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Management Plan for the Wolverine (*Gulo gulo*) in Canada

Wolverine

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada[3]. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for Wolverine and has prepared this management plan, as per Section 65 of SARA. To the extent possible, it has been prepared in cooperation with the government of Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland and Labrador, and with wildlife management boards as per Section 66(1) of SARA.

Success in the conservation 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 plan and will not be achieved by Environment and Climate Change Canada and the Parks Canada Agency, or any other jurisdiction alone. The public is invited to join in supporting and implementing this plan for the benefit of Wolverine and the ecosystems in which they are found.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

[3] *The Government of Quebec is not signatory to the Accord for the Protection of Species at Risk (1996). However, the Government of Quebec does cooperate with the federal government in the conservation of species at risk of common interest*."

Acknowledgments

The management plan was written by Bruce Laurich (ECCC-CWS-Northern Region), Kelby Ogryzlo (ECCC-CWS-Northern Region), Samantha Smuk (ECCC-CWS-Northern Region) and Michelle Sawatzky (ECCC-CWS-Prairie Region). Indigenous input, knowledge and guidance was provided through a series of workshops held across the range of the Wolverine in Canada. We thank participants for taking the time to participate and sharing their knowledge with us to better inform this plan. From these workshops reports were created that summarized the discussions that took place. Throughout the development of the management plan, the feedback received was used as guidance, and the workshop summary reports are referenced throughout the management plan highlighting the Indigenous knowledge and input shared at these workshops. Review and input were also provided by Wolverine experts from across Canada.

Thank you to the ECCC-CWS staff who took the time to review the management plan and who provided guidance along the way including, but not limited to, Thierry Calve, Marie-Helene Dickey, Paulson Des Brisay, Wendy Eskowich, Diana Ghikas, Jared Maida, Rhiannon Pankratz, Christina Rohe, Kathleen Simms, and Edward Beveridge. Also, thanks to the Parks Canada staff Anne Forshner and Jenna Rabley who reviewed the plan and provided content and comments.

Thank you to Aaron Russel with Conference Doodles for creating the four graphic diagrams the visually summarize the needs, threats, and conservation measures for Wolverines in Canada.

Thank you to everyone who took the time to provide comments either during the jurisdictional review process or through the public comment period.

Executive Summary

The Wolverine (*Gulo gulo*) is listed as a species of Special Concern under Schedule 1 of the *Species at Risk Act* (SARA), which requires the drafting of a management plan. Wolverines are the largest terrestrial member of the weasel family and can measure up to one meter in length and weigh up to 18 kilograms. They have a stocky build with elongated legs and semi-retractable claws. They have long bushy tails and high rounded backs. Their coat ranges from dark brown to a near-black, with distinctive blond or tan stripes on their back and a light-coloured patch on their chest. This pale chest patch is unique to each Wolverine and can be used to differentiate individuals. Their large feet enable them to move with relative ease in snow and cover long distances. Wolverines are primarily scavengers but will actively hunt in some situations. They have strong jaw muscles that can break through bone and frozen carcasses.

The Wolverine's range covers a large portion of Canada. They occur in all three territories and are found in mainland British Columbia, the mountains of Alberta, the northern half of the prairie provinces and Ontario. They are also linked genetically to the populations in the United States. There are reported sightings of Wolverine in Quebec, where the species is considered critically imperiled by the Government of Quebec. Wolverine are considered extirpated from the Atlantic provinces.

Across their range Wolverine are a culturally and economically important species for Indigenous peoples. There are many stories and legends about Wolverine in different Indigenous cultures. Their pelt is sought after in parts of their range where it can be sold or used in traditional practices. The importance of Wolverine to Indigenous peoples is reflected in the depth of knowledge held by Indigenous groups and the inclusion of Aboriginal Traditional Knowledge, Traditional Ecological Knowledge, and Inuit Qaujimajatuqangit in this management plan wherever available.

Wolverine are found across a wide range of Canada and therefore, the threats faced in certain parts of its range may not apply to other portions of its range. As such the Management Plan will address these regional differences wherever possible. The main threats facing Wolverine are listed in Section 4 and include, but are not limited to, climate change, forest fires, human development, industrial activities, overharvesting, increased road presence, and recreational activities.

The management objectives for Wolverines are to improve habitat connectivity in areas with high habitat fragmentation and maintain connectivity in areas with low habitat fragmentation, increase the Wolverine populations in the portion of its range where populations have declined while maintaining population levels in other portions of its range, and maintain the distribution of Wolverine throughout its current Canadian range. To help achieve these objectives seven broad strategies and associated conservation measures are outlined in this management plan in Section 6. Research that addresses knowledge gaps across the Wolverine's range will be key in guiding conservation efforts for this species.

Figure 1. Visual depiction of the needs (first row), threats (second row), and conservation measures (third row) of Wolverines in Canada.

Cultural Significance

Indigenous people have been co-living with and relying upon Wolverine for thousands of years, leading to many cultural, spiritual, and traditional practices related to Wolverine. Many Indigenous peoples across North America have their own term for the Wolverine, often relating to how big their feet are, how they walk, or relating them to a bear or weasel. Some Indigenous languages also have terms to respectfully refer to the Wolverine while it is being processed after harvest (Cardinal, 2004). There are many Indigenous stories relating to the Wolverine, often portraying them as bullies or anti-social tricksters, while some depict them as gods and helpful spirits. Although there have never been any reported attacks on humans, Wolverines are often characterized in these stories as aggressive, fierce, and devilish (Bonamy *et al.*, 2020). Some Indigenous people will offer a prayer to the Wolverine and avoid talking disrespectfully about them (Northern Workshop 3.2, 2023). Many harvesters also will recount encounters of Wolverines and tell stories demonstrating how intelligent, crafty, and fierce they are, like how they are able to evade traps and break into cabins (Lamothe *et al.*, 1973a, 1973b; Quebec Workshop 2023; Northern Workshop 1.1, 1.2, 2023; Northern Workshop Tłı̨chǫ, 2023; NSTA, Unpublished Report 2023). For some Indigenous peoples, like the Inuvialuit, harvesting a Wolverine is a rite of passage for youth and is a way to keep culture and traditional practices alive (Northern Workshop 2.1, 2023). In some Indigenous cultures Wolverines symbolize strength, endurance, and curiosity and the species is highly respected (Prairie Workshop 5, 2023). It is encouraged to learn the local Indigenous protocols around Wolverine and how they are culturally significant when working with Wolverine in a certain area.

Wolverine are harvested for various purposes, but mostly to use their fur for clothing. The fur of Wolverines can insulate from wind, and repel snow and frost accumulation, making it ideal for trim around the openings of parkas (Cotel *et al.*, 2004). Furs often stay in the local community since that is where the most demand is, the rest of the furs are sold on the international market where the price has remained relatively stable (Cardinal, 2004; Northern Workshop 2.2, 3.1, 3.2, 2023). Although the average price per fur varies across Canada some Indigenous hunters and trappers still make their living from harvesting furs, including Wolverines, however with the rising cost of equipment, gas, and other necessities for harvesting, the profit margin has decreased (Northern Workshop 1.3, 2023; NSTA, Unpublished Report 2023). Many Indigenous groups have sustainable harvest practices that help to maintain a stable population and show respect to the Wolverine (Northern Workshop 2.2, 2023). One of these practices is only harvesting when the Wolverine’s fur is prime or avoiding harvesting when females are pregnant.(Northern Workshop 1.2, 2.2, 2.3, 3.2, 2023).

It is important to learn about, apply, and use local Indigenous Knowledge when conducting research and implementing management strategies (Pacific Workshop, 2023). Because Indigenous people have inhabited areas for many generations, no one knows as much about that land as they do (Northern Workshop 3.2, 3.3, 2023). They observe the weather, the changes in the landscape, and the fluctuating abundances of

213 species and how they behave (Quebec Workshop, 2023, Northern Workshop 1.1, 3.2,
214 3.3, 2023). Indigenous people also see the implications and outcomes of management
215 actions firsthand and so it is important to learn from them and include them in decision
216 making and the development of conservation plans including this Management Plan.
217 More information on how Indigenous groups were engaged can be found in Appendix B.
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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2014

Common Name (population): Wolverine

Scientific Name: *Gulo gulo*

COSEWIC Status: Special Concern

Reason for Designation: This wide-ranging carnivore has an estimated Canadian population likely exceeding 10,000 mature individuals. Although population increases appear to be occurring in portions of the Northwest Territories, Nunavut, Manitoba and Ontario, declines have been reported in the southern part of the range, e.g. in British Columbia, and populations in a large part of the range (Quebec and Labrador) have not recovered. The species may be extirpated from Vancouver Island. Population estimates are very limited, and trends are not known. Most data are limited to harvest records, and harvest levels may be under-reported because many pelts used domestically are not included in official statistics. There is no evidence, however, of a decline in harvest over the last 3 generations. This species' habitat is increasingly fragmented by industrial activity, especially in the southern part of its range, and increased motorized access increases harvest pressure. Climate change is likely impacting animals in the southern part of the range, and this impact is expected to increase northward. The species has a low reproductive rate, is sensitive to human disturbance, and requires vast secure areas to maintain viable populations.

Canadian Occurrence: Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador

COSEWIC Status History: The species was considered a single unit and designated Special Concern in April 1982. Split into two populations in April 1989 (Western and Eastern populations). The original designation was deactivated. In May 2014, the Eastern and Western populations were considered as a single unit across the Canadian range and was designated Special Concern.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

On a global scale, the International Union for Conservation of Nature (IUCN) Red List has designated the Wolverine as Least Concern (Abramov, 2016). The conservation status of the Wolverine (*Gulo gulo*) through its North American range, conducted by NatureServe, is listed in Table 1, with the global status being Apparently Secure (G4) and Vulnerable in Canada (N3).

The Wolverine was first designated as Special Concern[4] in Canada in April 1982 but was split into two populations in 1989: Western and Eastern (COSEWIC, 2003). The justification for the separation was based on the very low, or extirpated, population found in Québec and Labrador, rather than the criteria of discreteness or significance used in present COSEWIC guidelines (COSEWIC, 2014). The Western population included Ontario and the provinces and territories to the west, and the Eastern

[4] Special Concern is defined as a wildlife species that may become a Threatened or an Endangered species because of a combination of biological characteristics and identified threats.

population included Québec and Labrador. The Western Population was assessed as Special Concern by COSEWIC in 2003 but was not listed federally due to concerns expressed by the Nunavut Wildlife Management Board. The Eastern Population was assessed as Endangered[5] at the same time and was added to Schedule 1 of the *Species at Risk Act* (SARA) in 2005 (S.C. 2002, c. 29). In May 2014, the Wolverine was reassessed, and the two populations were combined into a single designatable unit[6] and evaluated as Special Concern (COSEWIC, 2014). On May 30, 2018, the Wolverine was listed federally as Special Concern under the SARA. Assessments and designations by territorial and provincial governments are listed in Table 2.

Table 1. Conservation status ranks for Wolverine (NatureServe, 2016).

Global (G) Rank	National (N) Rank	Subnational (S) Rank	
North America – G4	Canada – N3	Alberta – S3 British Columbia – S3 Labrador – S1 Manitoba – S3S4 New Brunswick – SX	Northwest Territories – S3? Nunavut – S3 Ontario – S2S3 Quebec – S1 Saskatchewan – S2S3 Yukon – S3
	United States – N4	Alaska – S4 California – S1 Colorado – S1 Idaho – S1 Indiana – SX Iowa – SX Massachusetts – SX Michigan – SX Minnesota – SX Montana – S3 Nebraska – SX Nevada – SH	New Hampshire – SX New York – SX North Dakota – SX Ohio – SX Oregon – S1 Pennsylvania – SX South Dakota – SX Utah – S1 Vermont – SX Washington – S1 Wisconsin – SX Wyoming – S1S2

Conservation Status Ranks: X – Presumed Extirpated; H – Possible Extirpated; 1 – Critically Imperiled; 2 – Imperiled; 3 – Vulnerable; 4 – Apparently Secure; 5 – Secure; ? – Inexact Numeric Rank.

Table 2. Territorial and Provincial statuses for Wolverine.

Territory/Province	Legislation	Status
Yukon	*YT Wildlife Act*	No status except being considered "Big Game" and "Furbearer" (Government of Yukon, 2012)

[5] Endangered is defined as a species facing imminent extirpation or extinction.

