Red Lake Wolverine Project Field Report Winter 2020-2021

WCS CANADA

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Red Lake Wolverine Project Field Report 2020/2021

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10 Cumberland St. N
Thunder Bay, Ontario, P7A 4K9, Canada
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SUMMARY

Wildlife Conservation Society Canada's current wolverine study has been ongoing in Red Lake, Ontario since 2018. Our study involves identifying individual wolverines with bait stations and live traps to estimate wolverine abundance, collect biological samples, attach GPS collars. We then track wolverines to document foraging behaviours, sources of mortality, and reproduction. Our major accomplishments thus far include:

- Building 29 live traps and 10 run poles across a 5,470 km^2 study area.
- Monitoring 45 wolverines with GPS collars: 14 females and 31 males. We confirmed an additional 14 wolverines on camera that we were not able to live trap, bringing the total to 59 known wolverines in our study area.
- Collecting over 54,000 GPS locations from collared wolverines which has enabled us to understand wolverine home-range size, territory overlap, dispersal movements, habitat use, and denning behaviour. Notably, M31 dispersed over 350 km from Red Lake during spring and summer 2021 and now lives on the northwest edge of Lake Winnipeg.
- Documenting 10 wolverine mortalities: 8 human caused and 2 from predation.
- Visiting 88 "clusters" of GPS points to investigate wolverine activities. We found prey remains at 52 clusters with the majority of remains from moose and beaver.
- Locating 5 reproductive dens and working with the Ontario government to create best-management practices for protecting these areas.
- Collecting 292 wolverine biological samples: 147 scat samples, 75 hair samples, 26 blood samples, and 44 tissue samples.
- Providing the Cascades Carnivore Project with 132 wildlife tracks to help understand the accuracy of wolverine track identification by citizen scientists and professionals.
- Working with grade 12 students at Red Lake District High School to develop and write scientific reports using field data we have collected.
- Participating in the filming of a documentary on wildlife in the Great Lakes region.

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BACKGROUND

Wolverines once occupied all of Canada except for the easternmost portions of the Maritimes and portions of the Arctic tundra. Their distribution included the Great Plains and Great Lakes region although it is unknown whether these areas supported reproductive populations or were a dispersal front for wolverines. Wolverine range receded with wolverine mortality and habitat conversion associated with European settlement of North America, with range recession occurring mostly in southern and eastern portions of the lowland boreal forest and throughout the Great Plains (COSEWIC 2014).

Wolverines were historically distributed throughout Ontario's lowland boreal forest and Hudson Bay Lowlands. But after European settlement wolverines were only found in the northwest corner of the province. Wolverines have since slowly recovered to northcentral and northwestern Ontario and have been observed as far south as 50° N latitude (e.g., Dryden) and as far east as 84° W longitude (e.g., Hearst) (Ray et al. 2018).

Wolverines were listed as threatened in Ontario under the *Endangered Species Act, 2007*, as it is believed there are fewer than 1000 individuals remaining in the province. Scientists drafted a Wolverine Recovery Strategy (2013) in response to their listing and the Ministry of Natural Resources and Forestry (MNRF) followed with a Government Response Statement (2016) that prioritized research and conservation measures for wolverines in Ontario. Many of these measures were associated with understanding the effects of fur harvest and commercial forestry on wolverine abundance and distribution.

Our wolverine field project was designed to address 6 action items in the Government Response Statement including:

- Producing data that quantifies wolverine abundance in Red Lake and across the Ontario shield (Action #1).
- Determining wolverine habitat use and den-site selection in response to industrial disturbance (Actions #2 and #4).
- Developing best-management practices for human activities in wolverine habitats (Actions #7 and #13).
- Promoting public awareness of wolverines through targeted communication products (Action #14).

Our field work began in Red Lake in the spring of 2018 and centers around documenting wolverine movement, distribution, and abundance with the use of live traps, GPS collars, and run poles. We chose Red Lake because of our history of working in the area and because of the extensive commercial forestry and mining activity. This project report summarizes some of the data that we have collected in Red Lake over our 4 field seasons.

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Project funders include the W. Garfield Weston Foundation, the Ontario Species at Risk Stewardship Fund administered by the MECP, Evolution Mining, Domtar, The Donner Foundation, The Fitzhenry Foundation, The Wolf Foundation, Oak Island Films, and The Schad Foundation. The field crew is comprised of Wildlife Conservation Society Canada scientists, seasonal technicians, and local trappers.

METHODS & RESULTS

Wolverine captures/detections

An accurate estimate of wolverine abundance is necessary for managers to assess the current status of wolverines in Ontario and to use as a baseline assessment for future monitoring. We are estimating wolverine abundance in Red Lake by identifying the number of unique individual wolverines at live traps and run poles. We bait live traps with trapper-donated beaver carcasses (**Fig. 1;** also see blog post). When a wolverine pulls on the beaver bait in the trap, the trap lid closes, and a satellite transmitter immediately notifies us of the capture location. We anesthetize and attach ear tags to wolverines captured at live traps. We also take hair and tissue samples, weight, physical measurements, and attach a GPS collar.

Run poles are used to identify individual wolverines and also are baited with trapper-donated beaver carcasses (**Fig. 2**). When the wolverine climbs the run pole to access the bait, a motion-sensor camera opposite the bait takes pictures, hopefully with a clear view of the wolverine's chest. We can identify known wolverines at run poles with ear tags or GPS collars and unknown wolverines by identifying their unique chest markings. Moreover, barbed wire on the run pole snares hair samples for DNA analyses.

We initially established 10 live traps in the spring of 2018 and added 13 new live traps and 5 run poles in the winter of 2018/2019, 5 new live traps and 4 run poles in the winter of 2019/2020, and 1 new live trap and run pole in the winter of 2020/2021. In total, there are 29 live traps and 10 run poles distributed throughout our 5,470 km^2 study area (**Fig. 3**). Live traps and run poles have been operational for a total of 9,815 trap nights (number of live traps and run poles baited and open multiplied by the number of nights) over the course of the project. For live traps specifically, traps were operational for 259 trap nights in the spring 2018 field season, 2,321 trap nights in the winter 2018/2019 field season, 2,789 trap nights in the winter 2019/2020 field season, and 3,252 trap nights in the winter 2020/2021 field season. The increased number of trap nights over the years is due to the increased number of live traps that we have built since the project began.

We have collared 45 individual wolverines (14 females and 31 males) at our live traps. The average female wolverine weight was 9.7 kg and the average male weight was 13.6 kg (**Table 1** includes additional measurements). We also identified 14 additional wolverines at live traps and run poles (wolverines we have been unable to capture) based on photographs of unique chest patterns (**Table 2**). This brings the total number of individuals detected at live traps and run poles to 59.

We have detected wolverines at live traps and run poles distributed across our study area (**Fig. 4**). For example, 5 different wolverines were first detected at a live trap to the east of Little Vermillion Lake (Silver). The majority of our captured wolverines only visit the same 1 or 2 traps (**Fig. 4**). Individual wolverines were often detected across multiple field seasons with F01 the only wolverine detected in each of our 4 winter field seasons (**Table 2**).

Initial population estimate

A simple but rough method to calculate wildlife population size is called the Lincoln-Peterson (LP) estimator. The LP method relies on capturing and marking individuals in one field session and then estimating the ratio of marked versus unmarked individuals captured in subsequent field seasons to understand what proportion of the population is likely being detected by the research. The LP estimate was 25 wolverines in our trapping area in winter 2018/2019, 58 in 2019/2020, and 79 in 2020/2021. When this population estimate is divided by the area that our traps cover (5,470 km^2), we get a density estimate of 4.5 wolverines/1,000 km^2 in winter 2018/2019, 10.6 wolverines/1,000 km^2 in winter 2019/2020, and 14.4 wolverines/1,000 km^2 in winter 2020/2021. We caution that the trapping area we used is likely inaccurate because we are detecting wolverines from a much larger area than just the footprint of our live traps and run poles. This results in our population density likely being overestimated. We will be using more advanced methods in the future to ensure a more robust estimate of our trapping area.

Tracking wolverines

The wolverine GPS collars have enabled us to document wolverine den use, foraging, and habitat use. This information has and will be important for developing best-management practices for wolverine habitats in areas with commercial forestry. The GPS collars are programmed to take GPS positions every 2 hours for ~ 6 months until a mechanical buckle on a timer triggers and the collar falls off the wolverine. Alternatively, we can recapture the wolverine in a live trap and remove the collar on our own. There are 10 wolverines from previous field seasons who may still be wearing their GPS collars – future work will aim to remove these collars through recaptures or verify the collar fell off with photographs.

