNR 2009). Recovery zones for Wolverine (Figure 4) have been delineated to capture variation in: (1) Wolverine conservation condition, (2) degree and type of threats, and/or (3) appropriateness of management tools that are expected across and within Wolverine recovery range in Ontario. For example, all-weather road access and resource extraction activities are not expected to occur with the same intensity across the north due to varying habitat and terrain conditions, and management tools to achieve recovery objectives would be expected to vary as a function of both threat and relative abundance of Wolverine. A description of each recovery zone follows.

**Northern Recovery Zone**

This area (Figure 4) is approximately 226,600 km² in size and is comprised of portions of the Hudson Bay Lowland ecozone (Ecoregions 0E, 1E) (54% of the area) and the Boreal Shield ecozone (Ecoregion 2W) (46% of the area). It is bounded in the south by the Aguta moraine system, in the west by the approximate northern boundary of the Far North Planning area, and in the east by the northern boundary of Ecoregion 2E. There is currently no all-weather road access in this recovery zone and relatively little resource extraction (forestry, mining) compared to the other two recovery zones. The “Ring of Fire” mineral exploration zone straddles the boundary between the Northern and Eastern recovery zones. Wolverine are currently distributed throughout this zone and based on aerial survey results are believed to be stable or increasing.
Western Recovery Zone
This recovery zone is roughly 195,500 km² in size and extends north from the southern boundary of continuous Woodland Caribou distribution (OMNR 2009) to the northern edge of the major moraine system at the south end of Opasquia Provincial Park (Figure 4). This is generally thought to be the northern extent to which all-weather road access and widespread resource extraction (e.g., forest harvesting) would occur. This recovery zone lies entirely within the Boreal Shield ecozone (Ecoregions 2W, 3S, 3W, 4S). The zone includes areas within the currently managed forest as well as the Far North planning area and has high development potential and both all-weather and winter road access that will likely be expanded. Wolverine are primarily concentrated in the northern and western portion of this zone with increasing evidence of colonization of the east side of the zone based on recent aerial surveys.

Eastern Recovery Zone
This recovery zone is approximately 177,400 km² in size and is bounded by the northern boundary of Ecoregion 2E in the north, and in the south by the boundary of continuous Woodland Caribou distribution (OMNR 2009). This zone is primarily within the Hudson Bay Lowland ecozone (Ecoregion 2E) (68% of the area) and the southern portion in the Boreal Shield ecozone (Ecoregion 3E) (32% of the area). This zone includes a small area within the currently managed forest as well as the Far North planning area. There is high development potential from mining (e.g., diamonds and “Ring of Fire”), power development and forestry and a combination of all-weather and winter road access. Current “occupied” Wolverine range, based on aerial track surveys is low relative to the other zones, and at present, is concentrated in the northern portion of the recovery zone. Unverified reports of wolverines have been reported by trappers and other members of the public in the southern portion of the zone and occasionally in areas south of this proposed zone. A report of tracks by very experienced observers occurred near Chapleau during an aerial wolf survey in 2006 (OMNR upub. data). This zone is considered essential for providing a long-term link to Quebec and the nationally endangered Eastern Population of Wolverine.
Figure 4. Proposed Ontario Wolverine recovery zones. Note: Only large protected areas are depicted (outlined in dark green). The black squares represent communities.
## 2.3 Approaches to Recovery

### Table 2. Approaches to recovery of the Wolverine in Ontario

<table>
<thead>
<tr>
<th>Relative Priority (zone)</th>
<th>Relative Timeframe</th>
<th>Recovery Theme</th>
<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical (all zones)</td>
<td>Short-term</td>
<td>Protection, Management, Stewardship</td>
<td>1.1 Devise policy and guidance to inform implementation of section 23.19 (trapping - incidental catch) of Ontario Regulation 242/08. Further test and develop Wolverine specific best management practices to reduce incidental catch and trapline damage.</td>
<td>• Trapping&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>Critical (WRZ) Necessary (NRZ)</td>
<td>Ongoing</td>
<td>Protection</td>
<td>1.2 Incorporate and conduct compliance monitoring for section 23.19 (trapping – incidental catch) of Ontario Regulation 242/08 as part of annual Ministry compliance workplans.</td>
<td>• Trapping</td>
</tr>
<tr>
<td>Necessary (all zones)</td>
<td>Short-term</td>
<td>Protection, Management</td>
<td>1.3 Develop guidance on the disposition of Wolverine acquired through incidental trapping and means other than trapping (e.g. roadkill).</td>
<td>• Trapping, Roadkill, Human Perceptions</td>
</tr>
</tbody>
</table>
| Critical (all zones)    | Short-term         | Protection | 1.4 Undertake a conservation assessment pertaining to harvest of Wolverine. | • Trapping  
• Population Distribution and Abundance |
| Necessary (all zones)    | Short-term         | Protection | 1.5 Develop a ‘species specific’ habitat regulation or general habitat description for Wolverine and associated guidance defining “damage and destroy” to inform implementation of habitat protection. | • Habitat Fragmentation, Degradation and Loss  
• Cumulative Impacts |