[6] Designatable unit is a taxonomic entity such as species, subspecies, varieties or geographically or genetically distinct population of animal, plant or other organism.

Northwest Territories	*NWT Species at Risk Act*	Not at Risk – 2014 (Government of Northwest Territories, 2023a)
Nunavut	*NU Wildlife Act*	No status except being considered “Big Game” and “Furbearer” (Government of Nunavut, 2020)
British Columbia	*BC Provincial Forest and Range Practices Act*	- *Gulo gulo*: S3 / No List Status (Special Concern) (2015) - spp. l*uscus*: S3 / Blue List (Special Concern) (2010) - spp. v*ancouverensis*: SH / Red List (Possibly Extirpated) (2017) (Government of British Colombia, 2023)
Alberta	*AB Wildlife Act*	No status but assessed as May Be at Risk (Government of Alberta, 2023)
Saskatchewan	*SK Wildlife Act*	S2 / Imperiled (Government of Saskatchewan, 2023)
Manitoba	*MN Wildlife Act*	No status except being considered a “Fur Bearing Animal” (Government of Manitoba, 2023a)
Ontario	*ON Endangered Species Act*	Threatened - Reassessed 2014 (Government of Ontario, 2016)
Quebec	*QC Act Respecting Threatened or Vulnerable Species*	Threatened – 2000 (Government of Quebec, 2023)
Newfoundland and Labrador	*NL Endangered Species Act*	Endangered – 2003 (Government of Newfoundland and Labrador, 2023)

3. Species Information

3.1 Species Description

The Wolverine (*Gulo gulo*) is the largest terrestrial member of the weasel family (Carnivora: Mustelidae), measuring one meter in length from snout to the base of the

tail. Males, weighing approximately 13 to 18 kilograms, are larger than females who range from 7.5 to 12.5 kilograms. Measured at the shoulder they stand 36 to 45 centimeters tall. Wolverines have a stocky build, elongated legs, semi-retractable claws, and high rounded backs. Their long bushy tails measure one-fifth of their total body length (Pasitschniak-Arts and Larivière, 1995). Coat colour ranges from dark brown to near black, with blond or tan stripes that start at the shoulders and cross above the base of the tail. Each Wolverine has a unique pale chest patch that can be used to differentiate individuals (Stewart *et al.,* 2016). They have a large head with a short, wide muzzle, round prominent ears, and a pale facial mask. Large feet enable them to move with relative ease over deep snow. A highly developed sense of smell enables Wolverines to detect carcasses over long distances, even in the winter (Pasitschniak-Arts and Larivière, 1995; Hornocker and Hash, 1981). Wolverines are predators and facultative scavengers (Fisher *et al.*, 2022). Wolverines actively hunt and they have strong mandible muscles to break through bone and frozen carcasses (Douglas and Strickland, 1987; Hash, 1987; Pasitschniak-Arts and Larivière, 1995). Except for its bushy tail, Wolverine more closely resembles a small Black Bear (*Ursus americanu*s) rather than a member of the weasel family to which it belongs, which generally have a tubular body shape.

3.2 Species Population and Distribution

3.2.1 Global Population and Distribution

Wolverines are found in boreal, alpine, and arctic regions of North America and Eurasia. Two subspecies are currently recognized: the Eurasian Wolverine (*Gulo gulo gulo*), found from Scandinavia to Asia, and the North American Wolverine (*Gulo gulo luscus*), found in Canada, Alaska, and the northwestern United States. See Figure 2 for a map of the Wolverine distribution in North America. The 37th parallel is the southern limit of its distribution (Moisan, 1996). The Arctic distribution of Wolverine is estimated to account for 25% of global distribution, with 28% of the Arctic distribution occurring on Arctic Islands (which is 7% of total global distribution) (Glass *et al.,* 2022a). Historically, Wolverines in North America were found in all areas where snow persisted into the spring but by the mid-1900s, the range had greatly contracted, particularly along the southern and eastern boundaries (Aubry *et al.,* 2007; Forbes and McAlpine, 2020). In the contiguous United States, Wolverines are currently only found in small pockets of relatively undisturbed mountainous regions in Washington, Montana, Wyoming, and Idaho (Aubry *et al.,* 2007). Connectivity with Canada is essential to the long-term viability of Wolverines in the lower 48 states (US Fish and Wildlife, 2023). Current Canadian population distribution and abundance details are discussed below by province and territory.

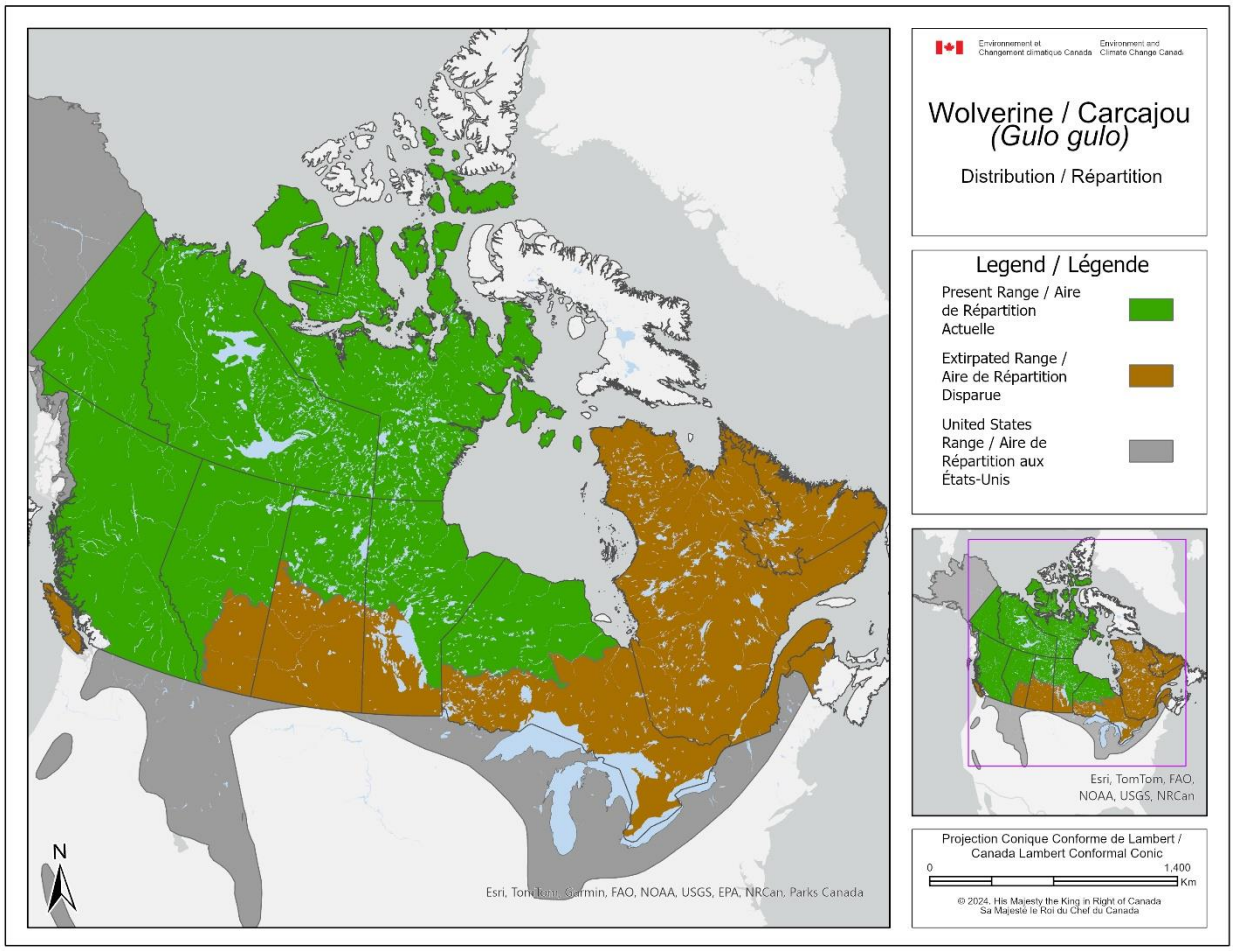

Figure 2. Wolverine Range in North America. The current range of Wolverine is shown in green and the extirpated range in brown. More information on Wolverine in each province and territory can be found in Section 3.2.2. The United States' range is based on the map in the COSEWIC 2014 report and was not updated for this document.

3.2.2 Canadian Population and Distribution

A complete breakdown of population estimates based on different ecozones can be found in Appendix C. Populations estimates based on Territory and Province are listed below.

Yukon

There is limited information available to infer population estimates of Wolverine in the Yukon. Studies and estimates are largely based on track surveys, and voluntary harvest reporting submitted by trappers and reimbursed by the Yukon Government. Using track sampling methods, the population density of Wolverine in south central Yukon was estimated at 3.0 individuals per 1000km^2, and 9.7 individuals per 1000km^2 in the northern study area near Old Crow Flats, (Golden *et al.,* 2007). The current population estimates suggests that Wolverine are present across the Yukon and the resident

population is estimated at 3500 to 4000. However, this estimate has remained unchanged for many years (COSEWIC, 2003, 2014; Slough, 2007).

Wolverine abundance and population health is largely inferred from harvest records. Harvest data and samples are voluntarily submitted by trappers and reimbursed by the Yukon Government. However, harvest is biased to the southwest of the Yukon and for juvenile males (< 2yr). During engagement workshops held to gather local knowledge about Wolverine, participants conveyed an observed rise in Wolverine sightings and an increase in trapping success over the past decade, which suggests a potential increase in the population in their local area of the Yukon (Northern Workshop 1.1, 1.3, 2.1, 2.2, 2.3, 2023).

Northwest Territories

Wolverines are distributed across the taiga, tundra, and boreal ranges of the Northwest Territories. It is thought that their presence is increasing on Banks Island and Victoria Island (Van Zyll de Jong, 1975; SARC, 2014). Overall, knowledge holders have described Wolverine populations as being stable or increasing in the territory (Cardinal, 2004, SARC, 2014). The Aklavik Community Conservation Plan (2016) notes that Wolverines are sparsely populated across the territory with “relatively few in the [Mackenzie] Delta”. Further regional specific population trends of Wolverine as described by communities and hunters in the Northwest Territories is provided in the NWT Species Status Report (SARC, 2014).

A multi-year study notes a decrease in Wolverine density of >40% at sites above the tree line and >29% below the tree line, but a density increase of 9.7% at a site that splits the tree line (Efford *et al.,* Unpublished Report 2022). Wolverine population in the Northwest Territories is estimated at 3500 to 4000 residents (Slough, 2007). During engagement workshops held to gather local knowledge about Wolverine, participants conveyed an observed rise in Wolverine sightings, particularly around communities, and an increase in trapping success over the past decade, which suggests a potential increase in the population in their local area of the Northwest Territories (Northern Workshop 1.2, 2.1, 2023).

Nunavut

There is limited western scientific information available on the distribution of Wolverine in Nunavut with the majority of information provided by Inuit Qauijimajatuqangit and Traditional Knowledge, local knowledge, and dated reports. This is especially true of the Arctic Islands and the High Arctic where reports of Wolverines are sporadic and limited (COSEWIC, 2014; Glass *et al.,* 2022a). For example, the presence of Wolverine on Baffin Island is mainly supported by limited track sightings, and reports from the 1900’s (Van Zyll de Jong, 1975; Mallory *et al.,* 2001). On the mainland of Nunavut, Wolverine are present but in low numbers and tend to be found around hilly and rocky areas (Awan *et al.*, 2012; SARC, 2014).

Wolverines are densest in western mainland Nunavut (Cardinal, 2004; COSEWIC 2014; Arviq HTO, 2015; Government of Nunavut, 2015). Communities in the Kitikmeot and Kivalliq regions report Wolverine populations to be increasing or stable (Awan *et al.,* 2012). Population density estimates in the Kivalliq range from 1.66 to 4.42 individuals per 1000 km^2 (Awan and Boulanger, 2016; Awan *et al.,* 2016). Density in the Kitikmeot is estimated to range from 3.10 to 6.85 individuals per 1000km^2 (Poole, Unpublished Report 2013; Awan *et al.,* 2020). There are no published population estimates of Wolverines in the Qiqiktaaluq, including the High Arctic.