We collected over 54,000 GPS locations from 42 wolverines (13 females and 29 males) between March 2018 and August 2021 (**Fig. 5**). The median (minimum, maximum) number of GPS locations from males was 1,055 (301, 3,866) and from females was 1,527 (283, 4,793). About 2/3 of our GPS locations have been from the summer relative to the winter because we capture many of our wolverines in late winter. Below we provide information that we have acquired from this GPS data including wolverine home-range size, home-range distribution, exploratory and dispersal movements, and foraging sites.

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Home-range size

We calculated average female home-range size (polygon surrounding 95% of the wolverine's GPS locations) across years as 916 km^2 (**Table 3**). Please note that we only report home-range size for wolverines who did not display significant dispersal movements. F05 had the smallest home range of any female (128 km^2) and was positioned along the Nungesser Road. The largest female home range was F12 who used an area of 3,049 km^2 (**Fig. 6**). The average male home range size across years was 1,298 km^2 (**Table 3**). The male with the smallest home range was M27 (83 km^2) but we suspect we did not monitor him long enough to get a suitable estimate of his home-range size. Wolverine M21 had the largest home range at 3,039 km^2 (**Fig. 7**). We noticed that M21 and M25 had home ranges that overlapped and at times these wolverines even travelled together. We suspect that M21 is a resident male and potentially the father of M25.

Home-range size: change over time

We investigated change in the location of wolverine home ranges from one season to the next. Again, note this analysis only applied to wolverines that did not have dispersal movements. As expected, we did not find any wolverines with static home ranges across years or seasons (**Table 4**). Males and females showed evidence of both home-range expansion and contraction across time (**Fig. 8A; Fig. 8B; Fig. 9A; Fig. 9B**). There are likely many reasons for these patterns including changes in age and status of wolverines (juvenile versus adult), competition from other wolverines, duration of GPS monitoring, or reproductive status. For example, F01 decreased her home range size by 26% in the winter of 2020/2021 relative to 2019/2020 (**Table 4; Fig. 8A**). This decrease could be associated with localized movements after parturition in spring 2021. M16's home range expanded in size by nearly 50% and encompassed areas used by both F01 and F06 (**Fig. 9A; Fig. 9B**). Relatedly, wolverine M02 decreased his home-range size in 2020 compared to 2019, possibly due to the presence of M16 in that area. M17's home range grew by 86% in winter 2021 but shifted entirely out of the Dixie Road area to the southeast, so much so that he only used 5% of his previous range from winter 2020. M21's home range also shifted to cover only 60% of the area he occupied in winter 2020 (**Fig. 9A; Fig. 9B**). Both M17's and M21's home-range shifts might be due to establishing their own territories and moving from natal areas.

Dispersal or exploratory movements

M31 was first live trapped on March 28th, 2021 in the Snake Falls area and by March 31st he began travelling in a relatively straight trajectory towards the northwest (**Fig. 10**). He arrived at the northeastern shore of Lake Winnipeg, Manitoba on May 2nd – this was a straight-line distance of 351 km that he covered in ~ 32 days. His actual travel path was not perfectly straight and thus much further. After he arrived at the shore of the lake he went out on the ice before turning back towards shore again. He has been living in a swampy area close to the shore ever since.

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F05 embarked on an exploratory movement on March 22nd to the northeast of her home range (**Fig. 10**). By April 8th she had gone 65 km at an average straight-line speed of 4 km/day. She then returned to her home range in 5 days at a rate that was over 3 times faster than the speed at which she left. She has since stayed within her usual home range.

F12 began travelling south of her home range on July 19th. She moved ~100 km before her collar dropped off on July 28th to the east of Perrault Falls.

Foraging sites

We have visited a total of 88 GPS "clusters", or concentrations of GPS locations from individual wolverines, since the project began. We typically visited a GPS cluster once the wolverine had been there for over 4 hours. The majority of clusters we visited contained a resting or bed site (a circular indent in the snow or dirt) and a latrine (a concentration of scat deposited in the same place) (**Fig. 11**). We have found evidence of prey remains at 52 of these clusters and some clusters contained more than 1 prey species. Of these 52 clusters we have found evidence of 30 with moose remains, 11 with beaver remains, and 5 with snowshoe hare remains (**Fig. 12**). Additionally, there were 2 sites where wolverines foraged on black bears, 2 sites where wolverines foraged on caribou, and 1 site where a wolverine foraged another wolverine. We occasionally saw different wolverines overlapping spatially or temporally at the same GPS cluster, especially when the cluster was a moose carcass (**Fig. 11**). Below we describe in more detail what we found at a few of these foraging sites.

Black bear
M16 spent 5 days concentrated in the same area in early January. We hiked in from the Chukuni Road and found that M16 was foraging on a dead black bear (**Fig. 13**). The bear was small and appeared old due to tooth wear. Although we searched the area, we are unsure if the bear was killed by M16 or another predator. We also are unsure if the bear was killed near its den.

Beaver
M16 spent 3 weeks at a riparian area off the west edge of Willans Lake. We hiked into the cluster once we knew he left and found evidence that he had killed numerous beavers (**Fig. 14**). There were beaver tracks and trails through the snow from a beaver lodge, suggesting that the beavers had exhausted their underwater cache and were foraging for food on land when M16 killed them. We also found evidence that M16 had dug into the beaver lodge but there were no prey remains at the lodge We followed wolverine trails into the forest on the north edge of the creek where there were well-used bed sites and latrines about 50 m apart (**Fig. 14**). More details and pictures of this cluster can be found in our recent blog post on tracking wolverines.

Moose
We noticed that F11, F12, and M26 were in the same area at the edge of a lake over a span of 16 days at the beginning of March. We hiked into the cluster when the wolverines left and found the remains of a moose - all that was left was a carpet of moose hair covering a grassy area at the edge of the lake and 1 bone (**Fig. 15**). This area was fairly open and there were well-used trails into the forest where we

found beds and scat. It was interesting to see these 3 wolverines overlapping in the same area which suggests they may be related or tolerant of others when there is abundant food.

Caribou
We were paying special attention to F06's movements in late March because she was denning. We noticed her movements were concentrated in a specific spot of mature forest off of South Bay Road. As we approached this site, we found a concentration of 5 caribou beds and nearby we could see eagles and ravens circling. We first noticed caribou fur stuck in the bark of the trees at chest height and then we found a young-male caribou that was recently killed (**Fig. 16**). It was clear that F06 was eating and carrying off parts of the caribou. However, we are unsure what killed the caribou but suspect it was not wolves because of how much meat was remaining.

Wolverine reproductive dens

Each spring we closely monitor collared females to determine if they are denning. We use a few pieces of evidence to justify searching for a wolverine reproductive den: a female expressing milk from her teats during handling, localization of female movement during the reproductive period, and missed GPS locations from a female collar during the reproductive period. The missed GPS locations generally occur because a female is in a den structure and the collar cannot acquire satellites for an accurate location. Sometimes days or weeks will pass before a collar can take a location because the female does not often leave the den while the kits are young. We are generally only able to track a female successfully to her den after the female begins to emerge again. If we are lucky, the collar will provide a few GPS locations near the den but often these locations are still many kilometers away from the actual den site. We locate the den using an antenna to track the VHF signal from the GPS collar – this is generally done on foot or during a flight. However, the signal generally only carries 1-2 km in the bush which makes this task difficult at times! Ideally, the female is in the den when we track her which allows us to determine the structure she is using and set up a camera. We have located 5 reproductive dens so far: 3 in tree-root balls, 1 in a slash pile, and 1 in a rock crack (**Figures 17, 18, & 19**). Below we discuss the behaviours of known reproductive females in our study area this winter.

Wolverine F01
Starting in February, F01 began missing some GPS uploads which indicated that she may be inside a structure without a clear view of the sky for her collar. On February 14th, we noticed a small cluster of GPS points off Primok Lake that ended up being trails and chewed moose bones. On February 20th, after more than a week without a GPS upload, F01 uploaded 2 points in a forested area to the southeast of Sobel Lake. We heard her VHF signal in this area and found her within a root ball with a small entrance hole (**Fig. 18**). There was a worn spot at the entrance hole indicating that she was standing outside the structure but not often leaving the den. The area was mostly lowlands with forested bogs/fens and marshes. We are unsure if she moved from this location because the battery of F01's collar died soon after we found her den. We suspect M16 is the father of her kits.

