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# Management Plan for Reducing Wolverine (Gulo gulo) Habitat Fragmentation in Canada: Travel Corridors Between Tonsa Peak and Stuart Knob

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## Problem Statement and Background

Wolverines (*Gulo gulo*) are large, terrestrial mammals within the mustelid family typically found in the western United States, Alaska, and Canada. Long legs, and large, semi-retractable claws allow wolverines to navigate through deep snow and climb trees. Generally, a wolverine will live in solitude, except for females with young. Wolverines require large home ranges that include forest areas, dense snow cover, and high elevations (Woodford 2014). Because wolverines can travel up to 25 kilometers in a day, they need a home range size of 160 to 1,000 square kilometers (World Wildlife Federation 2022). Males will generally have a larger home range than females, using more than double the area of females in some instances (Krebs et al. 2007). Wolverines also require snow for caching food and giving birth in snow-covered dens (Woodford 2014). Connectivity between suitable habitats is necessary for wolverines to have increased gene flow and reduced genetic isolation between individuals and populations (Sawaya et al. 2019). Their sizeable home range often makes connectivity a concern. Wolverines have an elusive nature, which makes observing their movements and behaviors more challenging and further complicates managing their populations. In fact, wolverines are currently listed as *Data Deficient* in Alberta, Canada because researchers do not have sufficient data to determine the severity of potential threats to wolverine populations (Alberta Conservation Association 2020). However, we do know human-caused habitat fragmentation poses a major issue for wolverines.

Wolverines adjust their behavior in response to anthropogenic effects, including roads, infrastructure, and winter recreation. Scrafford et al. (2018) found that when near a road, a wolverine's speed increases as it passes more cars as a defense to avoid threats and escape more quickly. Roadways deter wolverines (Scrafford et al. 2018), indicating they adjust their habitat use and navigation of home range based on the presence of roads. Additionally, May et al. (2006) observed wolverines avoiding areas impacted by anthropogenic effects, such as those from logging, infrastructure, and recreation. Areas untouched by humans have increased prey availability because wild reindeer also exhibit sensitivity to human development, which contributes to wolverine preferences for these uninhabited areas (May et al. 2006; Nellemann et al. 2003). Winter recreation negatively influences wolverines, as observed through adjusting their movement and avoiding recreation near roadways and human development strongly (Heinemeyer et al. 2019). Heinemeyer et al. (2019) established that disturbances from skiing, snowboarding, and snowmobiling more strongly impact habitat selection of female wolverines than males. Avoidance by wolverines can further increase habitat fragmentation, as human development and effects may force wolverines to inhabit a smaller area or bypass entire sections of their home ranges. Thus, anthropogenic effects have negative ramifications for wolverine habitat selection and use.

Another consequence of fragmented habitats in wolverines involves the restriction of gene flow. Habitat fragmentation inhibits gene flow, indicating that wolverine survival depends on connectivity (Sawaya et al. 2019). A lack of connectivity between wolverine habitats and within home ranges can cause genetic isolation within populations (Sawaya et al. 2019). Reduced gene flow decreases biodiversity in wolverines and, therefore, presents a large issue. Balkenhol et al. (2020) concluded that the density of human housing developments and other infrastructure best predicted gene flow among wolverine populations. As a result, connectivity between wolverine habitats is vital, especially in areas used by wolverines while dispersing and where high human density can potentially reduce gene flow (Balkenhol et al. 2020). Genetic isolation results from wolverine habitat fragmentation and avoidance behaviors and may lead to decreased fitness in wolverines.

Tonsa Peak in Alberta, Canada and Stuart Knob in Banff National Park provide snow-covered habitats at high elevations with some forest area. Tonsa Peak is located approximately 17 kilometers from Stuart Knob and both feature snow cover for caching and denning, high elevations, and low anthropogenic effects, which provide suitable wolverine habitat when combined. Habitat fragmentation is a concern between these peaks because of the Trans-Canada Highway, the Bow Valley Parkway, and Protection Mountain Campground. The Trans-Canada Highway is the biggest road running east to west in Canada with over 17,000 vehicles each day (Clevenger and Barrueto 2014), and its traffic in 2019 was twice the volume of 2009 (Sawaya et al. 2019). Clevenger and Barrueto (2014) also found that the Trans-Canada Highway has influenced gene flow negatively within female wolverines. While Tonsa Peak and Stuart Knob provide habitat requirements of wolverines, these major highways and the campground pose a challenge for wolverines navigating between the two areas. For managing Tonsa Peak, Stuart Knob, and the area between, the Wildlife Conservation Society (WCS) Canada has the primary goal to provide connectivity between suitable and critical wolverine habitat.