5. WRZ = Western Recovery Zone; ERZ = Eastern Recovery Zone; NRZ = North Recovery Zone (see section 2.2 – Recovery Zone Delineation)

6. Trapping includes both targeted efforts and incidental catch.
<table>
<thead>
<tr>
<th>Relative Priority (zone)</th>
<th>Relative Timeframe</th>
<th>Recovery Theme</th>
<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beneficial</td>
<td>Short-term</td>
<td>Management</td>
<td>1.6 Integrate Wolverine recovery objectives into Ministry of Natural Resource policy that focuses on management of Wolverine predator/prey species (i.e. Cervid Ecological Framework, Wolf Management Framework, Black Bear Management Framework).</td>
<td>• Predator Competition, Prey Availability</td>
</tr>
</tbody>
</table>

2. Reduce or eliminate known threats to Wolverine populations and their habitat within Ontario’s recovery range.

| Critical (WRZ) | Short-term | Protection, Management, Research, Stewardship | 2.1 Refine, test and implement Wolverine-specific best management practices for trapping to minimize both incidental catch and trapline damage. | • Trapping • Habitat and Habitat Management |
| Necessary (EandWRZ) | Short-term | Protection, Management, Research, Stewardship | 2.2 Evaluate the effectiveness of current and forthcoming forest management guidance (Area of Concern prescription and the Draft Forest Management Guide for Boreal Landscapes) in supporting attainment of the Wolverine recovery goal. | • Habitat Loss, Trapping • Habitat and Habitat Management |
| Necessary (all zones) | Short-term | Protection, Management, Research, Stewardship | 2.3 Develop, test and implement Wolverine-specific best practices for mining, mineral exploration, and additional resource management activities (e.g., peat extraction, hydro corridors, etc.). | • Habitat Loss, Trapping • Habitat and Habitat Management |

3. Increase understanding of Wolverine ecology, threats to their habitat and Wolverine survival through inventory, monitoring and research.

<p>| Critical (all zones) | Short-term and Ongoing | Management | 3.1 Maintain a standardized central data repository for Wolverine population and habitat data. | • Distribution and Abundance, Habitat and Habitat Management |</p>
<table>
<thead>
<tr>
<th>Relative Priority (zone)</th>
<th>Relative Timeframe</th>
<th>Recovery Theme</th>
<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
</table>
| Critical (all zones)   | Short-term and Ongoing | Research                            | 3.2 Initiate research into the ecology of Wolverine in lowland and boreal forest habitats, with emphasis on den site selection, productivity and survival rates in both undisturbed and modified habitats. | • Habitat Loss, Trapping, Cumulative Impacts  
• Habitat and Habitat Management, Human Perceptions                                                                 |
| Critical (all zones)   | Ongoing            | Research                            | 3.3 Initiate experimental treatments (management) in designated areas of proposed mitigative measures (e.g., trapping practices) to address key uncertainties (see section - Knowledge Gaps) that can be compared against control areas. | • Habitat Loss, Trapping, Cumulative Impacts  
• Habitat and Habitat Management, Human Perceptions                                                                 |
| Critical (all zones)   | Ongoing            | Research                            | 3.4 Develop models to examine the potential impact of climate change on availability of spring snow cover and mean August maximum temperatures for Wolverine in Ontario. Use scenario modeling that incorporates interactions between these predictions and anthropogenic land use change (cumulative effects). | • Habitat Loss, Trapping Cumulative Impacts  
• Distribution and Abundance, Habitat and Habitat Management                                                       |
| Critical (all zones)   | Ongoing            | Research                            | 3.5 Develop and test population models associated with proposed experimental treatments.                                                                                                                           | • Habitat Loss  
• Habitat and Habitat Management, Human Perceptions                                                                   |
| Critical (all zones)   | Long-term          | Inventory, Monitoring and Assessment | 3.6 Establish, implement and maintain a monitoring program that tracks landscape level habitat quality.                                                                                                          | • Habitat and Habitat Management                                                                                      |
| Critical (all zones)   | Long-term          | Inventory, Monitoring and Assessment | 3.7 Establish, implement and maintain a monitoring program that tracks Wolverine distribution, abundance and population trends.                                                                                     | • Distribution and Abundance                                                                                         |
## Recovery Strategy for the Wolverine in Ontario