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Wolverine F06
There was no indication that F06 was pregnant or lactating when she was caught on January 12th. But come March we noticed that her GPS locations were forming a cluster off South Bay Road. We assumed this was a foraging site because there were few missed GPS fixes or uploads. We visited this site on March 4th and found 1 dead and 1 live kit in a shallow-faced root ball (**Fig. 19**). We have photos of F06 returning after we left and we suspect she moved her live kit to another location. We revisited the original den location later in the spring and found what we believe was her natal den structure within 50 m of the den where the kits were found. This was a root ball from a fallen tree which is a typical den for the lowland boreal forest (**Fig. 19**). The den was situated along a riparian corridor in mature forest. We noticed early-seral cutblocks on the ridges above the riparian area and the remains of snowshoe hare scattered around the den site. We also believe that M16 is the father of F06's kits.

Wolverine F14
F14 was captured off Sidace Road on March 20th and was lactating. We were not able to search for her den because her home range was relatively inaccessible. She also was not missing many GPS location uploads or spending much time in the same area which made it hard to pinpoint where to search for her den. The growth of teats and lactation is not always a guarantee that a female is denning or had kits – the development of teats can occur simply if the female ovulated and bred, with or without fertilization.

Wolverine F05, F07, and F09
During winter 2019/2020, we found the dens of F05 and F07 and suspected F09 of denning based on missed collar uploads. F05 was captured during the reproductive period this winter and she did not show any evidence of pregnancy. F07 and F09 were not live trapped this field season but they were both seen on camera in our study area.

Wolverine mortalities and injuries

We've documented 10 wolverine mortalities: 4 during winter 2019/2020 and 6 during winter 2020/2021. Of these 10, 6 were associated with fur harvest and 2 were vehicle collisions. Interestingly, the 2 wolverines that were hit by vehicles (M07 and M09) were also missing their front-right paws from suspected injuries in marten sets. We also found 2 wolverines (F08 and M17) that were killed through predation this winter. F08 was killed by wolves off the Joyce road (**Fig. 20).** M17 was found dead near Portal Lake west of Perrault Falls but we are unsure what killed him. We found his remains cached in the dirt under a log with only part of his head and upper arms remaining (**Fig. 21**).

We saw evidence of fights between wolverines, particularly in March when the reproductive period can make wolverines more aggressive and there might be pressure for juveniles to disperse. M16 had a wound on the top of his head, M23 had a cut and loose skin on the top of his head, M24 had bites and lacerations on his face and neck and his ear was torn (**Fig. 22**), and M26 had scratches on his face. We removed the collars from both M23 and M24 so the collar would not interfere with healing. We also caught a new wolverine at the end of March that was too badly injured for us to handle (**Fig. 22**). We released him and did not catch or see him again on camera.

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Wildlife at live traps

Wolverines were live trapped 79 times in winter 2020/2021 while other wildlife, including lynx, fisher, fox, and marten, were live trapped 84 times (**Fig. 23**; **Fig. 24**). Besides live captures, we also have data on how often wildlife show-up or were detected on cameras at live traps. We found that martens were most often detected at cameras at live traps (seen 1089 days at 27 traps), followed by lynx (seen 349 days at 27 traps), then wolverines (seen 227 days at 22 traps) (**Fig. 25**). Wolves were photographed at 4 live traps and we live trapped 1 this winter. Fishers were photographed at 9 traps, foxes at 8, moose at 7, and a coyote at 1 (**Fig. 25**). Wolverines were most frequently photographed at our live traps in the early evening and in the morning at approximately 7:00 a.m. (**Fig. 26**). Lynx, fishers, foxes, and martens were photographed at live traps through all hours of the day (**Fig. 27**).

Wolverine biological samples

We have collected 292 biological samples– 75 hair samples, 147 scat samples, 26 blood samples, and 44 tissue samples. These samples are being analyzed at the University of Toronto and the Toronto Zoo to assess stress levels, reproductive hormone levels, and to determine prey within wolverine diets. We aim to use our tissue samples for DNA analysis to understand the relatedness of wolverines in the Red Lake area. We are also initiating a collaboration with the Minnesota Zoo to compare hormone levels in scats of captive wolverines to our wild samples.

Road cameras

We have distributed cameras on roads throughout the Red Lake area with the goal of understanding road characteristics (e.g., road age, road type, surround habitat, snow cover) that promote use by wolves, wolverines, bears, and other wildlife. We are particularly interested in how wolves and wolverines may use roads and encounter one another. We have deployed road cameras over 4 years, with 54 road sections monitored in the winter of 2018/2019, 19 in the summer of 2019, 58 in the winter of 2019/2020, 19 in the summer of 2020, and 17 in the winter of 2020/2021.

Carnivore track project

We helped collect data for a wildlife track study started by the Cascades Carnivore Project in Washington, USA (cascadescarnivore.org). The aim of the project is to evaluate the ability of biologists and other wildlife specialists to correctly identify pictures of wolverine tracks from other carnivore tracks submitted by the public. Our Red Lake project is in the unique position of being able to assign tracks to wildlife with certainty because we can track them after they are released from the live traps. These photos are then used to test the biologists on their track-identification ability. Check out our recent blog post for more information on this project. Over two winters we have collected 132 tracks to support this project– 83 from wolverines (**Fig. 28**), 27 from lynx, 11 from wolves, and 11 from other species.

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Red Lake District High School Volunteering

For the 2nd year in a row, grade 12 students at Red Lake District High School were involved in our wolverine field research. We gave a presentation to students on wolverine ecology and research and students used our field data to write scientific reports. Our field crew helped guide the development of student reports and offered comments and review of their final drafts. Our overall aim was for students to learn about the scientific process, careers in biology, and wolverine conservation.

Great Lakes Documentary

A film crew joined us in the field to document our wolverine work. Our wolverine project will be featured in a larger documentary on wildlife in the Great Lakes region by fall 2022.

DISCUSSION AND FUTURE PLANS

One of our primary goal since the project began has been to have a large enough sample of female wolverines to understand their habitat use, survival, and reproductive ecology. This at times has been a struggle for the project but we are starting to see our work pay off. This winter we increased our sample of female wolverines to 14 and have collected enough GPS data from 13 females for many of the analyses we want to complete. These data have allowed us to differentiate between resident and juvenile females and understand how their spatial distribution is affected by human disturbance.

We have increased our sample of reproductive dens to 5 after finding 2 new dens this past winter. The dens have been located in a variety of structures including root balls, slash piles, and rock cracks. What is obvious to us is that females are looking for areas of structure within their ranges to locate their dens. This can be rocks but also downed trees which tend to be more available in mature forests and forests in wetland or riparian areas. Snow provides an important secondary structure and insulator for these earth structures. Some dens are in remote areas while others are in areas that are relatively disturbed with recreation and commercial forestry. This variability in den-site selection might be related to individual wolverine behaviours or simply be representative of the availability of habitats in their range. The variability also speaks to the uncertainty associated with small sample sizes and therefore the importance of increasing sample sizes to understand general patterns.

Our capture and GPS data indicates females are scattered around the landscape at a relatively low density compared to males. We have detected a minimum of 59 unique wolverines in our ~5,470 km^2 study area over 9,815 trap nights. There are 45 wolverines with ear tags - 14 are females and 31 are males. This ~ 1:2 ratio of females to males has been present since the project began. We can only speculate why this pattern persists, but potential mechanisms include poor-quality habitat for females or that Red Lake is either the current or historic range edge for Ontario’s wolverine population. For the latter, if Red Lake is the range edge than core wolverine habitat is likely to the north. The wolverines that disperse to Red Lake might be comprised more of males because males, rather than females, are more likely to disperse long distances from the core. We intend to analyze this question in the future with our DNA data.

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We continue to better understand sources of mortality for the wolverines we are tracking. We have documented 10 mortalities among 45 collared wolverines: 2 from vehicle collisions, 2 from predation, and 6 from fur-harvest activities. There have been 3 wolverines with injuries from fur-harvest activities. These data suggest that human-caused mortality, particularly fur harvest, is the primary source of wolverine mortality in the larger Red Lake area. Wolverines are scavengers and are attracted to trapper sets even if the area is used by humans. Potential solutions to this issue include the use of traps that increase the likelihood of killing the target species instead of wolverines. Other solutions include reducing the use of large-bait piles or ceasing trapping activities when wolverine tracks are near trapping sets.