British Columbia

Wolverines are widely distributed, occurring in most regions on mainland British Columbia (Lofroth and Ott, 2007), and have historically occurred throughout the province with the exception of Haida Gwaii. Habitat quality for Wolverine within British Columbia is based on availability of large prey, denning habitat, and human disturbance, and is highest in the north central region and in the eastern mountain ranges, and lowest along the coast (Lofroth and Krebs, 2007). Wolverines were historically present on Vancouver Island, but they now are believed to be extirpated from the area. The last verified sighting on the island was in 1993. Vancouver Island Wolverines were previously thought to belong to a different subspecies (*Gulo gulo vancouverensis*) but a recent study comparing the DNA of museum specimens from Vancouver Island with mainland Wolverines found little support for the existence of a separate subspecies (Hessels *et al.,* 2021).

Wolverine density was estimated at two sites located in high quality habitat to be 6.2 individuals per 1000km^2 (Lofroth and Krebs, 2007). Based on the assumption that Wolverine density is directly related to habitat quality it was then estimated that density ranged from 0.3 individuals per 1000km^2 in low quality habitat to 6.2 individuals per 1000 km^2 in high quality habitat, and the total population in British Columbia was estimated to be 3,530 individuals (Lofroth and Krebs, 2007). In southeastern British Columbia Wolverine densities were estimated to be low, with the mean being 2 individuals per 1000km^2, and models indicated Wolverines were overharvested by 50% (Mowat *et al.*, 2020). Exploitation was inferred as a major driver of declines, and halving the current trapping mortality was recommended (Mowat *et al.*, 2020) and was regionally adopted as one of the very few recent Wolverine conservation actions in Canada (Fisher *et al.,* 2022).

Alberta

Wolverines occupy the boreal and montane regions of Alberta and are occasionally sighted in aspen parkland and grassland areas. These occasional sightings likely represent dispersing sub-adults rather than a range expansion.

Over the past 20 years, Wolverine density estimates in the Rocky Mountains of Alberta have ranged from 0.5 to 6.8 individuals per 1000km^2 (Fisher *et al.,* 2013; Barrueto *et al.,* 2020; Mowat *et al.,* 2020; Barrueto *et al.,* 2022). In this region, Wolverine density

increases with terrain ruggedness and spring snow cover and decreases with human disturbance (Fisher *et al.,* 2013; Mowat *et al.,* 2020). Wolverine density is approximately 2 to 3 times higher in protected areas than in nearby unprotected areas and Wolverine density was found to have decreased by 39% both inside and outside of the protected areas; development, anthropogenic disturbance, and overharvest were suggested as potential causes of this pattern (Fisher *et al.,* 2013; Barrueto *et al.,* 2022). Wolverine avoided areas with people and were lower in numbers near developed areas (Barrueto *et al.,* 2022).

Even fewer studies have examined Wolverine abundance in the boreal region of Alberta even though this ecoregion makes up a large part of the species range within the province. A study conducted by the Alberta Conservation Association (ACA) in the boreal forest of central Alberta estimated a density of 1.4 individuals per 1000km^2 (ACA, 2020). However, the size of this study area was small resulting in low precision for the density estimate. A study conducted in the northwestern boreal forest of Alberta produced a density estimate of 6.26 individuals per 1000km^2, with a 95% confidence interval of 3.88 to 10.14 (Scrafford, Unpublished Report 2023). This study also covered a relatively small study area, and the results may not be representative of the greater boreal region of Alberta. Interviews with experienced Métis hunters, gatherers and fishers in the Lac la Biche region indicated that wolverine are scarce in the boreal forest north of Lac la Biche and in the middle Athabasca River valley (LMCA unpublished report 2023). To date, there have been no assessments of population trends for Wolverines in the boreal region of Alberta. Alberta Environment and Parks is currently working on a province wide population abundance estimate.

Saskatchewan

Information on Wolverine distribution in Saskatchewan comes mainly from harvest records. Wolverines are generally found in the boreal forest north of the 54th parallel but are occasionally trapped farther south, particularly along the Saskatchewan-Manitoba border. In the last 10 years Wolverines have been sighted farther south in the province than previously sighted (Tokaruk, Personal Communication 2023).

There are no abundance or density estimates for Wolverines in Saskatchewan. Harvest records from 1999 to 2022 suggest that Wolverines are more abundant north of the 55th parallel. Trapper Questionnaire Surveys from 2011 to 2021 indicate that Wolverine is scarce in both the South Saskatchewan Trapping Area and the Northern Fur Conservation Area (Government of Saskatchewan, 2021). In parts of east-central Saskatchewan, including the region around Cumberland House, Pelican Narrows, Stanley Mission, and Grandmother's Bay Wolverines have been seen more frequently in recent years than they were in the past, it is unclear if this represents an actual increase in abundance or a shift in Wolverine's distribution because of local landscape changes (LLRIB, 2022 unpublished report, NSTA, Unpublished Report 2023; Prairie Workshop 1, 2023).

Manitoba

Like Saskatchewan, information on current Wolverine distribution in Manitoba comes mainly from harvest records. Wolverines occupy the boreal forest north of the 53rd parallel to the west of Lake Winnipeg and north of the 51st east of Lake Winnipeg. Gene flow between Manitoba and Ontario Wolverine populations is high but is limited between these provinces and the rest of western Canada (Kyle and Strobeck, 2002; Zigouris *et al.,* 2013).

There are no abundance or density estimates available for Wolverines in Manitoba, but an impact assessment done in 2012 reported Wolverine populations to be increasing in the Keeyask region and lower Nelson River region in northern Manitoba, potentially due to an increase from the Pen Island (Eastern Migratory) Caribou herd (KHLP, 2012; Berezanski, 2004). Harvest records from 1996 to 2002 suggest that Wolverines are more abundant in the north central region of the province.

Ontario

Historically, Wolverines were found throughout most of the province of Ontario until the 1800s when the species rather rapidly shifted away from the southern portion of the province (OWRT, 2013). At present, the species distribution in the province is considered primarily limited to Ontario's far north (OWRT, 2013; Ray *et al.,* 2018). Community members of the Moose Cree First Nation have observed an increase in Wolverine sightings including tracks around the community over the past five or six winters (Ontario Workshop, 2023). Additional observations support that the number of Wolverines in Ontario seem to be increasing and that there have also been more recent sightings in Northeastern Ontario (Ontario Workshop, 2023). The current Ontario population is estimated to be between 780 – 960 mature individuals (Scrafford and Ray, Unpublished Report 2023). However, 878 mature individuals is considered the most accurate estimate based on different adult/sub-adult class ratios in high and low occupancy areas of Ontario (Scrafford and Ray, Unpublished Report 2023).

Quebec

The historic distribution of Wolverines in Quebec included all areas of the province, though Wolverines were never abundant (Schmelzer, 2012). There are no current abundance or density estimates available for Wolverines in Quebec as they are largely thought to be extirpated from the province. However, two Wolverines, including one female, were harvested in 2019 near Hudson Bay in northern Quebec (Government of Quebec, Personal Communications 2023; Quebec Workshop, 2023). A sample from one of the harvested Wolverines was sent for analyses at Trenton University in Ontario to for DNA comparison to determine whether they were remnants of a low abundance population in Quebec, or traveled from nearby, or travelled further from Ontario or Manitoba. There was a potential it was from Nunavut however the results were not conclusive and therefore it could be from any of these populations. It is important to note that the samples in the database that were used for comparison were from mainland Nunavut, largely from the Bay Chimo and Kugluktuk regions, and none from

Baffin which would be closest to Quebec. It is more likely that the two Wolverines confirmed in 2019 in the north of Quebec were from Nunavut, rather than an established population in Quebec (Government of Quebec, Personal Communications 2023). Many Wolverine observations in Quebec have been reported during this period but have not been validated by experts and there is no current research being conducted to find more information about the species in Quebec.

Atlantic Region

Historically, Wolverines were present, though not abundant, in New Brunswick until the mid-1800's and in Labrador until the mid-1900's (Schmelzer, 2012; Forbes and McAlpine, 2020). The last official capture of Wolverines in Labrador occurred in 1965 (Dagenais, 1988). Over the last decades, there have been unverified Wolverine observations reported from Labrador. There is some evidence from written accounts that Wolverines were also present in Nova Scotia in the 18th century (Gallant *et al.,* 2016). Wolverines are currently believed to be extirpated in the Atlantic region.

3.3 Needs of the Wolverine

3.3.1 Broad Scale

The distribution of Wolverines in North America appears to be shaped by the availability of snow cover (Aubry *et al.,* 2007). In the Canadian Rocky Mountains, density of Wolverines was higher in areas with persistent spring snow cover (Barrueto *et al.,* 2022). Several authors have concluded that deep, persistent snow cover in the spring is the most important habitat characteristic for the location of reproductive dens as snow provides the young with protection from predators as well as the cold (Copeland *et al.,* 2010; Magoun and Copeland, 1998; May *et al.,* 2012).

Snow may also be important for preserving food caches (COSEWIC, 2014). Wolverines cache food in secluded, cold microhabitats to protect it from decomposition (Inman *et al.,* 2012a; van der Veen *et al.,* 2020). This caching behavior allows Wolverines to persist in harsh environments where food availability fluctuates dramatically. Cached food is thought to be particularly important for denning females and newborns (Inman *et al.,* 2012a). Additionally, snow cover may be important for successful dispersal to new or unoccupied areas, thereby affecting genetic connectivity of populations (Schwartz *et al.,* 2009; Balkenhol *et al.,* 2020). Dispersal is key to connecting metapopulations, especially in landscapes where extensive development has occurred that has fragmented the landscape (Carroll *et al.,* 2020; Fisher *et al.,* 2022). To assess broad habitat needs and potential habitat refugia[7] in British Columbia, researchers looked at available Wolverine habitat models, and used four existing models to create predictions for environmental data including snow, landcover, and roads (Schepens *et al.,* 2023). Genetic data has offered insights into dispersal and connectivity and has been used to

[7] Refugia is defined as areas that have relatively unaltered climates and habitats that can support a population that was previously widespread.

identify areas where population fragmentation across a highway has occurred (Cegelski *et al.,* 2003, 2006; Sawaya *et al.,* 2019).

3.3.2 Fine Scale

At a home range scale, Wolverine distribution is driven by prey availability, human disturbance, and the distribution of other carnivores. Indigenous peoples in Ontario have observed Wolverine and signs of Wolverine travelling along the coastal shorelines of Ontario's far north as well as observations of Wolverine moving upstream in the bush and suggest that they may be following waterways in search of prey species during migration (Ontario Workshop, 2023). Where available, Wolverines use high elevation habitats as well as steep, rugged[8] terrain (Fisher *et al.,* 2013; Poley *et al.,* 2018). Preference for high elevation and rugged terrain may be a result of abundant small prey, decreased competition from other carnivores, decreased predation by other carnivores, and/or because such areas have limited to no impact by human development. Wolverines tend to avoid areas of human disturbance and thrive in ecologically intact areas (Barrueto *et al.,* 2022; Scrafford *et al.,* 2018; Kortello *et al.,* 2019; Heim *et al.,* 2019; COSEWIC, 2014). The presence of other large carnivores such as Grizzly Bears (*Ursus arctos*) and Wolves (*Canis lupus*) are important as they provide Wolverines with carcasses to scavenge on, but these large predators can also prey on Wolverines (COSEWIC, 2014). In the boreal forest, Wolves have been known to kill Wolverines (Scrafford et al., 2017). Competition from smaller more numerous carnivores may also pose a competitive challenge to Wolverine in some areas. In the Canadian Rockies, the relative abundance of Coyotes (*Canis latrans*) and Red Fox (*Vulpes vulpes*) were negatively correlated with Wolverine abundance (Heim et al., 2017, 2019).

The availability of prey impacts both survival and reproduction of Wolverines (Krebs *et al.,* 2004; Persson, 2005). In addition to Grizzly Bears and Wolves, Wolverines were associated with the presence of Caribou (*Rangifer tarandus*) (COSEWIC, 2014, Northern Workshop 1.1, 3.2, 2023). Predation of ungulate calves and small mammals is more common in the spring and summer, while scavenging on carrion left by other carnivores and eating cached food items is more common in the winter (Inman and Packila, 2015; Mattisson *et al.,* 2016). Wolverines consume the most abundant and easily accessible prey in the areas that they occupy, including large ungulates, porcupines, beavers, small mammals, birds, and fish (Samelius *et al.,* 2002; Lofroth *et al.,* 2007; Scrafford *et al.*, 2017; Glass *et al.,* 2023, Northern Workshop 1.1, 1.2, 2.1, 2.2, 3.2, 2023). As such, the Wolverine diet varies seasonally, annually, and geographically. Due to their restricted home ranges, females, particularly reproductive females, rely more heavily on small prey (e.g. rodents, hares, birds) than males (Landa *et al.,* 1997; Lofroth *et al.,* 2007; Van Dijk *et al.,* 2008).