<table>
<thead>
<tr>
<th>Relative Priority (zone)</th>
<th>Relative Timeframe</th>
<th>Recovery Theme</th>
<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessary (all zones)</td>
<td>Ongoing</td>
<td>Inventory, Monitoring and Assessment</td>
<td><strong>3.8</strong> Support Aboriginal communities in collecting, storing and managing local and traditional knowledge related to Wolverine and its habitat.</td>
<td>• First Nations knowledge, perspectives and practices; all threats</td>
</tr>
</tbody>
</table>
### Recovery Strategy for the Wolverine in Ontario

<table>
<thead>
<tr>
<th>Necessary (all zones)</th>
<th>Long-term</th>
<th>Inventory, Monitoring and Assessment</th>
<th>3.9 Establish, implement and maintain a monitoring program that tracks societal awareness and engagement.</th>
<th>• Human Perceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessary (all zones)</td>
<td>Ongoing</td>
<td>Research, Management</td>
<td>3.10 Develop habitat suitability models associated with proposed experimental treatments (recovery approach 2.6).</td>
<td>• Habitat Loss, Cumulative Impacts • Habitat and Habitat Management</td>
</tr>
<tr>
<td>Necessary (all zones)</td>
<td>Short-term</td>
<td>Research</td>
<td>3.11 Conduct a jurisdictional scan of management practices being employed relevant to Wolverine conservation to support recovery approaches 2.1, 2.2 and 2.3.</td>
<td>• All threats • Habitat and Habitat Management • Cumulative Impacts</td>
</tr>
<tr>
<td>Necessary (all zones)</td>
<td>Short-term</td>
<td>Inventory, Monitoring and Assessment</td>
<td>3.12 Explore opportunities to incorporate collection of Wolverine values (i.e., sightings, tracks, etc.) into established broad-scale terrestrial monitoring programs (e.g., Moose Aerial Inventory).</td>
<td>• Distribution and Abundance, Habitat and Habitat Management</td>
</tr>
<tr>
<td>Necessary (all zones)</td>
<td>Short-term</td>
<td>Inventory, Monitoring and Assessment</td>
<td>3.13 Monitor sources of Wolverine mortality (e.g., roadkill, incidental catch, harvest); document in central data repository.</td>
<td>• Distribution and Abundance, Human Perceptions</td>
</tr>
<tr>
<td>Beneficial (all zones)</td>
<td>Short-term</td>
<td>Research</td>
<td>3.14 Build a picture of Wolverine historical occupancy in Ontario through traditional knowledge and Hudson Bay harvest records.</td>
<td>• Distribution and Abundance, Human Perceptions</td>
</tr>
</tbody>
</table>

4. Integrate Wolverine conservation efforts across provincial, territorial and federal jurisdictions, between ministries and with First Nations and planning processes.

| Critical (all zones) | Ongoing | Management | 4.1 At the landscape scale, integrate Wolverine conservation efforts with other provincial boreal species at risk initiatives, specifically Woodland Caribou. | • Habitat Loss |
## Recovery Strategy for the Wolverine in Ontario