We are excited about our collaborations and what they add to our understanding of wolverine ecology in Red Lake and throughout North America. Our biological sample collaborations with the University of Toronto, Toronto Zoo, and the Minnesota Zoo is allowing us to understand what physiological effects commercial forestry might have on wolverines in Red Lake, particularly stress effects associated with cortisol concentrations. We are also starting to understand hormone signatures in female scats and how that might provide clues on their reproductive status. Our collaboration with the Cascades Carnivore Project is helping to better understand the reliability of wolverine track identification by both biologists and non-biologists. Tracks are easy to mistake in the field but are also very important data for non-invasively monitoring wolverine distribution.

We aim to have a field season later in the winter of 2021/2022. The primary goals of this field season will be to remove GPS collars that have not dropped off already and to collar additional wolverines, particularly females, so we can identify further denning areas. We anticipate this coming field season being the last winter of telemetry.

WOLVERINES IN THE MEDIA

Wildlife Conservation Society Canada wolverine story map.

Red Lake Wolverine Project Field Report 2019-2020.

Wolverine: Ghost of the Northern Forest film.

Building a wolverine trap.

Collaborating with the Cascades Carnivore Project.

Tracking wolverines.

Wildlife response to forest fires in Ontario.

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FIGURES

Figure 1. Wolverine M17 at the entrance of a live trap in Red Lake, Ontario. The wolverines are attracted to the beaver bait inside the traps. When the wolverine pulls on the bait, the trap door closes and the satellite transmitter (attached to the plywood on the crossbeam) notifies us through email that the trap is sprung.

Figure 2. A wolverine on a run pole in Red Lake, Ontario. Much like the live trap, the wolverines are attracted to the run pole because of beaver bait that is hanging from a wire. A camera opposite the wolverine takes a picture of its chest when the wolverine tries to access the bait. We can then use this picture to identify unique individuals. Moreover, the uprights on the run pole have barbed wire that snares fur for DNA analyses.

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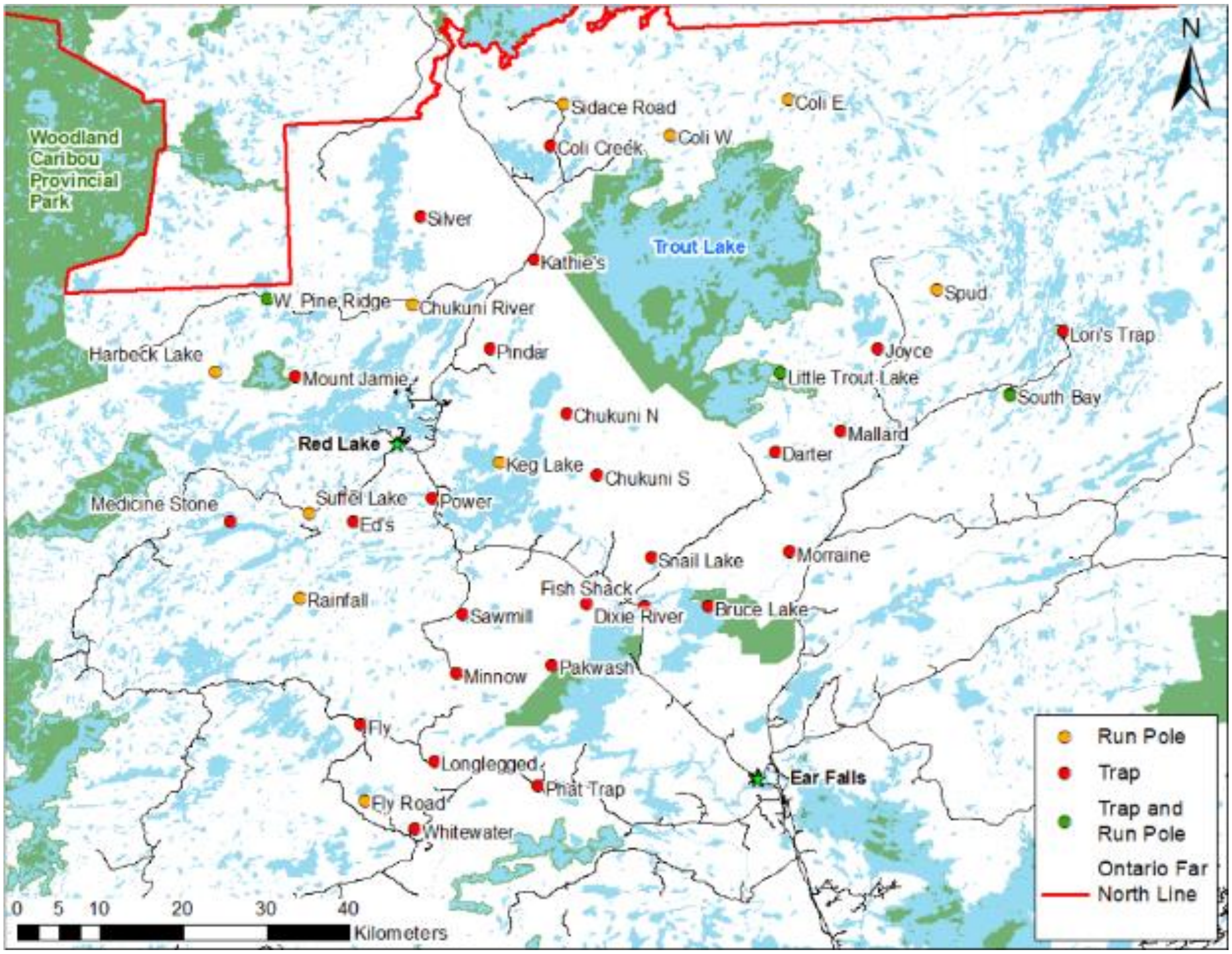

Figure 3. The distribution of live traps and run poles around Red Lake, Ontario. The red points are live traps, yellow points are run poles, and green points indicate there is both a live trap and run pole at that location. Live traps and run poles are spaced ~10 to 15 km from each other when possible. A polygon surrounding the live traps and run poles has an area of 5,470 km^2 which is what we designate as our study area.