Management Objectives

WCS Canada has two objectives to achieve connectivity between wolverine habitats. The first objective involves WCS Canada constructing one wildlife underpasses to allow wolverines to avoid the Trans-Canada Highway, Bow Valley Parkway, and Protection Mountain Campground.

Travel corridors allow wolverines and other species deterred by anthropogenic effects to safely navigate across roadways. WCS Canada will require two years to build the underpass and install fencing that guides wolverines to the entrances. To monitor whether the wildlife underpass provides increased connectivity, we will use camera traps to remotely determine how frequently wolverines use the corridor. WCS Canada has a second objective to increase gene flow between wolverines divided by the major highways and campground. We will use non-invasive camera and hair-snag stations with beaver carcass as a bait. We will place stations in several locations within the management area during the first two years to provide a baseline of gene flow. To monitor gene flow in following years, we will place barbed wire hair-snags in correlation with cameras on both sides of entrances to the travel corridor. We will collect and use DNA analysis for hair samples and check camera traps weekly for three years and then reevaluate management practices for the future based on our findings.

Management Actions and Monitoring Plan

**Construction of Travel Corridors**

To combat habitat fragmentation and increase connectivity in wolverines, WCS Canada will build one wildlife underpass that runs below the Trans-Canada Highway and the Bow Valley Parkway (Figure 1). WCS Canada chose an underpass because studies have shown other predators, like mountain lions and black bears, prefer more covered crossing structures (Clevenger and Waltho 2005). WCS Canada will use a three-sided concrete culvert for the underpass, which will be 8 meters wide and 5 meters tall to specifically accommodate medium- and large-sized mammals (FHWA 2011). The wildlife underpass will span 1.3 kilometers (1300 meters) in length from 51°18’45” N 116°01’46” W at the base of Tonsa Peak to 51°19’01” N 116°00’43” W at the base of Stuart Knob (Figure 1). We will include fencing to guide wolverines and other wildlife to the travel corridor and away from the road. The fencing will start 20 meters before the underpass and will be in a V-shaped formation, with narrower fencing closer to the underpass entrance. The underpass will have native soil for the substrate and the sides will be lined with brush and root wads, as this increases the probability that wolverines will use it (FHWA 2011). We will also include lights every 10 meters to allow for visibility. Because of the wolverine's sensitivity to anthropogenic impacts, additional sound-attenuating concrete will be used at entrances to decrease effects of noise from vehicles overhead (FHWA 2011). This three-sided concrete culvert will take approximately two years to construct. Sawaya et al. (2014) observed increases in gene flow in grizzly bears across the Trans-Canada Highway after constructing a travel corridor. Clevenger and Barrueto (2014) also found evidence indicating female wolverines use wildlife crossings, and a genetic difference exists between females on opposite sides of the Trans-Canada Highway. The development of a travel corridor provides wolverines the ability to safely cross, avoid major roadways and recreation, and increase connectivity.


**Figure 1.** Screenshot from Google Earth of management area. Tonsa Peak and Stuart Knob are represented with yellow pins, and the wildlife underpass will be located along the yellow line.

**Baseline Gene Flow Assessment**

To establish a baseline for gene flow on different sides of the highways, WCS Canada will place five camera and hair-snag stations in the forests on either side of the wildlife underpass. At each station, we will use a beaver carcass as bait to attract wolverines (Magoun et al. 2011). We aim to attract wolverines, obtain several images, and snag a hair sample to determine differences in genes from wolverines on each side of the highways. Sawaya et al. (2019) established that a genetic difference exists between female wolverines on either side of the Trans-Canada Highway, but we want to obtain more specific data from our management area. In combination, the camera traps and hair snags can provide valuable data used to individually identify wolverines and assess genetic variation (Magoun et al. 2011). We will collect hair samples and check cameras weekly for the first two years while building the travel corridor. Batteries and memory cards of cameras will be replaced each month.