<table>
<thead>
<tr>
<th>Critical (all zones)</th>
<th>Short-term, Ongoing</th>
<th>Management</th>
<th>4.2 Develop an integrated and proactive land use planning process that addresses cumulative effects (including climate change) and ensures consistency with the protection of Wolverine and its habitat (forestry, access, power developments, tourism, mineral exploration and development, etc.).</th>
<th>• Cumulative Impacts</th>
</tr>
</thead>
</table>
| Critical (all zones) | Ongoing | Management | 4.3 Establish standard Wolverine information requirements for incorporation in environmental assessments and resource development proposals. | • Habitat Loss  
• Cumulative Impacts |
| Critical (all zones) | Ongoing | Management | 4.4 Incorporate habitat and population-level recommendations or criteria into land use and resource management planning initiatives. | • Habitat Loss  
• Cumulative Impacts |
| Critical (all zones) | Ongoing | Protection, Management, Stewardship | 4.5 Develop a process that fosters engagement of First Nations communities and incorporates traditional knowledge in Wolverine recovery efforts. | • Trapping  
• Human Perceptions |
| Necessary (W and N RZ) | Ongoing | Management | 4.6 Work with the province of Manitoba to ensure consideration of Ontario’s recovery goal in the preparation of a provincial (Manitoba) Wolverine management plan and encourage cross-border management of this shared population. | • Cumulative Impacts |
| Beneficial (E RZ) | Ongoing | Management | 4.7 Work with the National Wolverine (Eastern population) Recovery Team and responsible jurisdictions (Quebec and Labrador) to facilitate recovery of Wolverine to these formerly occupied areas. | • Distribution and Abundance |
| Beneficial (W and E RZ) | Long-term | Management | 4.8 Establish criteria to inform when translocation of Wolverine may be undertaken to support recovery efforts. | • Distribution and Abundance |

5. Generate support and partnerships for Wolverine conservation by promoting education, awareness and stewardship of Wolverine and boreal forest ecosystems.
### Recovery Strategy for the Wolverine in Ontario

| Critical (all zones) | Ongoing | Stewardship | **5.1** Encourage First Nations and trappers’ leadership in achieving Wolverine recovery. | • Human Perceptions |
|----------------------|---------|-------------|----------------------------------------------------------------………………………|---------------------|
| Necessary (all zones) | Ongoing | Education and Outreach | **5.2** Establish a formal mechanism for information exchange between the Ministry of Natural Resources, northern trappers and First Nations regarding Wolverine conservation efforts. | • Human Perceptions |
| Necessary (all zones) | Short-term | Education and Outreach | **5.3** Develop and implement a communications plan to enhance awareness of Wolverine conservation and create a positive atmosphere to support recovery efforts. | • Human Perceptions |
Recovery Strategy for the Wolverine in Ontario

Narrative to Support Approaches to Recovery

The listing of Wolverine as a species at risk in Ontario has created a number of significant management challenges, particularly in the areas of trapping and resource management. Recently Ontario Regulation 242/08 under the ESA was amended revoking section 14 (trapping – incidental catch) and replacing with section 23.19 (trapping – incidental catch). Under the new regulation, trappers who incidentally harvest Wolverine despite the exercise of due diligence are exempt from the ESA provided that they obtain a license to possess a pelt as required under Part II of Ontario Regulation 666/98 made under the *Fish and Wildlife Conservation Act, 1997*.

Wolverine best management practices (BMP) to reduce the incidence of harvest should be developed and include guidance on safe release techniques for Wolverine where there is a reasonable chance of survival in the wild and killing in a humane manner, where necessary. BMP’s should also be devised for reducing trapline/trap cabin damage by Wolverine.

The revised regulation does not permit the sale of Wolverine. Given this, an analysis of the opportunity to sell incidentally caught Wolverine, under specified conditions, so as to reduce the likelihood of waste, potential non-registry, and legal challenges should be undertaken. The final policy and guidance should be clear and provide consistent direction to trappers and foster support and stewardship of the trapping community for Wolverine data collection and population assessment. Opportunities to entrench best management practices into future regulatory amendments should be examined and actioned where feasible.

A conservation assessment pertaining to harvest of Wolverine (Approach 1.4) should be completed to inform potential future regulatory amendments under the ESA. While established Aboriginal and Treaty rights are recognized under the ESA (e.g., harvest and sale of species at risk), the fact that non-Aboriginal individuals, fur dealers, and auction houses are presently unable to purchase, possess or sell Wolverine has resulted in an inability to track mortality of this species in much of its range, thereby potentially affecting recovery efforts.