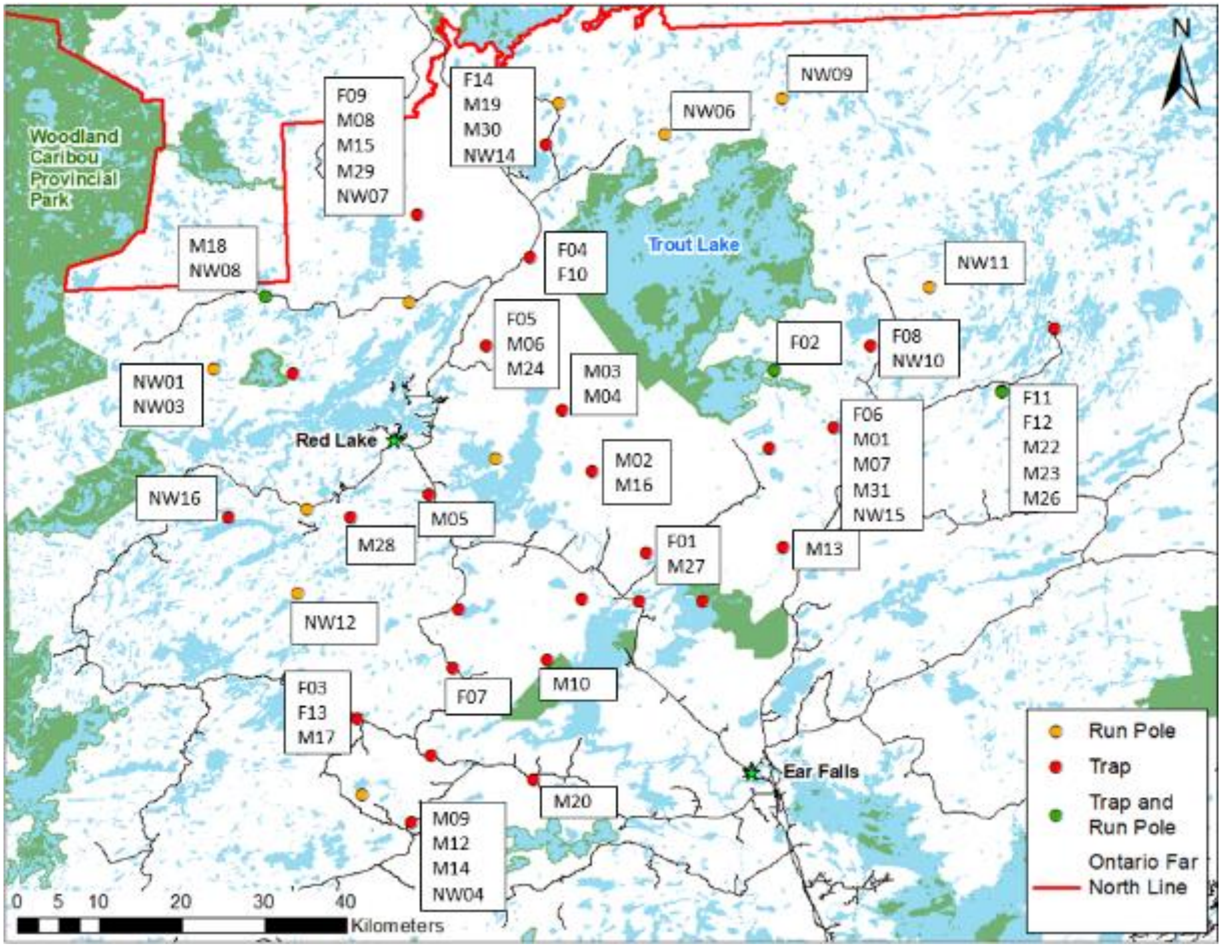

Figure 4. The live trap and run-pole locations where individual wolverines were initially detected (live trapped or photographed). An "F" before the number indicates a female wolverine, an "M" indicates a male wolverine, and a "NW#" indicates a new wolverine that has been identified on camera with a unique chest pattern but is not yet tagged. The year(s) we detected each wolverine can be found in **Table 2**.

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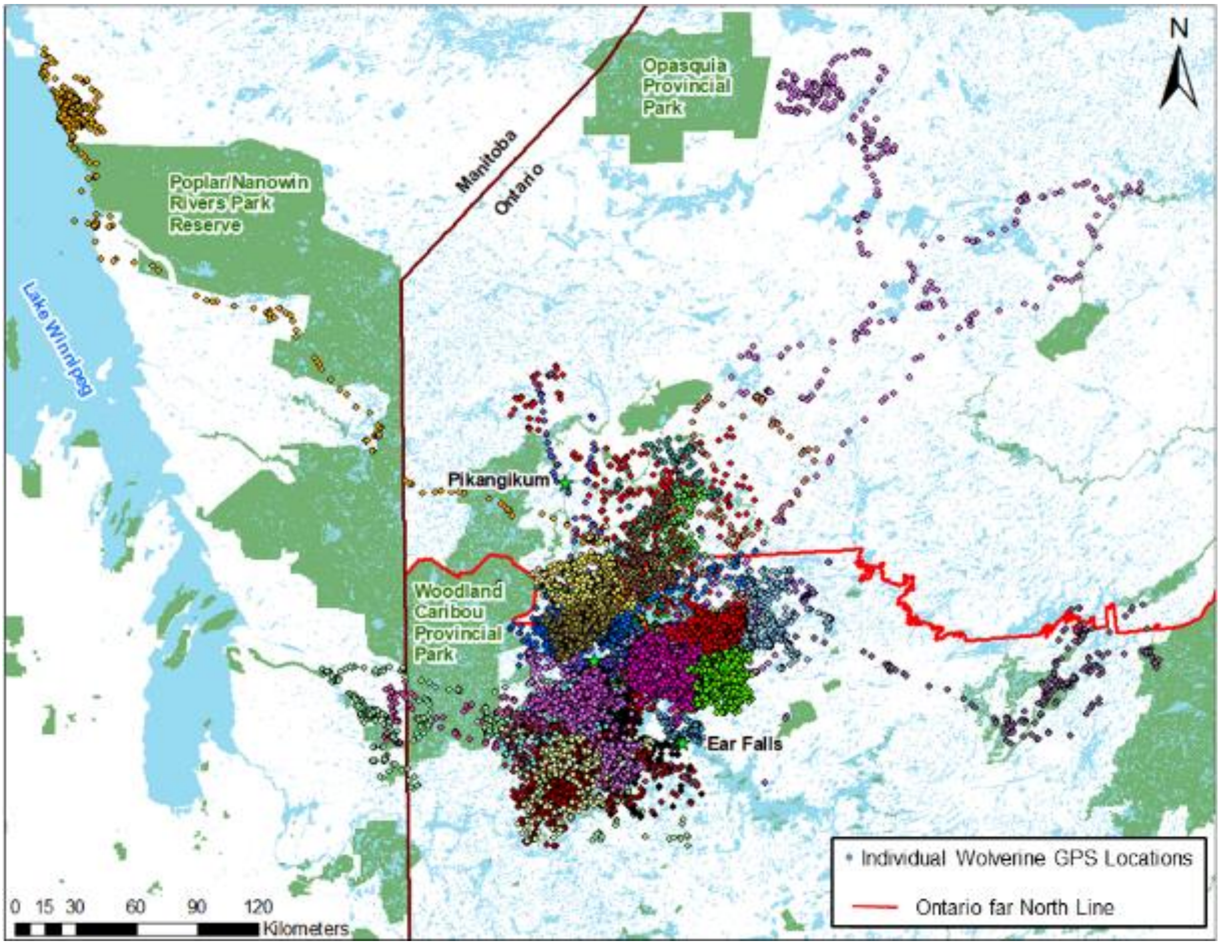

Figure 5. Wolverine GPS locations from 42 wolverines in Red Lake, Ontario. The GPS collars take GPS locations at 2-hour intervals. We have collected over 54,170 GPS locations since the project began in 2018. Different coloured points indicate unique wolverines.