[8] Rugged is defined as an uneven surface, typically caused by rocks or vegetation, which causes difficulty while travelling.

Due to their solitary nature and the patchy distribution of food in the low productivity habitats that they occupy, Wolverines must maintain large home ranges. Male territories are larger than those of females (Hornocker and Hash, 1981; Dawson *et al.,* 2010; Inman *et al.,* 2012b). There is little home range overlap between adults of the same sex, however the home range of one male may include portions of the home ranges of several females (Inman *et al.,* 2012b; Persson *et al.,* 2010). Adult females have high faithfulness to their territories and will not travel outside of it (Aronsson and Persson, 2018). Juveniles remain with their mothers until they are around one year old (Inman *et al.,* 2012a). Males disperse long distances, sometimes even crossing large areas of low-quality habitat, to establish their own territories (Packila *et al.,* 2017; Carroll *et al.,* 2020). Females do not disperse as far as males, often remaining near their mother's territory or taking over areas of deceased individuals (Vangen *et al.,* 2001; Glass *et al.,* 2022b).

Wolverines have specific physical requirements for den sites (COSEWIC, 2014). In the mountains, dens are in areas where snow accumulates such as on talus[9] or scree[10] slopes and under fallen trees (Magoun and Copeland, 1998). In the Arctic, dens have been found primarily in areas where snow forms drifts including along stream banks, cutbanks on the edges of lakes, beside boulders, and in caves (Glass *et al.,* 2022b). Male and non-reproductive Wolverines also use burrows in deep snow as resting dens (Glass *et al.,* 2021, 2022b).

It has also been found that Wolverines reproduce in areas where snow does not persist late into the spring (Webb *et al.,* 2016, 2019) which has caused some debate on the importance of deep, persistent snow for denning females. In the boreal forest where snow is not as deep and does not last late into the spring, will den in the hollows created by the uplifted root balls of windblown trees and in log piles (Dawson *et al.,* 2010; Jokinen *et al.,* 2019). In Sweden, Wolverines have been expanding their range into areas lacking persistent spring snow cover in recent years, suggesting that snow may not be as essential a component of denning habitat as previously believed (Persson *et al.,* 2023). Wolverine dens in the boreal forest of Alberta have also been found in areas with little snow cover (Jokinen *et al.,* 2019).

3.3.3 Limiting Factors

Wolverines naturally occur at low densities because of their large spatial requirements, scavenging feeding strategy, and intrasexual territoriality. Males disperse long distances and cross low-quality habitat, but dispersal of females is much more limited. While male biased dispersal may be sufficient to maintain genetic connectivity of populations, female dispersal is required to expand and replenish the Wolverine's range. Furthermore, the reproductive output of Wolverines is generally low. Female Wolverines reach sexual maturity at 2 years old but often do not reproduce until at least 3 years

[9] Talus is defined as the rock and bolder debris that accumulates at the base of very steep rock face or cliff and lock together to form a stable surface, typically in a cone shape.

[10] Scree is defined as medium to small rock fragments that form from the weathering of talus or plate type rocks like shale or slate, and it will form a loose surface.

(Persson *et al.,* 2006; Rauset *et al.,* 2015). The average annual birth rate is low, ranging from 0.69 to 0.89 young per female as not all females reproduce in subsequent years (Magoun, 1985; Copeland, 1996; Rauset *et al.,* 2015). These factors limit the Wolverine's potential for population growth as well as its ability to recolonize suitable habitat. As a top predator and scavenger, Wolverines may also be limited by the abundance of prey species and other predators. The decline in Caribou as a source of scavenged meat may be limiting the population growth in certain areas (COSEWIC, 2014).

Figure 3. Visual depiction of the needs of Wolverines in Canada

4. Threats

4.1 Threat Assessment

The Wolverine threat assessment is based on the IUCN-CMP (International Union for Conservation of Nature–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future, the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, and other relevant information that help understand the nature of the threats, are presented in the Section 4.2 Description of Threats. The COSEWIC threat assessment table can be found in Appendix D with each of the IUCN-CMP threat categories.

The Wolverine threat assessment was informed by COSEWIC's species status report (COSEWIC, 2014) and was conducted through a multifaceted approach that included collaborative workshops with Indigenous organizations, harvesters, and knowledge holders, provincial and territorial governments, extensive review of scholarly articles, and in-depth discussions with Wolverine experts. The collaborative workshops were held across regions of Canada where Wolverine occur to gather local information for this elusive and wide-ranging species. Due to the wide range and diverse habitat of Wolverines the severity, scope and timing of threats varies throughout their range so threats not ranked in terms of concern but instead listed alphabetically.

4.2 Description of Threat

Climate Change (IUCN-CMP Threat 11.1 & 11.3)

The impact that climate change will have on Wolverines is unknown, however potential effects can be inferred based on climate projections and knowledge of the species' needs and evolutionary history. The apparent Pleistocenic origins of Wolverine suggest a species adapted to a cold snowy climate, and this is likely a driver of some ecological challenges it faces today (Fisher *et al.,* 2022). Average annual temperatures have been increasing across Canada in recent decades and are projected to continue increasing, with temperatures in the north increasing at a faster rate than in southern Canada and winter temperatures increasing more than summer temperatures (Zhang *et al.*, 2019).

As a result of increasing temperatures, the duration of snow cover and seasonal accumulation of snow have decreased across Canada since 1981 and are expected to decrease further in coming decades (Derksen *et al.,* 2019). In Canada, the duration of spring snow cover in the Arctic is expected to decline by 5 to 10% by 2050 (IPCC, 2021). In mountainous regions of western North America large declines in spring snow

cover are expected at lower elevations by the mid-21st century (Barsugli *et al.,* 2020; Schepens *et al.,* 2023). In the boreal forest the proportion of precipitation falling as snow has decreased since the 1950's because of warmer fall, winter, and spring temperatures and this trend is expected to continue with further warming (Price *et al.,* 2013).

Reduced snowpack, particularly during the spring denning period, and changes to snow properties may decrease survival and reproductive success of Wolverines. The importance of snow for denning Wolverines remains unclear. Both the current and historical distribution of Wolverines in North America have been correlated with areas that have persistent spring snow cover (Aubry *et al.,* 2007; Copeland *et al.,* 2010). Spring snow cover has been found to positively influence Wolverine occupancy in the mountains of southern British Columbia and Alberta though to a lesser extent than other factors including anthropogenic disturbance and food availability (Heim *et al.,* 2017; Kortello *et al.,* 2019). In addition to changes in the amount of snow and duration of snow cover, climate change induced changes in snow properties may have a negative effect on Wolverines. Rain-on-snow events are also increasing in the winter, which creates ice layers within the snowpack and makes it hard for wildlife, both big and small, to travel and forage (Northern Workshop 1.1, 2023). Wolverines in the arctic are sensitive to not only the presence of snow but also to snow density, depth and melt status, therefore increased spring snow melt and mid-winter melt events may decrease the suitability of snow for denning and food caching (Glass *et al.,* 2021). Heavier rains in parts of the boreal forest during the denning period may also impact Wolverine dens (NSTA, Unpublished Report 2023).

Rising temperatures may also impact Wolverines' survival and reproduction by decreasing the availability of cold locations to use as food caches. Caching of abundant food during the summer is important for female Wolverine survival and reproductive success over the winter when food is scarce and unpredictable, and energetic requirements are high (Inman *et al.,* 2012a). Species, like Wolverine, that cache highly perishable food items for long term storage are expected to be highly susceptible to climate change (Sutton *et al.,* 2016).

The connectivity of Wolverine populations could also be impacted by climate change. Deep, persistent snow was an important predictor of successful dispersal of Wolverines in the United States (Balkenhol *et al.,* 2020). Changes to the snowpack may therefore decrease the movement of Wolverines for the purposes of mating and juvenile dispersal which could lead to genetic isolation of subpopulations. In the southern range periphery especially, snow-associated places are increasingly limited under climate change, reducing dispersal opportunities (Inman *et al.*, 2012b). Changes in the timing of sea ice formation and melt in the Arctic may lead to genetic isolation of Wolverine populations on arctic islands (Glass *et al.,* 2022a). With reduced arctic ice cover, shipping through the Northwest Passage is predicted to increase and further degrade the ice cover and therefore the ability for Wolverine and their caribou prey to migrate (Northern Workshop 3.1, 2023).

Climate change may also have an indirect effect on Wolverines by altering prey availability and composition, competition dynamics between predators, and increasing prevalence of parasites and diseases. Climate change has led to observations of invasive species over the past few years in Ontario's far north and could be an indicator of impacts or changes occurring for Wolverine as well (Ontario Workshop, 2023). Distribution shifts of prey species have the potential to have a positive, negative, or neutral effect on Wolverines. In the Arctic, increased occupancy of prey species, such as moose, beaver, and snowshoe hare, may facilitate a northward range expansion of Wolverines (Glass *et al.,* 2022a). Changes to migration timing and routes of ungulate prey may negatively affect Wolverines by causing a mismatch between the availability of ungulate carcasses and nutritionally demanding periods in the Wolverines' life cycle. However, due to the ability of Wolverines to consume a wide variety of prey items it is possible that they will be able to adapt to changes in prey species composition driven by climatic shifts (Inman and Packila, 2015). Climate change may facilitate range expansion of other carnivore species (for example coyotes and foxes) which could result in competitive exclusion of Wolverines from parts of their current range (Inman and Packila, 2015; Ontario Workshop, 2023). Rising temperatures may also allow for an expansion of parasites and disease vectors previously limited to southern climates (Northern Workshop 3.3, 2023; Watson *et al.,* 2020; Glass *et al.,* 2022a).

Further potential effects of climate change on Wolverines are discussed in the section on Forest Fires (IUCN-CMP Threat 7.1).

Forest Fires (IUCN-CMP Threat 7.1)

Fires are a natural part of many ecosystems in North America and have been occurring for thousands of years, with many plant and animal species adapted to survive fires and the impacts fires cause (Jager *et al.,* 2021). All Wolverines, even those in areas that do not typically have forest fires, are at risk of forest fires and the impacts can be felt across their range. The impact of wildfire on Wolverines has not been studied but it has been suggested that animals that have a generalist diet, large home range, and ability to migrate long distances can adapt to habitat alterations caused by fire (Ketcham and Koprowski, 2013; Northern Workshop NSMA, 2023). However, with human alteration of fire regimes through decades of suppressing fire, and with climate change increasing the frequency and intensity of forest fires, the threat they pose to many species has increased significantly (Bowman *et al.,* 2020; Tyukavina *et al.,* 2022; NSTA, Unpublished Report 2023). According to Natural Resources Canada, over 17 million hectares of Canadian wildland was burned in 2023, over twice the previous record of 7 million hectares in 1995.

The direct impact of forest fires to wildlife is burn injuries, death, and respiratory trauma due to smoke inhalation (Jolly *et al.,* 2022; Sanderfoot *et al.,* 2022). Although the likelihood of injury and death to Wolverine is believed to be uncommon due to their capacity to move quickly and travel long distances, increasing severity, size and speed of forest fires could hinder the Wolverine’s ability to flee or find refuge (Jolly *et al.,* 2022; Lyon *et al.,* 2000). Smoke from fires can reduce visibility and obscure odors, which can

affect wildlife's natural behaviors like predation and movement. Forest fires and smoke can also cause increased stress in wildlife as they are forced to flee the area or hide underground (Sanderfoot *et al.,* 2022). A decrease in health, either through physical impacts like burns, smoke inhalation, or through increased stress levels, may affect the distance Wolverines are able to travel, their predation success, and their reproductive success.