Under current resource management, land use planning processes, and associated policies, consideration of Wolverine (given its threatened status) (e.g. *Wildlife Policy 6.04.01* (OMNR 1990): *Management of Timber for Featured Wildlife Species*) is a requirement; however, no species-specific habitat guidance exists, aside from the protection of den sites in the *Forest Management Guide for the conservation of biodiversity at the stand and site scales* (OMNR 2010).

As of June 30, 2013, Wolverine receive general habitat protection under the ESA. Ontario’s Wolverine population is considered part of the national Western Population, which was assessed by COSEWIC as special concern; as such, designation of Critical Habitat is not required under the federal SARA (Statutes of Canada 2003). Articulating
measures for habitat protection is an essential aspect of Wolverine recovery in Ontario and it is recommended that a species specific habitat regulation or general habitat description is developed (Approach 1.5) to provide greater clarity on the area of habitat protected for Wolverine. Associated technical guidance to support implementation of habitat protection should be devised and address land use planning and resource extraction activities at various spatial and temporal scales and define in general terms the activities that may result in damage or destruction of protected habitat.

There are several direct and indirect threats to Wolverine resulting from anthropogenic activities that serve to compound the already limited resilience of this species. Because many of these lack conclusive empirical evidence of their real or potential role in Wolverine decline, continued research will be necessary to link direct and indirect threats to the mechanisms that drive them (Approach 3.2). Moreover, interactions between a species, its habitat, and other species in the environment are complex and dynamic. Knowledge of the role played by individual factors and how they act in a cumulative fashion will aid execution of the actions put forward in this recovery strategy and contribute to the prevention of further erosion of current Wolverine range.

Concurrent with the development of this recovery strategy, several policy and planning initiatives with the potential to influence and support Wolverine conservation efforts are underway. Integration of Wolverine recovery efforts should be considered in the development of the Boreal Landscape Guide for Forest Management Planning; development of the Far North Land Use Planning Strategy, and the establishment and implementation of the community-based land use strategies across the Far North of Ontario; implementation of the Caribou Conservation Plan (OMNR 2009); active mining and mineral exploration and development (especially the Ring of Fire); renewable energy developments (e.g., wind and waterpower); and the proposed establishment of all-weather roads to service development and enhance access to remote First Nation communities. As such, Approaches 4.1 to 5 are identified as critical to ensure that Wolverine recovery is adequately considered within the context of the numerous planning and environmental assessment processes now and in the future. It is important that recovery actions be aligned with other boreal species at risk, particularly woodland caribou given that these species share the same landscape, similar threats, and have similar large landscape requirements that should be addressed through an ecosystem approach (Approaches 1.6 and 4.1).

To address high levels of uncertainty regarding Ontario Wolverine status and ecology, research on the population ecology of Wolverine in lowland boreal forests, with emphasis on den site selection, productivity and survival rates in both undisturbed and modified habitats is urgently needed to inform future policy and management decisions. It is recommended that implementation of recovery actions follow an adaptive management approach. Under such an approach, actions should be implemented in an experimental manner, designed with adequate controls and with appropriate
documentation, monitoring, and evaluation to maximize learning potential and adjust management actions accordingly.

Encouraging and securing trapper and First Nation leadership (Approach 5.1) is essential to achievement of recovery. The Recovery Team recognizes the knowledge and expertise these individuals, communities and organizations can provide to support recovery implementation. Immediate action should be taken to engage these groups and secure support for recovery of Wolverine.

Finally, approaches to alter negative social perceptions of Wolverine are considered critical to the success of recovery efforts (Approach 5.3).

2.4 Performance Measures

Evaluation of the achievement of the recovery goal and objectives will require long-term monitoring of ecological and social indicators over large areas (Approaches 3.6-3.8). Although there is knowledge of what indicators should be utilized, the measurable standards have yet to be determined and should be established through research and where necessary, tailored to Ontario. Ecological indicators associated with Wolverine population status (e.g., area of occupancy, probability of persistence, intrinsic rate of increase) reflect the response of Wolverine to recovery actions and the suitability of the landscape to support populations. Social indicators reflect the extent to which recovery actions have been implemented and supported. The spatial and temporal scale and acceptable values of indicators may vary among recovery zones. Regular monitoring and reporting on these indicators will allow comparison against desired outcomes and may lead to adaptation or adjustment of recovery approaches. Baseline values (against which future indicators will be measured to evaluate success), monitoring approaches, and spatial and temporal scale of indicators should be established as a first step to developing a program for measuring progress on Wolverine recovery in Ontario.