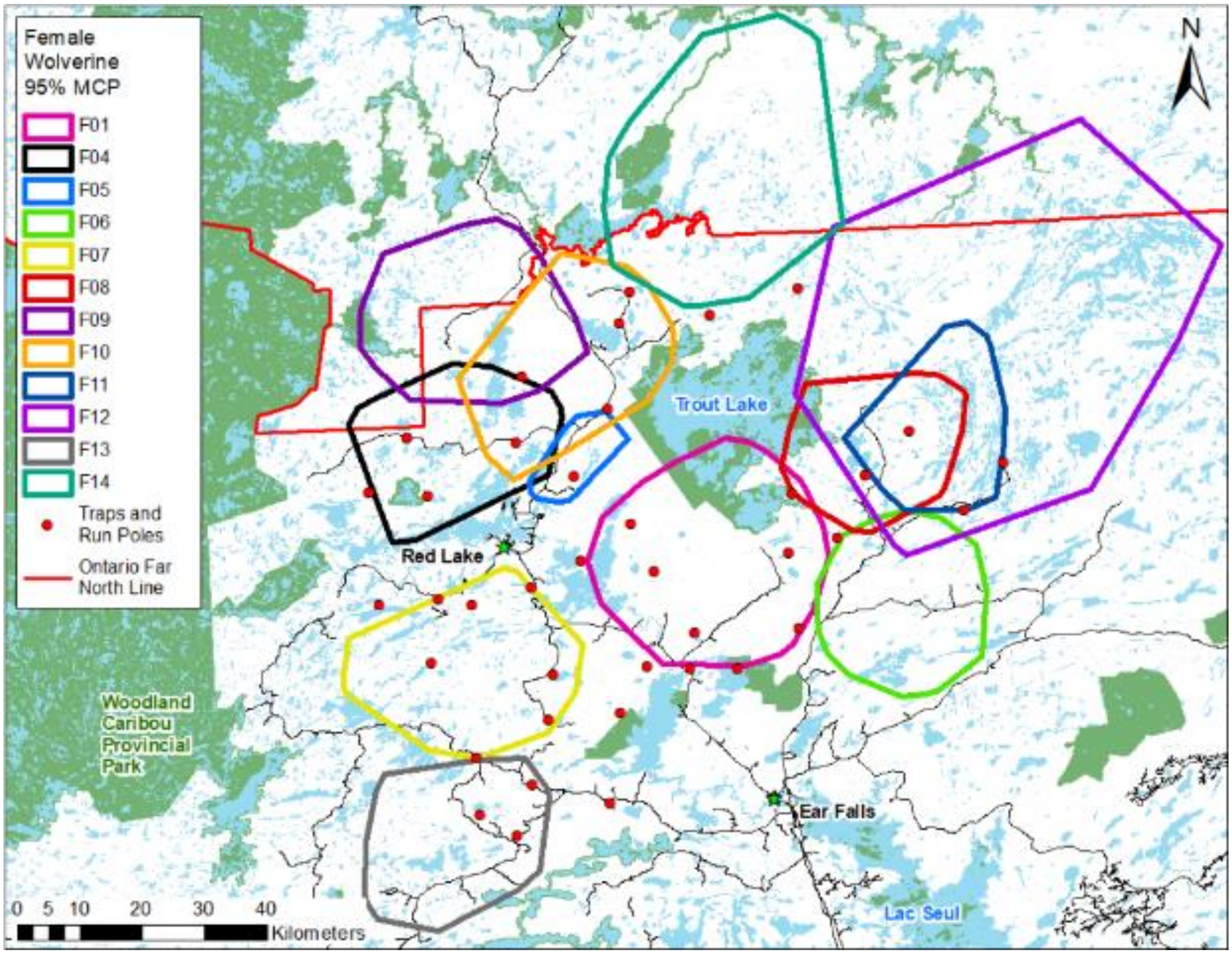

Figure 6. The home-range size of resident female wolverines in Red Lake, Ontario. We constructed home ranges as a 95% minimum convex polygon (MCP; a polygon surrounding 95% of a wolverine's GPS locations). We did not include wolverine F03 who dispersed north out of the study area.

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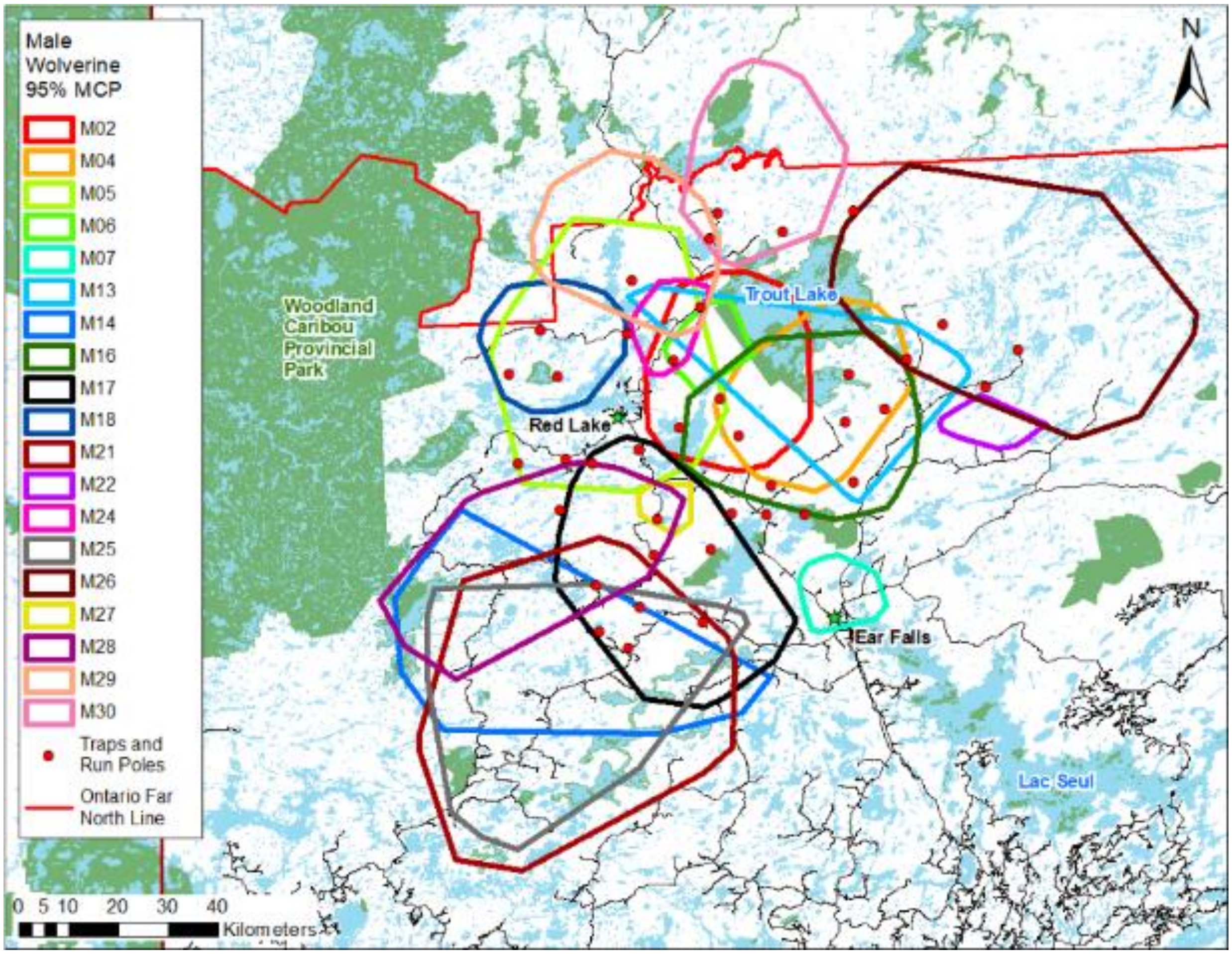

Figure 7. The home range size of resident male wolverines in Red Lake, Ontario. We constructed home ranges as a 95% minimum convex polygon (MCP; a polygon surrounding 95% of a wolverine's GPS locations). We did not include wolverine M01, M03, M12, M15, or M31 because they dispersed out of the study area. Also not included are wolverines without enough GPS locations (M08, M09, M10, M11).

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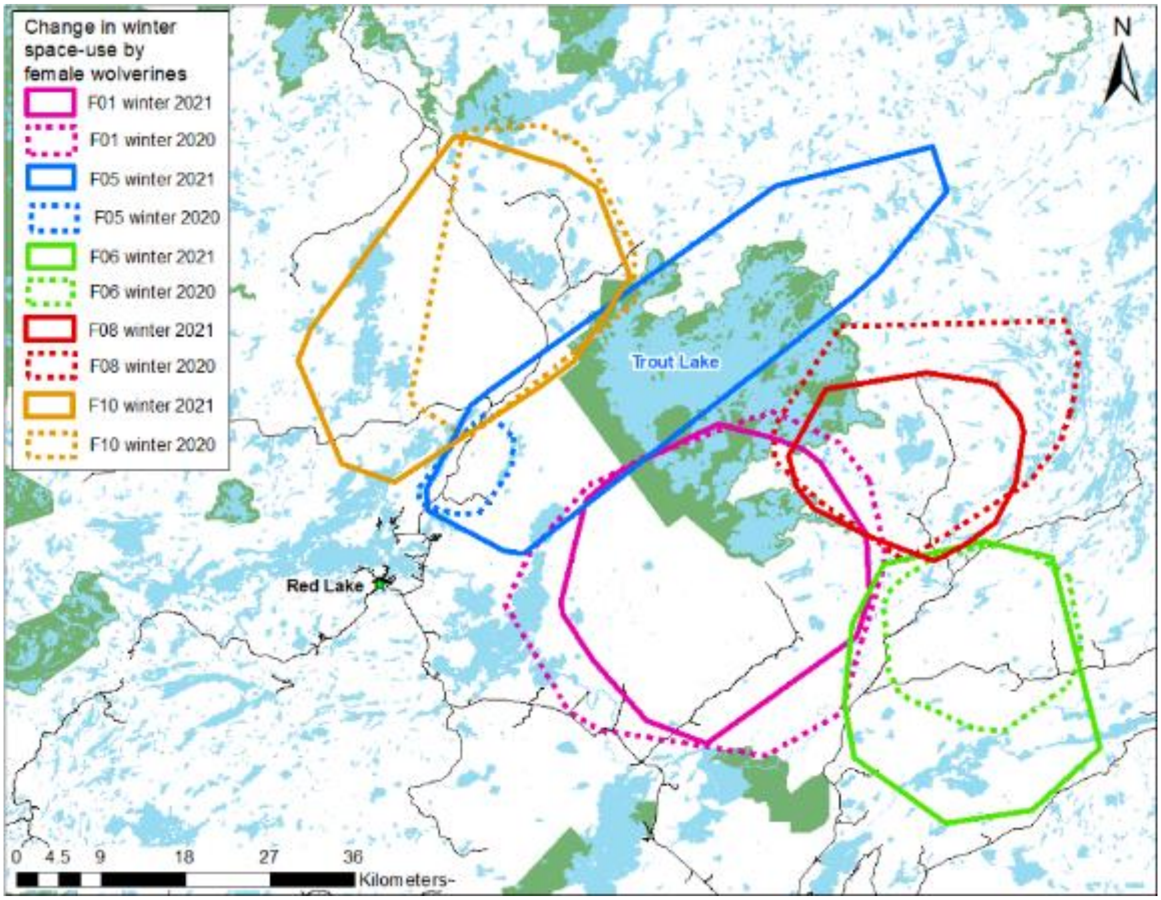

Figure 8A. Comparing resident female wolverine home ranges (95% MCP) in consecutive winters (November – April). Dashed lines represent a female home range in one year and solid lines of the same colour are the next year. The data associated with these home range shifts can be found in **Table 4**.