Depending on the severity of the wildfire the amount of habitat destruction will vary significantly. Low intensity surface fires burn ground vegetation and downed debris, but most trees in the stand survive and it only takes a few years for significant regeneration to occur. The burned areas are often smaller with refuges found in wetlands and underground in sinkholes and burrows (Jager *et al.,* 2021). Wolverines will avoid burned patches within their territories for a few years until the vegetation has regrown and prey return to the area (Northern Workshop 2.1, 2.2, 2023). While the vegetation is regrowing, Wolverines may have to travel longer distances to find prey outside of the burned areas. Once the new vegetation grows back, prey will return, often in higher numbers than before the fire due to increased diversity of vegetation (Fisher and Wilkinson, 2005; Furnas *et al.,* 2022; Northern Workshops 2.1, 2.2, 2023).

In contrast, severe fires burn all the ground vegetation and trees, fragment the habitat and take many years to regenerate. Due to climate change and fire suppression, severe stand-replacing fires, as opposed to surface fires, are becoming more frequent and affect larger areas every year (Bowman *et al.,* 2020; Tyukavina *et al.,* 2022). Wolverines that inhabit areas that have been severely burned are faced with a significant decrease in prey availability (Palm *et al.,* 2022).

Although little research has been conducted on how forest fires affect snow condition, early research indicates that loss of vegetation affects snow depth, pack, and spring melt times, which is detrimental to wildlife that den in the snow since it can cause dens built in the snow to collapse (Maxwell *et al.,* 2019; Richardson *et al.,* 2007). Because of the destruction of their habitat by wildfires, Wolverine may have to migrate longer distances to find new ranges that are large enough to sustain their needs. Some Indigenous land users in the territories reported increasing wildlife numbers, including Wolverines and their prey, and believe this to be due to an increase in severe forest fires in the boreal region of the provinces pushing wildlife north (Northern Workshop 1.3, 2.1, 2.2, 2.3, 2023). Indigenous Elders and land users in central Saskatchewan have also reported increased Wolverine sightings, and have attributed this to changes in food availability due to large wildfires that have burned farther north (LLIB unpublished report 2022, Prairie Workshop 1 2023 Depending on whether Wolverines sustain injuries during a fire, how extensive the habitat loss is, and whether other adjacent habitats are occupied, it might be difficult for Wolverines to migrate and find new territory with suitable habitat. The fragmentation of habitat by severely burned areas can split up populations and limit movement across their range resulting in decreased access to prey, lower genetic diversity, and decreased resiliency to future disturbances. (Schwartz *et al.*, 2009; Balkenhol *et al.*, 2020).

Housing and Commercial Development (IUCN Threat 1.1, 1.2 & 1.3)

The areas of Canada that have seen the greatest range contractions for Wolverines correspond with the areas with the highest human footprint (Hirsh-Pearson *et al.,* 2022; Ontario Workshop, 2023). Currently, residential, and commercial development are primarily of concern along the southern edge of the Wolverine's range in northwestern Ontario, the prairie provinces and in southern British Columbia where human populations have increased in recent years (Statistics Canada, 2022). The development of tourism and recreation areas (which can include trails, campgrounds, ski resorts, access roads) is of particular concern in the mountainous regions of Alberta and southern British Columbia (see below section on Recreational Activities (IUCN-CMP Threat 6.1, 6.3 & 1.3) for more information). In the Canadian Rocky Mountains, Wolverine density and detection probability decreased near development (Barrueto *et al.*, 2022).

Residential and commercial development, including development of tourism and recreation areas, result in both direct and functional loss of Wolverine habitat. Wolverine occupancy has been found to decrease in areas with more human development (May *et al.,* 2006; Fisher *et al.,* 2013; Webb *et al.,* 2019). Females have a stronger negative relationship with human development than males (Lofroth *et al.,* 2007) and tend to avoid human infrastructure when selecting den sites (May *et al.,* 2012). In addition to habitat loss, human development can lead to changes in prey availability, increased competition with other carnivores and altered Wolverine behaviour all of which may impact survival and reproduction of Wolverine (Heim *et al.,* 2017, 2019; Stewart *et al.,* 2016). Urban development may also limit dispersal of Wolverines, thereby reducing connectivity between subpopulations (Balkenhol *et al.,* 2020). Additionally, residential, and commercial development is typically accompanied by the construction of new roads which can increase access for hunting and trapping of Wolverines and cause displacement of Wolverine (discussed in the below section Overharvesting (IUCN-CMP Threat 5.1)).

Industrial Development (IUCN-CMP Threats 3.1, 3.2, 3.3 & 5.3)

The construction and operations of mines create a chain of disturbances that can negatively impact Wolverine and can increase the impacts of other threats through increasing road density and allowing access to new habitat (see the section below Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2) for more information). The impact of mining can be split into five main components, habitat destruction, habitat fragmentation, the disruption of the ecosystem, pollution and contamination, and increased human presence and disturbance.

The habitat destruction and alteration caused by mines has a negative relation with Wolverine abundance. The loss of habitat tends to drive the Wolverine away as they are more likely to select undisturbed habitat of higher quality (Fisher *et al.,* 2013; Quebec Workshop, 2023). The habitat loss also affects Wolverines through decreased prey

abundances as the prey species that Wolverines feed on tend to avoid the mining sites (Johnson *et al.,* 2005). Trappers are also likely to avoid the disturbed areas around mines which results in a loss of local information (Northern Workshop 2.3, 2023). Loud noises from the mine, such as blasting, mining operations, or transportation, can cause Wolverines and their preys to move away from the area and can alter behaviors (Francis and Barber, 2013; Duarte *et al.,* 2015).

Pollution and contamination are another concern around mines that can impact Wolverine. Contamination from mines can leak into the environment and have long term negative impacts including leaking into water sources, impacting animals that rely on them for drink and food (Wong *et al.,* 1999; Palmer *et al.,* 2019). Pollutants in water sources can negatively impact the animals that rely on them as a water source but can also harm the fish living in the water, an important food source for Wolverines. Increased sediment load and pollutant levels in rivers can decrease fish abundance through the destruction of habitat, decreased reproduction and decreased survival rates. Increased pollution can also impact the quality of the fish as a food source through decreased fish size and the bioaccumulation of contaminants in the food chain (Saunders *et al.,* 1967; Affandi and Ishak, 2019). Given the broad range of food that Wolverine eat the impact of pollution can vary, whether its direct run off from contaminated sites, the slow release of toxic chemicals into the air and water as a byproduct of the mining process, or the bioaccumulation of pollutants in the food web.

To support mining operations a long network of roads is often built. For more information see the section below on Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2).

Oil and gas development is increasing across parts of the Wolverine’s range in Canada. This threat is primarily a concern in Alberta where most of Canada’s oil and gas production occurs but may also impact Wolverine in the northeast region of British Columbia, along the southern boundary of its range in Saskatchewan, as well as in certain areas of Ontario and the Northwest Territories.

Oil and gas exploration and development pose a threat to Wolverine through loss and degradation of habitat, increased human access, changes to prey populations, changes to populations of other predators, and pollution. The construction of open-pit mines, drilling of oil and gas wells, and development of associated infrastructure can directly affect Wolverines by destroying denning and foraging habitat. Similar to housing and commercial development, oil and gas development can lead to functional habitat loss when Wolverines avoid otherwise suitable habitat due to increased human disturbance.

Indirect effects of oil and gas development include increased density of linear features (discussed in the below section on Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2)), increased vehicle traffic, and environmental pollution. Oil and gas extraction in the Alberta oil sands region has the potential to impact Wolverine health through air and water pollution. Air pollution produced by oil sands development includes stack emissions and fugitive dust from land clearing, mining, and roads which contain nitrogen

oxides, sulfur oxides, volatile organic compounds, and particulate matter (Kelly *et al.,* 2010; Kirk *et al.,* 2014; Bari and Kindzierski 2015; Wasiuta *et al.,* 2019). Airborne contaminants have been detected up to 30 km from their source (Lynam *et al.,* 2015) and waterborne contaminants have been detected up to 200 km downstream (Kelly *et al.,* 2009, 2010). Concerns about the impact of pollution from the oil sands region have been expressed as far away as eastern Saskatchewan (NSTA, Unpublished Report 2023). Contaminant exposure of Wolverines in the Alberta oil sands region has not been studied. However, contaminants associated with oil sands development have been found in Wolverine prey species as well as wolves in the Peace-Athabasca region of Alberta (Lundin *et al.,* 2015; Wilcox *et al.,* 2023). The long-term health effects of industrial pollution on Wolverines are currently unknown.

Another major industry in parts of the Wolverine's range in Canada is forestry. Between 710,000 and 810,000 hectares of forest were harvested each year in Canada from 2010 to 2020. Within the current range of the Wolverine most of the logging is occurring in British Columbia, Ontario, and Alberta with lower levels occurring in Saskatchewan, Manitoba, and Yukon (NRC, 2022).

Wolverines may be directly impacted by the destruction of denning habitat during logging operations as well as disturbance associated with increased density of access roads (Quebec Workshop, 2023), however the effect of forestry on Wolverine use of landscapes remains unclear. Landscape genetics analyses suggest that genetic connectivity of Wolverines across western North America has been positively influenced by fine-scale forest cover (Day *et al.*, Unpublished Report 2024). In northwestern Alberta, Wolverines were attracted to cutblock edges, perhaps due to increased opportunities for small mammal hunting or easier movement, but avoided the centers of cutblocks (Scrafford *et al.,* 2017). In Montana, Wolverine tracks were observed crossing cutblocks (Hornocker and Hash, 1981). Wolverine natal dens have even been found in cutblocks in piles of logging debris (Scrafford *et al.,* 2017; Jokinen *et al.,* 2019). The indirect effect of altered prey dynamics may be greater than the direct effect of habitat loss. Following commercial forestry, 53% of harvested area has been artificially regenerated by planting or seeding while the remaining harvested area has been left to regenerate naturally (NRC, 2022). Most artificially regenerated stands are made up of conifers and it is common for herbicides (e.g. glyphosate) to be applied to control competing vegetation and accelerate establishment of the desired species. Cutblocks artificially regenerated and sprayed with herbicides provide reduced forage availability for ungulates such as moose, elk, and deer (Boan *et al.,* 2011; Stokely *et al.,* 2021; McKay and Finnegan, 2023). Additionally, the treatment of regenerating cutblocks with herbicides can decrease forage quality for up to 12 years (Werner *et al.,* 2022). A monitoring project conducted by Whitefish Lake First Nation in north central Alberta detected decreased wildlife foraging in conifer cutblocks that had been sprayed with herbicides (Prairie Workshop 5, 2023). Decreasing ungulate populations may in turn contribute to declines in Wolverine numbers.

Overharvesting (IUCN-CMP Threat 5.1)

Hunting and trapping of Wolverines for their fur during the 19th century for the Hudson Bay Company and North West Company is thought to be the potential cause of the initial decline of the species in Quebec and Labrador (Fortin *et al*., 2005; Schmelzer, 2006; Quebec Workshop, 2023). Nowadays, most provinces and territories have wildlife acts that regulate when, where, and how Wolverines can be harvested to prevent them from being overharvested (see Table 3 for more information). However, many do not have annual harvest quotas, leading to some hunters and trappers taking more than what other harvesters deem sustainable (Northern Workshop 1.2, 3.1, 2023). Harvesting late in the season is more likely to have a negative impact on the population since there is an increased chance of harvesting older adults and denning females who are emerging with warmer temperatures (Kukka *et al.,* 2017, Northern Workshop 1.2, 3.1, 2023). Harvesting during the middle of the winter, when it is coldest and the fur is at its thickest and longest, and therefore has the higher market value, was also listed as a way to respectfully harvest Wolverine (Northern Workshop 1.2, 2.2, 2.3, 3.2, 2023). Unsustainable trapping was a key factor involved in a decline in Wolverine numbers inside and outside of National Parks in the Canadian Rocky Mountains (Barrueto *et al.,* 2022). In British Columbia, models indicate that Wolverines were overharvested by 50%, and, as a result, the trapping allowance was reduced by half (Mowat *et al.*, 2020).

With advancing technology, it has become increasingly easier to harvest Wolverines with since new vehicles make it quicker and safer to travel deep into the wilderness and new equipment makes it easier to track and kill animals (Northern Workshop NSMA, 2023). The increasing presence of roads and corridors allow people to travel farther and quicker and allows for easier harvesting and poaching (see below section on Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2) for more information).