Our camera and hair-snag stations will be set up according to the following procedures from Magoun et al. (2011) (Figure 2). We will tie a cable between two trees to hang the beaver carcass. On one tree, we will construct a platform for wolverines to use to access the bait. On the platform, we will include a hair-snag post with several barbs connected to a support structure the wolverines can use to reach the bait. We will place a camera on the second tree at the same height as the platform to take images when triggered by a wolverine.

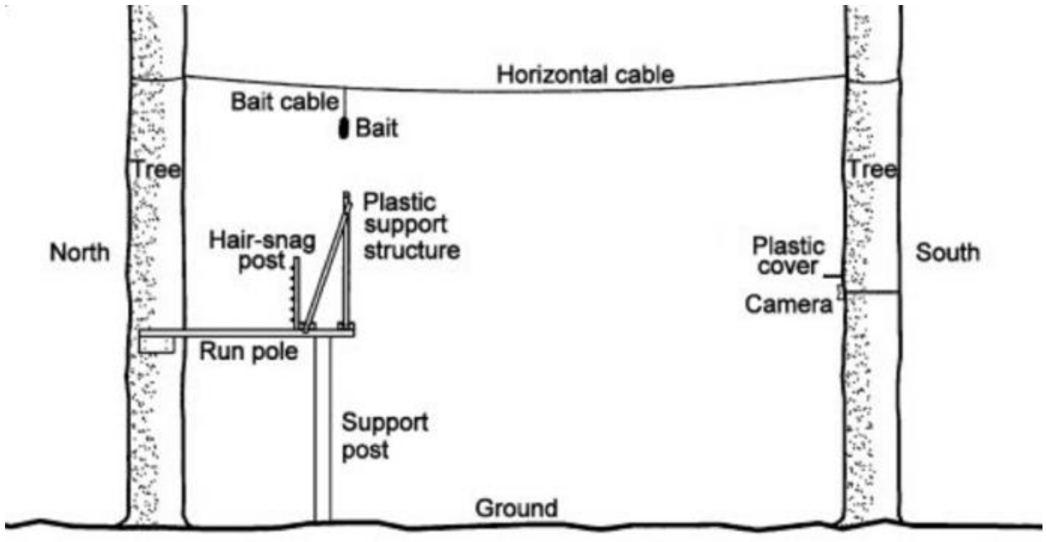


**Figure 2.** Camera and hair-snag station set up. Image retrieved from study using similar methods to identify wolverines with camera and hair-snag stations (2011).

The images and hair samples will be used together to identify individuals. Using ventral patterns on the chests of wolverines, we will visually differentiate between individuals at the stations (Magoun et al. 2011). We will then extract genomic DNA from hair samples to identify sex and genotypes of different individuals (Magoun et al. 2011). We will look for genetic similarities and differences among wolverines on the same side of the highways and between the two sides. This data will provide a baseline of gene flow and its current status in the management area. Our objective is to increase gene flow by at least 10 percent; however, we may increase this value based on our findings in the initial gene flow assessment.

**Monitoring via Camera Traps and Hair Snags**

To monitor the effectiveness of the underpass at providing connectivity, WCS Canada will use four thermal infrared camera traps and barbed wire hair-snags. Camera traps will allow us to physically see the wolverines using the underpass, and the hair samples will aid in determining if gene flow increases between opposite sides of the Trans-Canada Highway. Two cameras will be placed at each entrance to the wildlife underpass to allow two different angles of the wildlife using the structure. Ventral patterns of wolverines are an important tool to visually distinguish between individuals, so two cameras will increase our chances of differentiating between wolverine individuals. On either side of the entrance, we will place barbed wire snags in correlation with camera traps to collect hair samples from wolverines that use the underpass. WCS Canada will check camera traps and collect hair snags weekly, recording all data for wolverines and other species. We will replace camera batteries and memory cards monthly, and we will maintain the barbed wire hair snags, as necessary. We will use camera traps to assess how frequently wolverines are crossing and to see ventral patterns on the chests of wolverines. We will also use DNA analysis of hair samples to extract genomic DNA and determine information about each individual's sex and genotype (Magoun et al. 2011). WCS Canada will continue this study for at least three consecutive years after construction to allow us to assess our success in identifying individuals over several years and our overall success in providing connectivity between critical wolverine habitats. WCS Canada will then base our decision to continue monitoring with both camera traps and barbed wire snags on the data collected and conclusions drawn in previous years.

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