With respect to the development of habitat suitability models (Approach 3.9), landscape level habitat quality should be assessed according to broad indicators of forest composition and structure. Indicators include:

- level of landscape pattern indices (specific indices should be harmonized with the draft Boreal Landscape Guide) indicating size of contiguous tracts of older conifer-dominated forest; and
- proportion of each recovery zone occupied by infrastructure. May vary by infrastructure class (roads, communities, mines, transmission lines).

Wolverine population status is difficult to assess, so various indices of relative abundance, range occupancy, and population genetics should be used to glean insight into population trends. Abundance and distribution of Wolverine are linked and
retraction or expansion of range can usually be interpreted as a change in population size. Occupied range is a concept applied across large spatial extents where habitat varies in suitability over space and time. Criteria for occupied range may vary by recovery zone. Changes within this range will reflect the relative success of recovery actions. Indicators include the following.

- Index of relative abundance of both Wolverine and their prey/competitors (caribou, moose, wolves) based on occurrence measures from direct surveys (tracks).
- Index of relative abundance based on occurrence measures from indirect surveys (trap line reports).
- Size of area in each recovery zone with specified levels of occurrence (highest level in range delineation and is reported by range size). A specific case is the size of the core range area in the Western and Northern recovery zones.
- Gene flow across provincial populations (evidence that peripheral populations are readily exchanging dispersers with core populations and demonstrating minimal genetic differentiation).
- High genetic variability within recovery zones (evidence of high numbers of alleles and high levels of heterozygosity).
- Level and geographic distribution of Wolverine harvest.
- Level and geographic distribution of Wolverine vehicle collisions.
- Biometric data from sampled Wolverine.

Long-term involvement and demonstrated commitment from society in Wolverine conservation and recovery is essential to its success (Approach 3.8). This includes Provincial and First Nations governments, resource development industries, fur trappers and fur managers, environmental agencies, the academic community and the non-affiliated general public. Societal indicators may include the following.

- Level of public awareness of Wolverine recovery and opinions on Wolverine recovery issues.
- Reporting rates of Wolverine observations by land users [sign (such as tracks) or provision of biological samples].
- Level of utilization of best management practices (i.e., trapping technologies) intended to reduce incidental catch (i.e., number of training session provided to trappers and trapper attendance).
- Level of harvest of Wolverine and other human caused mortality such as road kills.
- Number of, and land area covered by, land use and resource development plans that have specific objectives and management direction to address Wolverine recovery efforts.
- Number of plans that adjust their management actions for Wolverine based upon other existing or proposed planning processes.
• Level of participation by First Nations governments and neighbouring provincial governments in Wolverine recovery planning, knowledge exchange, research, and resource development planning (e.g. Community-based Land Use Plans) designed to address Wolverine recovery.
• Quantity and extent of relevant research sponsored and conducted by government, academic, and non-government organizations for the purpose of: a) addressing threats, and b) improving the scientific basis for understanding Wolverine ecology and management in Ontario.
• Compliance with voluntary measures regarding resource and land use activities affecting Wolverine.
• Number of development and resource extraction initiatives that integrate objectives and actions for both caribou and Wolverine conservation.

Regular monitoring and reporting on the above indicators will allow comparison against desired outcomes that are yet to be determined. A timeframe for the evaluation cycle will need to be developed based upon the level of risk faced by each population (i.e., populations at greater risk will receive greater monitoring frequency or intensity) or through the application of one level of monitoring and evaluation across all geographically defined populations. This will allow for evaluation of the progress of the recovery strategy and provide opportunities to identify additional approaches that may be necessary for Wolverine recovery.

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

The following recommendation for consideration in the development of a habitat regulation for Wolverine in Ontario has been derived to support the attainment of the recovery goal of this strategy (see section 2.1).

In light of the relative infancy of the best available scientific knowledge of Wolverine ecology in Ontario, provision of a recommendation for an area to be prescribed in a habitat regulation is extremely challenging. However, drawing from knowledge acquired through recent provincial research efforts, extrapolation of relevant literature from alternate jurisdictions, and application of a precautionary approach, the recovery team recommends that the entire area captured by the three recovery zones (Figure 4) be prescribed as regulated Wolverine habitat under the ESA. This recommendation
recognizes that functional habitat for Wolverine is provided at the larger landscape scale and that an ecosystem approach will be necessary to achieve habitat conservation for this broad-ranging species. It further recognizes that protected habitat does not necessarily mean that no activities can occur. If the activity does not damage or destroy habitat (i.e., does not alter habitat in ways that impair or eliminate its function for the species), then that activity may continue. A proposed activity that would damage or destroy protected habitat would require authorization under the ESA.