Harvesting of other wildlife often leaves behind gut piles and attracts scavengers like Wolverines. The gut piles act as a food source, therefore supporting the population, but can increase the chances of being harvested by drawing Wolverine to areas frequented by harvesters (Northern Workshop 1.3, 2023). Wolverines are most often harvested for their pelts which have been commonly used as trimming and ruffs on parkas for hundreds of years (Cotel *et al.,* 2004). Wolverine pelt prices have maintained a high value throughout history because of the insulating quality of the fur and the elusiveness of the animal, often being the most expensive furs on the market (Kukka, 2017). Although, if a species is protected under a provincial species at risk act, like it is in Ontario, pelts cannot be sold and can only be used by the Indigenous person who trapped it, or within their community (Ontario Workshop, 2023). The high value of the Wolverine pelts is likely a large contributing factor to harvesting that still occurs. However, the high cost of the equipment, gas and other necessities required to hunt and trap make the profit margin of pelts lower than what it was in the past, so harvesters are more often hunting and trapping as a hobby or to maintain traditional practices, rather than for income (Northern Workshop 1.2, 2023). Recreational hunting of Wolverines has become increasingly popular, sometimes being led by outfitters for tourists to hunt big game (Northern Workshops 2.2, 3.2, 2023). Although sport hunters must follow local and regional regulations, hunting may not be done in a sustainable or ethical way.

Sustainable harvest levels are hard to determine because Wolverine population levels and trends are difficult to estimate since the species is wide-ranging and elusive. Currently, most population estimates are calculated using harvest data, which is often biased (see Section 3.2 for more information). There are many contributing factors that influence a population's ability to sustain harvesting pressure, including nearby refuge where trapping does not occur and human disturbance is low, habitat quality, food availability, and range fragmentation. In British Columbia and Alberta, Wolverine trapping sustainability study determined that trapping mortality needed to be reduced by more than half to promote population growth for regional recovery (Mowat *et al.,* 2020). Having areas where trapping does not occur has been found to be important for maintaining higher harvest rates in the surrounding areas (Mowat *et al.,* 2020; Kukka, 2017; Golden *et al.,* 2007).

Since Wolverines can travel long distances, especially juveniles who are trying to find new home ranges, refugia with low human disturbance can supplement areas that are experiencing higher mortality from harvesting pressures. However, the refuge and the area being harvested must be free of impairment to movement like large roads or human developments to prevent the populations from being fragmented. Protected areas have been found to have more than three times the density of Wolverines than non-protected areas (Barrueto *et al.,* 2022). However, in these same protected areas, density estimates were lower than predictions from nearby high-quality habitat, and density decreased towards park boundaries (Barrueto *et al.*, 2020). Human-caused mortality, habitat displacement, and edge effects occurring at protected area boundaries may reduce the refugia function (Barrueto *et al.*, 2020, 2022).

Table 3. Regional acts relating to Wolverine harvest and average annual harvest amounts.

Territorial Acts	Regulations	Average Yearly Harvest
Yukon Wildlife Act	Commercial harvest with the intent to sell pelts requires a trapping license or assistant trapper license, with the trapping season from November 1st to February 28th. All pelts harvested must be submitted to receive a metal seal and gather general information. They are also considered big-game and can be hunted with a centerfire rifle (Government of Yukon, 2022).	An average of 144 ± 40 (SD) Wolverines per trapping season from the 1989/1990 season to 2003/2004 (Government of Yukon, 2022)
Northwest Territories Wildlife Act	There are slightly different regulations, hunting areas, bag limits, and seasons depending on the type of harvester. The same is	In the Inuvialuit Settlement Region 44.7 Wolverine per year between 1988-1997 (Joint Secretariat, 2003)

	true for trappers. Indigenous harvesters in their traditional areas and general hunting license holders are not limited in the number of Wolverines they may harvest. Wolverine are tagged and it is an offense to waste, destroy, abandon, or spoil a raw pelt or hide (Government of Northwest Territories, 2023b).	In the Gwich'in, 8.44 Wolverine per year between 1995/1996-2003/2004 (McDonald, 2009) In the Sahtu region, 6 Wolverine per year between 1998-2005 (Bayha and Snortland, 2002, 2003) In the Tłı̨chǫ region, 9 Wolverine/year between 2000-2005 (IMG-Golder, 2006) In the Dehcho region, 7 Wolverine per year between 2000-2005 (IMG-Golder, 2006)
Nunavut Wildlife Act	Nunavut residents (Canadian citizens or landed immigrants that have resided in Nunavut for at least six months) do not have an annual harvest limit. Non-residents and non-resident foreigners are restricted to one Wolverine a year conditional on approval from the local hunter and trapper organization. It is illegal to waste the raw pelt or hide of Wolverine and feed the meat to domestic animals.	A total of 310 Wolverines were harvested in Nunavut between 2013 and 2018, largely from the Kitikmeot region (Awan, 2020). However, reporting is voluntary, and the actual harvest number is likely higher.
Provincial Acts	**Regulations**	**Average Yearly Harvest**
British Columbia Wildlife Act	It is illegal to kill Wolverines for any other reason than to harvest pelts with a trapping license and on a registered trapline during the open trapping seasons in certain regions and all captures must be reported within 15 days following the end of the trapping season.	An average of 168 Wolverines were harvested annually over the past decade (Lofroth, 2001)

Alberta Wildlife Act	Regulated by a registered trapline system where licensed trappers must own a registered trapline and can only keep one per year. One incidental harvest is allowed per trapper per year. Season runs from November 1 to January 31 in most Wildlife Management Units with an extended season to February 15 in certain areas.	An average of 31 individuals per year from 1995-2012 (Webb *et al.*, 2013)
Saskatchewan Wildlife Act	Trappers are required to hold a license and use approved trapping materials. The province is separated into trapping areas that have slightly different registration requirements. Wolverine trapping is limited to Saskatchewan residents only. The season runs mid-October to mid-February and there is no limit on how many can be harvested.	An average of 14 individuals per year from 1999-2022 (SK CDC, 2023)
Manitoba Wildlife Act	Season is from November 1st to February 15th in all Registered Trapline Districts (extended season to February 28 in Barrenlands and Northern Registered Trapline Districts), no Wolverine harvest allowed in Open Trapping Area certain zones (Government of Manitoba, 2023b).	An average of 42 individuals per year from 2007-2011, 76 individuals per year from 2012-2016, and 74 individuals per year from 2017-2021 (Government of Manitoba, 2023b)
Ontario Fish and Wildlife Conservation Act	The species is classified as a furbearer under the Fish and Wildlife Conservation Act, 1997. The hunting and trapping seasons for Wolverine were closed in 2009, after several years of zero quota assignments, and the harvest of the species prohibited (Government of Ontario, 2016).	Data deficient
Quebec Act Respecting the Conservation and	There is no hunting or trapping season for Wolverine, but Indigenous harvest rights are	Data deficient

Development of Wildlife	protected under Section 35 of the Constitution.	
Newfoundland and Labrador Wild Life Act	There is no hunting or trapping season for Wolverine, but Indigenous harvest rights are protected under Section 35 of the Constitution.	Data deficient

Recreational Activities (IUCN-CMP Threat 6.1, 6.3)

Humans are increasingly using the back country year-round for recreational activities, including hiking, camping, off-road vehicle driving, backcountry skiing and snowboarding, cross country skiing, snowmobiling, hunting, and fishing. The surge of recreational activities is happening across the country, affecting all the Wolverine's range. Although there is a larger concentration of backcountry use closer to cities and towns, there is increased use of recreational vehicles on resource roads and corridors to reach remote areas (see the section below in Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2) for more information) and increasing demand for fly-in activities. The impacts created by recreational activities may include habitat modification, behavior changes, pollution, or, on rare occasions, accidental killings (Knight and Cole, 1995).

In the Canadian Rocky Mountains, detection probability decreased with human recreational activity, with Wolverine even avoiding areas with very low levels of human-use (Barrueto *et al.,* 2022). In the mountainous regions of the United States Wolverines avoided otherwise high-quality habitats in areas with higher recreation levels (Heinemeyer *et al.,* 2019). Wolverine were more likely to avoid areas with increased recreation, increased off-trail activities, and they were more likely to avoid areas with motorized than non-motorized recreation (Heinemeyer *et al.,* 2019). Females are particularly vulnerable to human disturbance at den sites (Copeland, 1996; Magoun and Copeland, 1998; Myrberget, 1968; Pulliainen, 1968). As demand for recreational space increases, the pressure on Wolverine in protected areas is expected to increase adding to the list of stressors for Wolverine (Fisher *et al.,* 2022). Recreation is also predicted to increase and become more concentrated in the future in the far southern portion of Wolverine range as snow-covered areas decline due to climate change (US Fish and Wildlife, 2023).

Wolverines need large areas of undisturbed land for their home ranges so any area that overlaps with land used for recreation would be considered low value and Wolverines will try to avoid these areas as much as possible (Krebs *et al.,* 2007). The avoidance of these areas may change behaviors related to travel, hunting and scavenging, mating, denning, and kit rearing. Prey species may be scared away from recreational areas or have a change in behavior and lower the predation success rate of Wolverines (Seip *et*

al., 2007). Larger predator species, like wolves, which Wolverines rely on to provide scraps to scavenge on, may also avoid these areas (Northern Workshop 1.2, 2023). Winter activities can cause additional stress to females since they are either pregnant or caring for their kits at this time and cannot travel as far to find resources (Heinemeyer *et al.,* 2019; Banci, 1994). Reproduction requires a lot of resources, mainly food availability and habitat quality, and disturbances caused by recreational activities to these resources during delayed implantation, pregnancy or lactation will affect the ability of a female to raise its offspring and therefore maintain a stable population (Persson, 2005; Rauset *et al.*, 2015). Furthermore, recent studies suggest that the effect of winter recreation on Wolverines may be exacerbated by climate change (see the above section on Climate Change (IUCN-CMP Threat 11.1 & 11.3) for more information) (Heinemeyer *et al.,* 2019). If disturbance becomes too severe, Wolverines may migrate to new habitat, typically north where there is less human presence (Northern Workshop 2.1, 2.3, 2023; Quebec Workshop, 2023).

There are some benefits for Wolverines that are created by recreational activities. Trails through thick brush or compact snow in the winter can allow for easier movement across the land. Hunters and fishers may leave behind scraps, like gut piles, that the Wolverine can scavenge (Northern Workshops 2.1, 2.2). However, scrap piles on the sides of roads, corridors or shores can also enable easier hunting and poaching of Wolverines or an increased chance of being hit by a vehicle (see the section below on Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2) for more information).

Roads and Corridors (IUCN-CMP Threats 4.1 & 4.2)

Humans are increasingly creating corridors through natural areas for urban development, goods and human transportation, resource extraction, and recreation. These corridors can come in the form of roads, corridors for railways, trails, power lines, and seismic lines. Roads and corridors are in a positive feedback loop with urban sprawl, resource extraction, and recreational activities since roads are created for these activities and therefore make it easier for other activities to be developed, perpetuating the need for more roads to be created (Northern Workshop 2.3, 2023). Roads are a precursor and side effect of housing and commercial development, mining, oil, gas, and recreational activities, each having their own additional impacts (see the above sections on Housing and Commercial Development (IUCN-CMP Threat 1.1 & 1.2), Indistrial Development (IUCN-CMP Threat 3.1, 3.2, 3.3 & 5.3), and Recreational Activities (IUCN-CMP Threat 6.1, 6.3 & 1.3) for more information). Roads also provide an easy way to access remote areas for hunting and trapping, and illegal poaching, exacerbating the impacts that overharvesting creates (see the above section Overharvesting (IUCN-CMP Threat 5.1)) (Northern Workshop 2.2, 2023).

Roads and corridors occur more densely around human settlements but can stretch far into untouched backcountry areas. Construction requires the removal of vegetation and the alteration of topography and subsequent vehicle use results in pollution. The impacts created by corridors occur across the Wolverine range, but the level of impact to Wolverines varies depending on the number of activities that are happening in an

area. For example, roads in the tundra have relatively low impact since there are few roads to begin with and less vegetation removal and topographical change needs to occur (Northern Workshop 2.2, 2023). Landscape change in arctic environments is currently much less pronounced but development pressure from mining and transportation continues, but these effects are understudied (Fisher *et al.,* 2022).

Wolverines avoid roads and Wolverine occurrence declines with road density (Bowman *et al.,* 2010; Ray *et al.,* 2018). In the Alberta Rocky Mountains, Wolverine distribution and density decreased with density of anthropogenic linear features, including roads and petroleum-exploration 'seismic' lines (Fisher *et al.,* 2013; Heim *et al.,* 2017). In British Columbia, male and female Wolverines responded negatively to roads and motorized recreation (Lofroth and Krebs, 2007).