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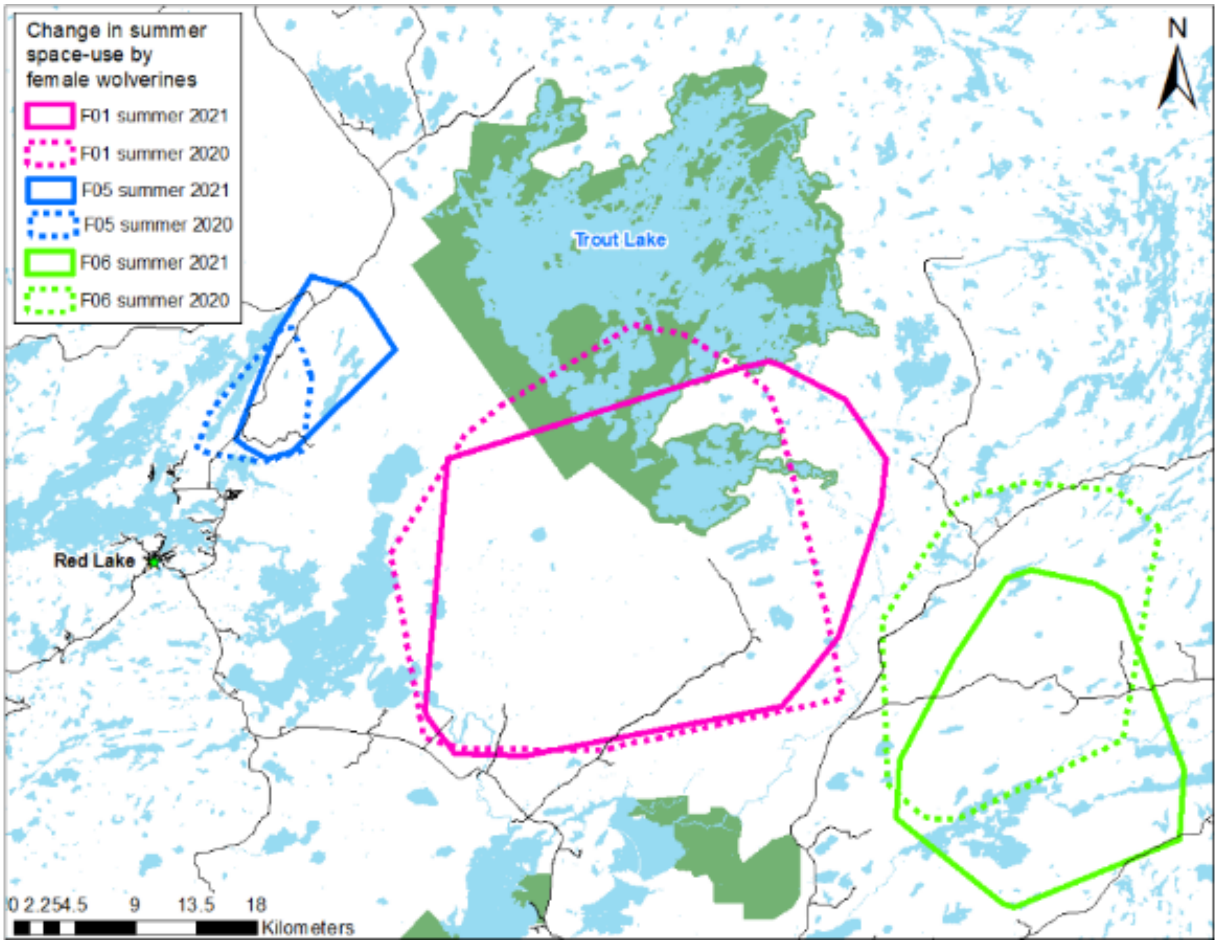

Figure 8B. Comparing resident female wolverine home ranges (95% MCP) in consecutive summers (May – October). Dashed lines represent a female home range in one year and solid lines of the same colour are the next year. The data associated with these home range shifts can be found in **Table 4**.

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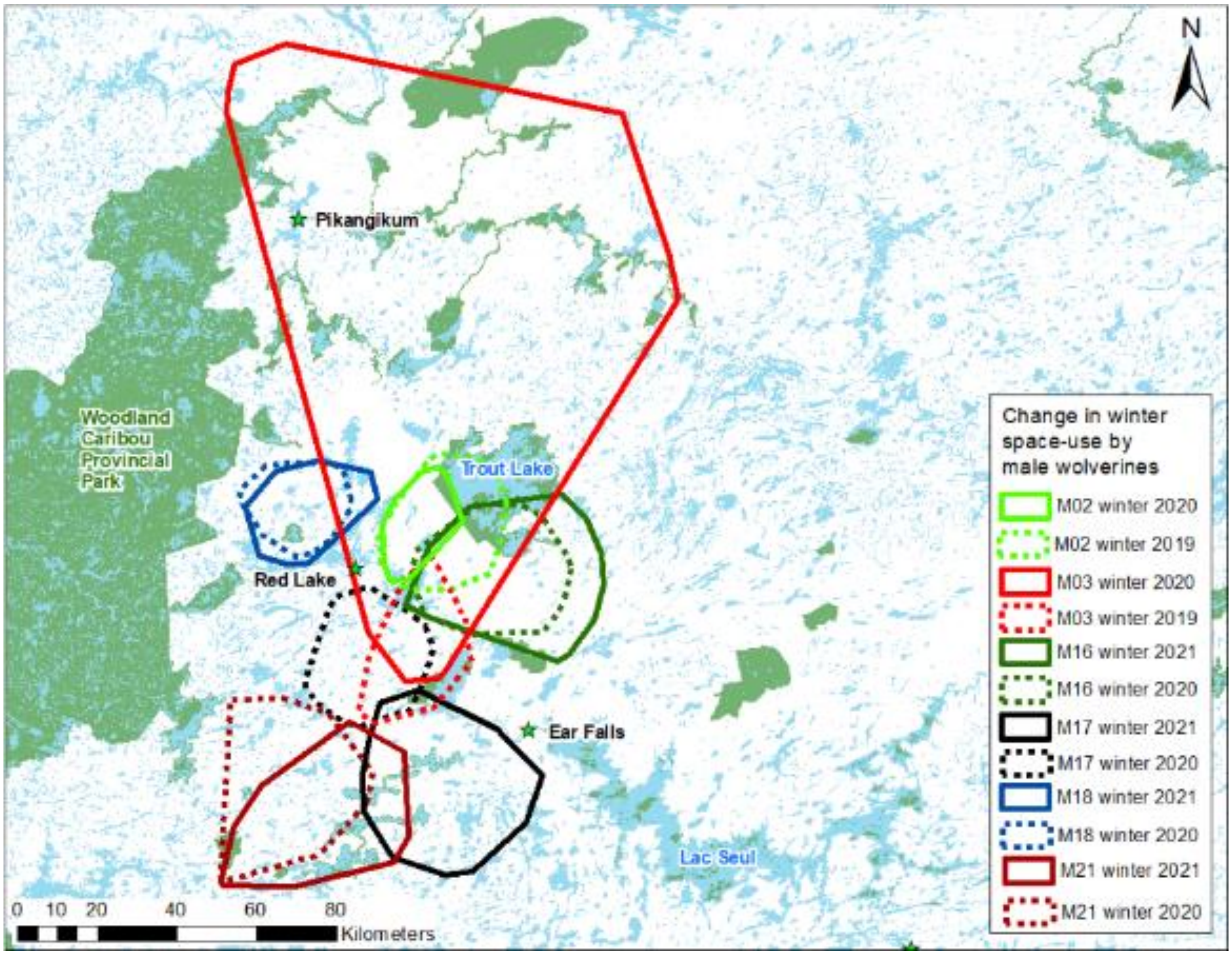

Figure 9A. Comparing resident male wolverine home ranges (95% MCP) in consecutive winters (November – April). Dashed lines represent a male home range in one year and solid lines of the same colour are the next year. The data associated with these home range shifts can be found in **Table 4**.