To meet their life history requirements, Wolverine select habitat at multiple spatial scales. For example, functional elements of habitat are provided from the large landscape scale (hundreds of thousands of km²) to the den site, all of which are necessary to ensure the population sustainability of Wolverine. This means that site-level mitigation of habitat impacts is unlikely to support achievement of the population-level recovery goal. Therefore, in addition to population sustainability, a fundamental objective of Wolverine recovery is to provide for connectivity across Wolverine recovery range in Ontario and to neighbouring jurisdictions. Effective protection of habitat at this scale is necessary both to address direct and indirect factors that influence mortality, natality, movement and distribution of Wolverines across the landscape and to facilitate continuous metapopulation connectivity between Ontario and the national Western Wolverine population, and between Ontario and the nationally endangered Eastern Population. Delineation at this scale is therefore consistent with recovery objectives (1 and 2) and ultimately the recovery goal. Future boundary refinement of the three recovery zones should encompass historical, current, and anticipated future range of Wolverine, accommodating movement across the boreal landscape between Ontario and Manitoba, and through to Quebec.

Like most large-bodied carnivores, Wolverine are a highly mobile species, who do not appear to demonstrate a strong or consistent affinity to any particular habitat type. Their 'scavenging' lifestyle requires Wolverine to cover extensive areas in search of food sources. One notable habitat feature is the apparent requirement for persistent spring snow cover to support successful denning. Refinement of the area delineated for habitat protection should consider this requirement, in addition to the necessity to be located a substantive distance from human disturbance, during the denning period. Research results from alternate jurisdictions suggest a requirement for areas with at least one metre of persistent snow depth from February through the end of April. It is important to note that the entire area does not have to be snow-covered, but rather there must be smaller areas in which these conditions persist due to topography etc. to provide denning opportunities.

Although there are uncertainties regarding the impacts of land use change, other anthropogenic disturbances, and the underlying mechanisms, Wolverine nonetheless exhibit a demonstrated vulnerability to such threats (discussed extensively in this document). This merits a precautionary approach under the assumption that knowledge will become more robust with time and will be applied where appropriate towards
adjusting recovery actions within the context of adaptive management. This also means that a reductionist approach to habitat protection in which only key features are recognized and regulated as habitat will fall short of the ecosystem-based approach that is recommended for Wolverine and necessary if the recovery goal as proposed is to be realized.

Areas considered unsuitable such as built-up areas, including communities and a reasonable ‘disturbance’ buffer should be excluded from regulation. However, areas that may be presently unsuitable but have the potential if managed properly (restorative or rehabilitative action) should be included in the habitat regulation.
GLOSSARY

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperilled
2 = imperilled
3 = vulnerable
4 = apparently secure
5 = secure

*Endangered Species Act, 2007* (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Mustelid: This is a term given to mammals that are part of the family Mustelidae. The Mustelidae are a family of carnivorous mammals, including otters, badgers, weasels, martens and wolverines.

Parturition: the action or process of giving birth to offspring.

*Species at Risk Act* (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk to which the SARA provisions apply. Schedules 2 and 3 contain lists of species that at the time the act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

REFERENCES


Recovery Strategy for the Wolverine in Ontario


Haglund, B. 1966. Winter habits of the lynx (Lynx lynx L.) and Wolverine (Gulo gulo L.) as revealed by tracking in the snow. Viltrevy 4:81-309.


Recovery Strategy for the Wolverine in Ontario


Recovery Strategy for the Wolverine in Ontario


## Recovery Strategy Development Team Members

<table>
<thead>
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* Individuals were members of initial recovery team, initiated in 2006. Howard Noseworthy left the recovery team in October, 2008 and David Peerla left in December 2006.
** Individuals joined the recovery team in 2009.
*** The Wolverine Recovery Advisory Committee was utilized during the preliminary phases of drafting the recovery strategy 2006 – 2007.