Wolverines' negative relationship to linear features is partly a result of mortality (Fisher *et al.,* 2022). In boreal Alberta, Wolverine mortality increased during the summer and winter around low-traffic winter roads as these roads are used by Wolves as movement corridors (Scrafford *et al.,* 2017). Mortality from collisions with vehicles and trains is low but still occurs, with less than 5% of radio-collared Wolverines being killed by vehicle collision in North America from 1972 to 2001 (Krebs *et al.,* 2004). Roads and corridors also have indirect impacts including the reduction and fragmentation of habitat, regardless of the presence of wildlife crossing structures and fencing (Scrafford *et al.,* 2018; Sawaya *et al.*, 2019). Restricted movement across the land makes it difficult to find food, suitable shelter, and find mates leading to lowered health and genetic drift. The wider the road and the more traffic there is the less likely Wolverines will cross it (Austin *et al.,* 1999). Females are especially impacted since their home ranges are smaller, they do not typically travel far from their natal home ranges, and they prefer to den as far away from roads as possible (May *et al.,* 2012; Sawaya *et al.,* 2019). Population fragmentation from restricted female movements and dispersal across highways can reduce population viability (Proctor *et al.*, 2005). Only one-migrant-per-generation is needed to maintain genetic connectivity and that migration rate can easily be achieved with males alone; however, Wolverine and other carnivore metapopulations depend on female movements for population re-colonization and range expansion (Inman *et al.*, 2013; Mills and Allendorf, 1996; Proctor *et al.*, 2005). Wolverine prey, like moose, caribou, and other ungulates, are also affected by roads and will avoid areas with dense corridors and heavy traffic, which further devalues these areas as habitat (Beazley *et al.,* 2004; Boulanger *et al.*, 2020, Northern Workshop 3.2, 2023). Vehicle and train transportation is a large contributor to pollution both during creation and in use.

Seismic lines are a major landscape feature in parts of the Wolverines range with extensive oil and gas exploration. Wolverine occurrence in western Alberta was found to be negatively related to the density of seismic lines (Fisher *et al.,* 2013; Heim *et al.,* 2017). Seismic lines may decrease prey availability or increase the risk of predation by wolves (Fisher *et al.,* 2013). Seismic lines facilitate the range expansion of coyotes and foxes, two species that may outcompete Wolverines for limited food (Heim *et al.,* 2017, 2019). Roads and seismic lines increase human access and can increase hunting,

trapping and recreation in previously remote areas (Dabros *et al.,* 2018). Increased access for Wolverine harvest is discussed in the above section Overharvesting (IUCN-CMP Threat 5.1) and recreation is discussed in the above section Recreational Activities (IUCN-CMP Threat 6.1, 6.3 & 1.3). Once vegetation has begun to regrow seismic lines may provide Wolverines with increased prey density along with decreased risk of encountering wolves and humans (Scrafford *et al.,* 2017). However, human use of seismic lines can slow regeneration (van Rensen *et al.,* 2015).

Figure 4. Visual depiction of the threats that affect Wolverines in Canada.

5. Management Objectives

The management objectives for Wolverine in Canada are:

- Increase habitat connectivity in areas with high habitat fragmentation and maintain connectivity in areas with low habitat fragmentation.
- Increase Wolverine population sizes in the portions of its range where populations have declined and maintain population levels in other portions of its range.
- Maintain the current distribution of Wolverine throughout its current Canadian range.

5.1 Rationale for Management Objective

Wolverines were assessed by COSEWIC as Special Concern because of population declines in the southern portion of its range in Canada and Wolverine do not appear to have recovered in Quebec and Labrador. However, the population appears to be increasing in parts of its range including, Northwest Territories, Nunavut, Manitoba, and Ontario.

Wolverines are sensitive to habitat degradation and fragmentation, human disturbance, climate change, and pressure from overharvesting. Due to their large range, the threats to Wolverines are variable and regionally specific approaches will be necessary to address the most prevalent threats (see Section 4 for more information). Wolverine habitat is becoming increasingly fragmented by roads and other human development, especially in the southern portion of its range (COSEWIC, 2014). The increasing number of roads is also providing increased access to Wolverine habitat and exacerbating the impact of other threats, such as recreational and overharvest pressures, on Wolverine (COSEWIC, 2014). However, if there are large, undisturbed areas with low human-use that can act as refugia then repopulation of suitable habitat is achievable. Reducing the impact of human-caused threats in the Wolverine range would in turn increase survival rates and improve connectivity of reproductively mature individuals. Improving communication between Provinces / Territories, Indigenous organizations, and harvesters, promoting collaboration and standardized monitoring across jurisdictions, reducing incidental harvest, reducing human-caused habitat fragmentation, promoting land-use planning for a range of human-use levels, and ensuring that total human-caused mortality is sustainable will enhance the support for meeting the objective (see Section 6 for more information).

6. Broad Strategies and Conservation Measures

6.1 Actions Already Completed or Currently Underway

Nationally

- Yellowstone to Yukon Conservation Initiative organized a virtual Wildlife Wise Workshop Series to educate winter recreationists on responsible recreation in Wolverine habitat.
- Wolverine Watch is collecting Wolverine observations and possible den locations from reported sightings and signs from the public.
- Genetic delineation of Wolverine sub-populations in western and northern Canada and the United States are used to determine the effect of major roads on connectivity and identify pathways for connectivity.
- Some National parks have proposed multi-species action plans that outline recovery actions for Wolverine, and other species at risk.

Yukon

- Tr'ondëk Hwëch'in First Nation is collaborating with the University of Alberta and Yukon University on a project using remote cameras to look at the impacts of industrial development on Wolverine and allied species.
- Vuntut Gwitchin First Nation is using remote cameras to study the effects of cutline features in their Traditional Territory on animals' movements, including Wolverine.

Northwest Territories

- Harvesting is limited to beneficiaries unless a person is granted a license.

Nunavut

- Government of Nunavut is conducting non-invasive mark-recapture studies on the mainland (Kitikmeot and Kivalliq), which had been ongoing since around 2016. The results are used to determine population density in the area.
- Nunavut Wildlife Management Board has a community-based monitoring network where local harvesters report data on wildlife observations, with the data stored in the communities.

Alberta

- Alberta Environment and Parks is working on an updated provincial Wolverine population estimate and status assessment.
- First trend study in North America complete in mountain national parks and adjacent unprotected areas.
- Harvest limit is set to 1 individual per trapper for each season.

Manitoba

- Wildlife Conservation Society is working with the Government of Manitoba to identify harvest refugia for Wolverines using provincial harvest data.

Ontario

- Wildlife Conservation Society Canada has developed an updated population estimate for Ontario (Scrafford and Ray, Unpublished Report 2023).
- Under Ontario's Endangered Species Act, Wolverine was listed as Threatened and a Recovery Strategy was first published on November 22, 2013. The Government of Ontario's goal for the recovery of the Wolverine is to maintain the current distribution of Wolverine in Ontario and support natural increases in the population abundance and distribution. Actions identified as being necessary for achieving the recovery goal are:
    - Monitoring and research with the objective to increase knowledge about Wolverine biology, ecology, distribution, population dynamics, threats and habitat use in Ontario.
    - Habitat management with the objective to maintain the availability of suitable habitat for Wolverine in Ontario in collaboration with Indigenous communities and organizations, and stakeholders.
    - Stewardship and outreach with the objective to work collaboratively to increase public awareness about Wolverine and reduce negative perceptions and threats to the species.

Quebec

- Sightings are collected, analyzed, and compiled annually by the provincial government.
- Detection stations (cameras, baits, olfactory lures) have been monitored at strategic locations (e.g., along the Quebec/Ontario border) since 2010 in order to document the species' presence.

6.2 Broad Strategies

The broad strategies for achieving the management objective for Wolverine fall under the following categories:

- **Land and Water Management**
- **Awareness Raising**
- **Livelihood, Economic and Moral Incentives**
- **Conservation Designation and Planning**
- **Legal and Policy Frameworks**
- **Research and Monitoring**
- **Education and Training**
- **Institutional Development**

6.3 Conservation Measures

Table 4. Conservation Measures

Broad Approach	Conservation Measure	Location	Priority[a]	Threats or Knowledge Gaps Addressed
1. Land and Water Management				
1.1 Site/Area Stewardship	Encourage the creation, conservation, and stewardship of healthy ecosystems in Wolverine range	Entire Range	Medium	Housing and Commercial Development, Indistrial Development, & Recreational Activities
	Decommission old roads and limit construction of new roads by reusing existing roads and corridors where possible	Entire Range	High	Roads and Corridors
3. Awareness Raising				
3.1 Outreach and Communications	Educate public on regional threats to Wolverine, for example the impacts of recreation and tourism on Wolverines and their habitat	Entire Range	Medium	Recreational Activities
5. Livelihood, Economic & Moral Incentives				
5.2 Better Products and Management Practices	Develop best practices to avoid incidental take of Wolverines	Entire Range	Medium	Overharvesting
	Develop Wolverine specific best practices for mining, mineral exploration, and resource management activities (e.g., peat extraction, hydro corridors, etc.).	Entire Range	Medium	Industrial Development

6. Conservation Designation and Planning				
6.1 Protected Area Designation and/or Acquisition	Promote and support the application of existing acts and regulations that help preserve and restore Wolverine habitat	Entire Range	High	Housing and Commercial Development, Industrial Development, & Recreational Activities
	Support the development of protected areas with low human disturbance, including Indigenous protected areas, large enough to act as refugia for Wolverines	Entire Range	Medium	Housing and Commercial Development, Industrial Development, & Recreational Activities
6.3 Land/Water Use Zoning & Designation	In areas of high human disturbance, reduce human caused habitat fragmentation and promote land-use planning that supports habitat connectivity	Southern Portions of the Range	Medium	Housing and Commercial Development, Industrial Development, Recreational Activities & Roads and Corridors
	Consider Wolverine habitat, such as denning sites, when development decisions are made	Southern Portions of the Range	Medium	Housing and Commercial Development, Industrial Development, & Recreational Activities
7. Legal and Policy Frameworks				
7.2 Policies & Guidelines	Implement sustainable harvest levels for areas with decreasing Wolverine populations	Southern Portions of the Range	High	Overharvesting
8. Research and Monitoring				
8.1 Basic Research & Status Monitoring	Develop population units to promote planning that is specific to different regional threats	Entire Range	Medium	All Threats

	Conduct and maintain population surveys across the Wolverine's range, including repeat surveys to measure population trends	Entire Range	High	Harvesting, Housing and Commercial Development, & Indistrial Development
	Conduct research on Wolverine distribution to better identify the range of Wolverine	Entire Range	Medium	Harvesting, Housing and Commercial Development, & Indistrial Development
	Support Indigenous Knowledge studies including interviews with elders, trappers, and land users to gather information on local Wolverine populations	Entire Range	Medium	All Threats
	Determine the ecological conditions and thresholds that promote persistence of Wolverine (e.g. availability of dens, availability of prey, competition, human density)	Entire Range	High	Forest Fires, Housing and Commercial Development, & Indistrial Development
	Obtain and compare genetic samples from across the Wolverines range to determine habitat connectivity and movement between Wolverine populations	Entire Range	Low	Forest Fires & Roads and Corridors
	Study the impact of habitat fragmentation on Wolverine	Southern Portions of the Range	Medium	Housing and Commercial Development, Industrial Development, Recreational Activities & Roads and Corridors
	Obtain detailed data and information on the impact of diseases and parasites on Wolverine. If they pose a significant threat determine the vector for transmission between Wolverine	Entire Range	Low	Climate Change

	Investigate the impact of climate change on Wolverine	Entire Range	High	Climate Change
	Study the impact of forest fires on Wolverine distribution and habitat use	Entire Range	High	Climate Change & Forest Fires
	Investigate the impact of shipping in the Arctic on Wolverine movement and survival	Northern Portions of the Range	Medium	Climate Change
	Promote collaboration and the standardization of the methods used for monitoring and abundance estimates across jurisdictions	Entire Range	Medium	Harvesting, Housing and Commercial Development, & Industrial Development
	Identify and protect dispersal corridors and habitat refugia for Wolverine	Southern Portions of the Range	High	Climate Change
9. Education and Training				
9.2 Training & Individual Capacity Development	Support trapper education programs to teach safe, culturally respectful harvesting techniques and to reduce incidental harvest of Wolverine	Entire Range	Medium	Overharvesting
	Raise public awareness about Wolverines and their habitat, to change negative attitudes and behaviour toward Wolverines	Entire Range	Medium	Housing and Commercial Development, Recreational Activities
10. Institutional Development				
10.3 Alliance & Partnership Development	Facilitate two-way communication between governments and harvesters to ensure information on Wolverine harvest and Wolverine research is being shared to all parties	Entire Range	Medium	Harvesting
	Promote and support partnerships for conserving Wolverine populations	Entire Range	Medium	All Threats

	Institute or continue initiatives that promote engagement and cooperation of governments, Indigenous groups, and key stakeholders in Wolverine conservation	Entire Range	Medium	All Threats

[a]"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.

6.4 Narrative to Support Conservation Measures and Implementation Schedule

Wolverines are a wide-ranging species with threats that vary across its range. A conservation plan for the species needs to take into account the varying threats it faces across its range and the different status it has in different parts of the country. Wolverine are considered extirpated, or potentially extirpated, in parts of its historic range, such as Quebec and Vancouver Island. Large portions of Wolverine range in southern Canada, close to the United States border, are fragmented by roads, cities, and industrial development. In other parts of its range there are also large disturbances caused by natural resource extraction. Any long-term management strategy for Wolverine should be adapted for climate change and shifting needs for Wolverine. Identifying what habitat is currently important for Wolverine while also investigating and identifying habitat refugia in the face of climate change will be vital to ensuring long term Wolverine survival. Further understanding of the increased risk of disease and parasites to Wolverine is important for making sound long-term conservation decisions (Northern Workshop 3.2, 3.3, 2023). Understanding how these threats may change in the future is important for long term planning and management planning.

Restoring previously developed habitat areas, such as roads created for resource extraction or even the resource extraction site itself, can help Wolverine in multiple ways (Ontario Workshop, 2023, Prairie Workshop 5, 2023). Reducing road access to Wolverine habitat can increase Wolverine survival by reducing vehicle collisions with Wolverine and make it harder for individuals to access habitat for harvesting Wolverine. Restoring habitat is also important as it creates healthy ecosystems that Wolverine rely on. Wolverine conservation can be promoted by combining conservation measures and action for numerous species. By identifying and targeting areas and actions that benefit multiple species conservation efforts and funding can be spread further (Pacific Workshop, 2023).

To ensure appropriate management strategies and conservation measures for Wolverine, it is important to first know how the population is doing in that region (Northern Workshop 3.1, 3.2, 2023, Prairie Workshop 5, 2023, Quebec Workshop, 2023). Creating a standardized method for population abundance and monitoring techniques that are repeatable and used across the range will help create an accurate picture of where to target conservation efforts (Ontario Workshop, 2023). Wolverines are elusive, rare, and wide-ranging and it is difficult to estimate population sizes. However, due to their high detectability at baited stations and their unique fur markings, Wolverines are well-suited for non-invasive DNA and remote camera monitoring techniques. Local monitoring, by groups like Indigenous Guardians, could help collect samples and observations to help determine population sizes and status. Furthermore, genetic information can be collected and analyzed across large areas to provide evidence-based information for land-use planning and decision-making. In Canada, Wolverine population inventories have only been conducted in small pockets, and contemporary population density trends are unknown, which complicates developing appropriate management actions.

Sharing information and education is also extremely important to successful conservation. Sharing information and working together with harvesters, governments, Indigenous groups, and key stakeholders can increase the effectiveness of their conservation actions (Northern Workshop 3.1, 2023, Prairie Workshop 1, 5, 2023). Sharing information is also important to inform management decisions at all levels. Information exchange between locals and harvesters with governments can help inform policy makers and researchers on the status of Wolverine in their area. If governments and other researchers share their information with individuals and local organizations, informed and meaningful decisions can be made at the community level such as determining sustainable harvest numbers.

Educating harvesters is also an important step in conserving Wolverine as harvesting at different times of year can alter the impact harvesting has on Wolverine (Northern Workshop 3.1, 3.2, 2023, Ontario Workshop, 2023). Northern harvesters also believe that to honor the Wolverine they should only be harvested when the pelt is at its thickest and longest, often referred to as prime fur, so that the pelt is at its most valuable and is not wasted (Northern Workshop 2.2, 2023). Prime season will vary regionally but typically occurs during the coldest months of January and February. Another ethical practice is making sure to not harvest too late in the season when females may be pregnant or nursing kits, whereas trapping early increases the chance of catching a young male (Northern Workshop 1.2, 2023). Harvesting late in the season is more likely to have an impact on the population since there is an increased chance of harvesting older adults and denning females (Kukka *et al.,* 2017).

Figure 5. Visual depiction of conservation needs for Wolverines in Canada.

7. Measuring Progress

The performance indicators presented below provide a way to measure progress towards achieving the management objectives and monitoring the implementation of the management plan.

- Habitat connectivity is maintained and increased in areas of high habitat fragmentation.
- Over a 5-year period there is an observed, or inferred, increase in Wolverine population abundance in the southern portions of its Canadian range.
- Over a 5-year period there is no observed or inferred decrease in the portion of the Wolverine range that is exhibiting an increase in Wolverine population.
- The current species distribution in Canada is maintained.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[11]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[12] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself but are also summarized below in this statement.

Conservation efforts for Wolverine will have positive impacts on other species. Conserving habitat important Wolverine will positively impact other species that rely on that habitat. Given that Wolverine can be found in a wide range of habitat from mountainous regions to arctic tundra the number of species that could benefit from habitat conservation is quite large. Implementing the conservation measures highlighted in section 6.3 will also have varied, but positive, impacts on other species. Reducing the level of habitat fragmentation in the environment would benefit numerous species, especially those with large home ranges. Reducing these dispersal barriers would also benefit migratory species, such as caribou, which migrate across wide swaths of land.

Other conservation measures that focus on research could also benefit other species. Understanding how the landscape will change from climate change will be important for numerous species. Understanding how changes in shipping caused by opening in the arctic shipping lanes will help inform conservation actions for species which move between the arctic islands and mainland Canada. Understanding how forest fires will change in scope, severity and frequency will help all species who live in or rely on forested areas. Research on changes in disease and parasite presence in response to climate change will also benefit other species as they face the broad impacts of climate change. Finally, any modeling done to identify and then protect habitat refugia will be useful in conserving other species. Numerous species rely on the same habitat as Wolverine and by identifying and conserving habitat that will be suitable for Wolverine in the future these species will have suitable habitat available to them as well.

[11] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[12] www.fsds-sfdd.ca/index.html#/en/goals/

Appendix B: Canadian Wolverine Density Estimate Summary

Table 5: A summary of density estimates for Wolverine in Canada.

Ecozone	Location	Density Estimate (ind/1000km2)	Years	Source
Mountains	Wilmore Wilderness Area, Alberta	6.8	2006 - 2008	Fisher *et al.*, 2013
	Upper Rocky Mountain Foothills, Alberta	3	2004 - 2005	Fisher *et al.*, 2013
	Upper Rocky Mountain Foothills, Alberta	1.8	2005 - 2006	Fisher *et al.*, 2013
	Southeastern BC & Southwestern Alberta	2	2011 - 2016	Mowat *et al.*, 2020
	Banff, Yoho & Kootenay National Parks, BC & Alberta	3.3	2011	Barrueto *et al.*, 2020
	Banff, Yoho & Kootenay National Parks, BC & Alberta	3	2013	Barrueto *et al.*, 2020
	Banff, Yoho & Kootenay National Parks, BC & Alberta	3.6	2011	Barrueto *et al.*, 2022
	Banff, Yoho & Kootenay National Parks, BC & Alberta	2.1	2020	Barrueto *et al.*, 2022
	Adjacent to Banff, Yoho & Kootenay National Parks, BC & Alberta	0.9	2011	Barrueto *et al.*, 2022

	Adjacent to Banff, Yoho & Kootenay National Parks, BC & Alberta	0.5	2020	Barrueto *et al.*, 2022
	Omineca Mountains, BC	6.5	1995 - 1998	Lofroth & Krebs, 2007
	Columbia Mountains, BC	5.8	1996 - 1999	Lofroth & Krebs, 2007
Boreal Forest	Birch Mountains, Alberta	1.4	2016 - 2017	ACA, 2020
	Rainbow Lake, Alberta	6.26	2013 - 2016	Scrafford, unpublished report 2023
	Red Lake, Ontario	3.36	2019 - 2022	Scrafford & Ray, unpublished report 2023
Taiga	Daring Lake, NWT	6.69	2004	Efford *et al.*, Unpublished Report 2022
	Daring Lake, NWT	5.08	2005	Efford *et al.*, Unpublished Report 2022
	Daring Lake, NWT	6.1	2006	Efford *et al.*, Unpublished Report 2022
	Daring Lake, NWT	5.89	2007	Efford *et al.*, Unpublished Report. 2022
	Daring Lake, NWT	4.85	2009	Efford *et al.*, Unpublished Report 2022
	Daring Lake, NWT	2.95	2011	Efford *et al.*, Unpublished Report 2022

	Daring Lake, NWT	3.03	2013	Efford *et al.*, Unpublished Report 2022
	Daring Lake, NWT	2.99	2014	Efford et al., Unpublished Report. 2022
	Diavik, NWT	5.71	2005	Efford *et al.*, Unpublished Report 2022
	Diavik, NWT	7.02	2006	Efford *et al.*, Unpublished Report 2022
	Diavik, NWT	6.02	2010	Efford *et al.*, Unpublished Report 2022
	Diavik, NWT	4.27	2011	Efford *et al.*, Unpublished Report 2022
	Diavik, NWT	2.54	2014	Efford *et al.*, Unpublished Report 2022
	Ekati, NWT	6.51	2005	Efford *et al.*, Unpublished Report 2022
	Ekati, NWT	4.87	2006	Efford *et al.*, Unpublished Report 2022
	Ekati, NWT	4.54	2010	Efford *et al.*, Unpublished Report 2022
	Ekati, NWT	6.54	2011	Efford *et al.*, Unpublished Report 2022
	Ekati, NWT	3.88	2015	Efford *et al.*, Unpublished Report 2022
	Gahcho Kué, NWT	4.41	2005	Efford *et al.*, Unpublished Report 2022

	Gahcho Kué, NWT	4.56	2006	Efford *et al.*, Unpublished Report 2022
	Gahcho Kué, NWT	3.65	2013	Efford *et al.*, Unpublished Report 2022
	Gahcho Kué, NWT	3.12	2014	Efford *et al.*, Unpublished Report 2022
	Snap Lake, NWT	1.95	2013	Efford *et al.*, Unpublished Report 2022
	Snap Lake, NWT	2.14	2014	Efford *et al.*, Unpublished Report 2022
	Upper Turnagain Arm & Kenai Mountains, Yukon (south central)	3.0	2004	Golden *et al.*, 2007
	Old Crow Flats, Yukon (Northern)	9.7	2004	Golden *et al.*, 2007
Arctic	Aberdeen Lake, Nunavut	2.36	2013	Awan and Boulanger, 2016
	Aberdeen Lake, Nunavut	1.66	2014	Awan and Boulanger, 2016
	Henik Lake, Nunavut	4.42	2015	Awan and Boulanger, 2018
	Henik Lake, Nunavut	3.38	2016	Awan and Boulanger, 2018
	High Lake, Nunavut	6.85	2008	Poole, Unpublished Report 2013

	Izok Lake, Nunavut	4.8	2008	Poole, Unpublished Report 2013
	Napaktulik Lake, Nunavut	3.1	2018	Awan and Boulanger, 2020
	Napaktulik Lake, Nunavut	4.14	2019	Awan and Boulanger, 2020

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Appendix C: Threat Assessment Table for the Wolverine

Following updated guidelines, a new Threat Assessment Table is required for this Management Plan. The updated Threat Assessment Table is being developed using the information used to develop this management plan, including, but not limited to, the Indigenous Knowledge shared during the workshops held for this Management Plan and the available western science. The updated threats table will be consistent with the threats section of this Management Plan and will not contain any new information or identify any threats that are not in the threats section of this management plan. The updated table will be added as soon as possible and will be included before the 60 day public comment period occurs.