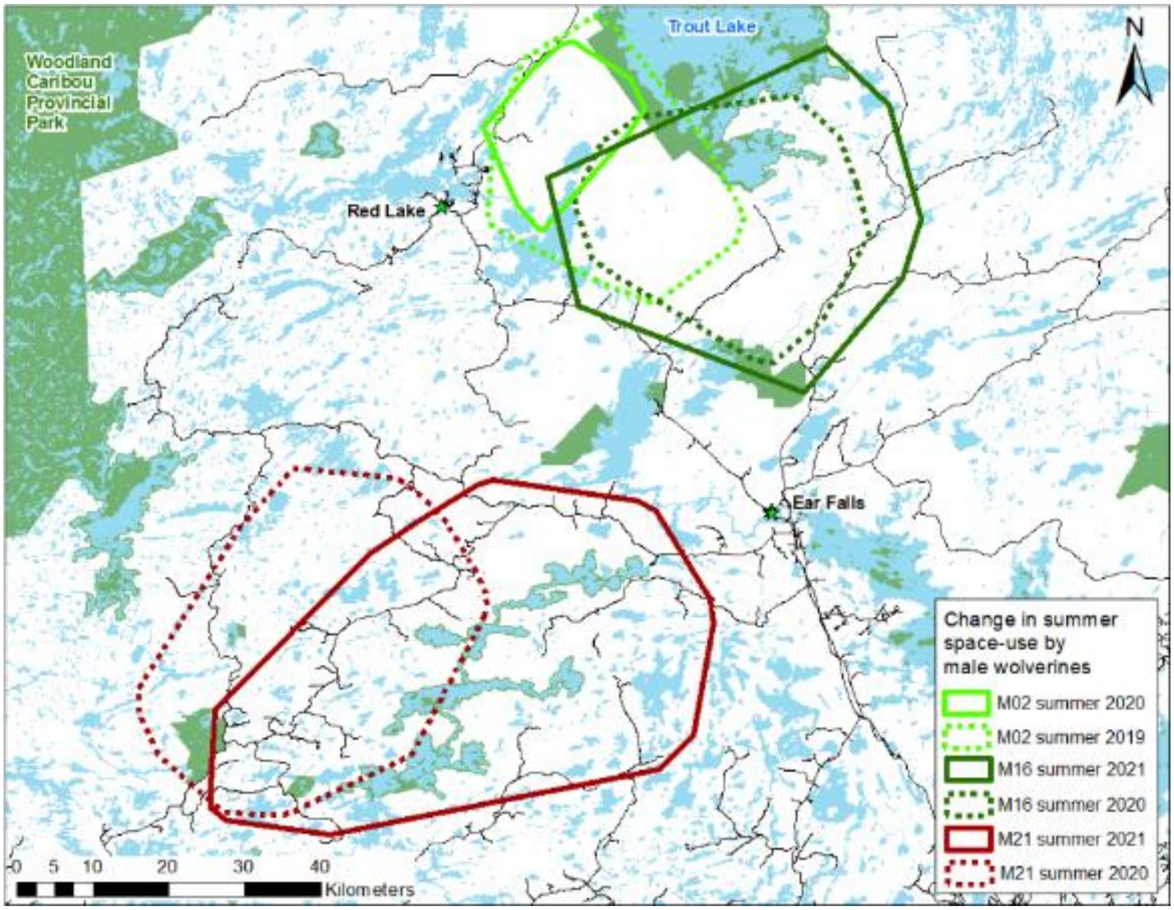

Figure 9B. Comparing resident male wolverine home ranges (95% MCP) in consecutive summers (May – October). Dashed lines represent a male home range in one year and solid lines of the same colour are the next year. The data associated with these home range shifts can be found in **Table 4**.

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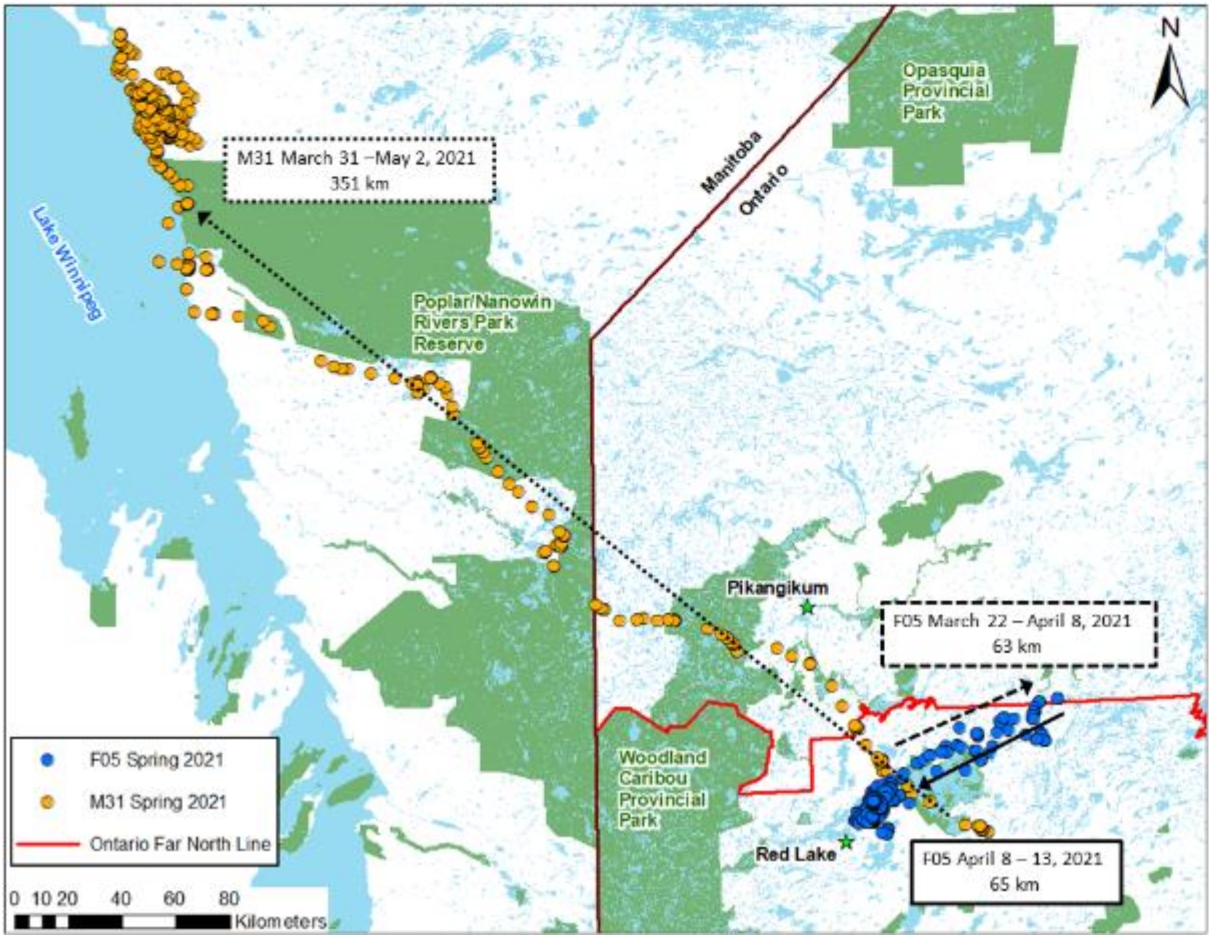

Figure 10. Long-distance movements of wolverine F05 and M31 from Red Lake, Ontario. Both F05 and M31 initiated their dispersal movements in late March 2021. F05 has since dropped her collar within her typical home range after returning from her exploratory movement, while M31's collar has not yet dropped off. Arrows indicate straight-line distances between start and end dates and do not account for travel paths.

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Figure 11. Top: A wolverine bed at the base of a spruce tree (**left**) and a latrine site (**right**). Both beds are at the base of trees which is very typical. **Bottom:** The remains of a moose carcass foraged by wolverines.

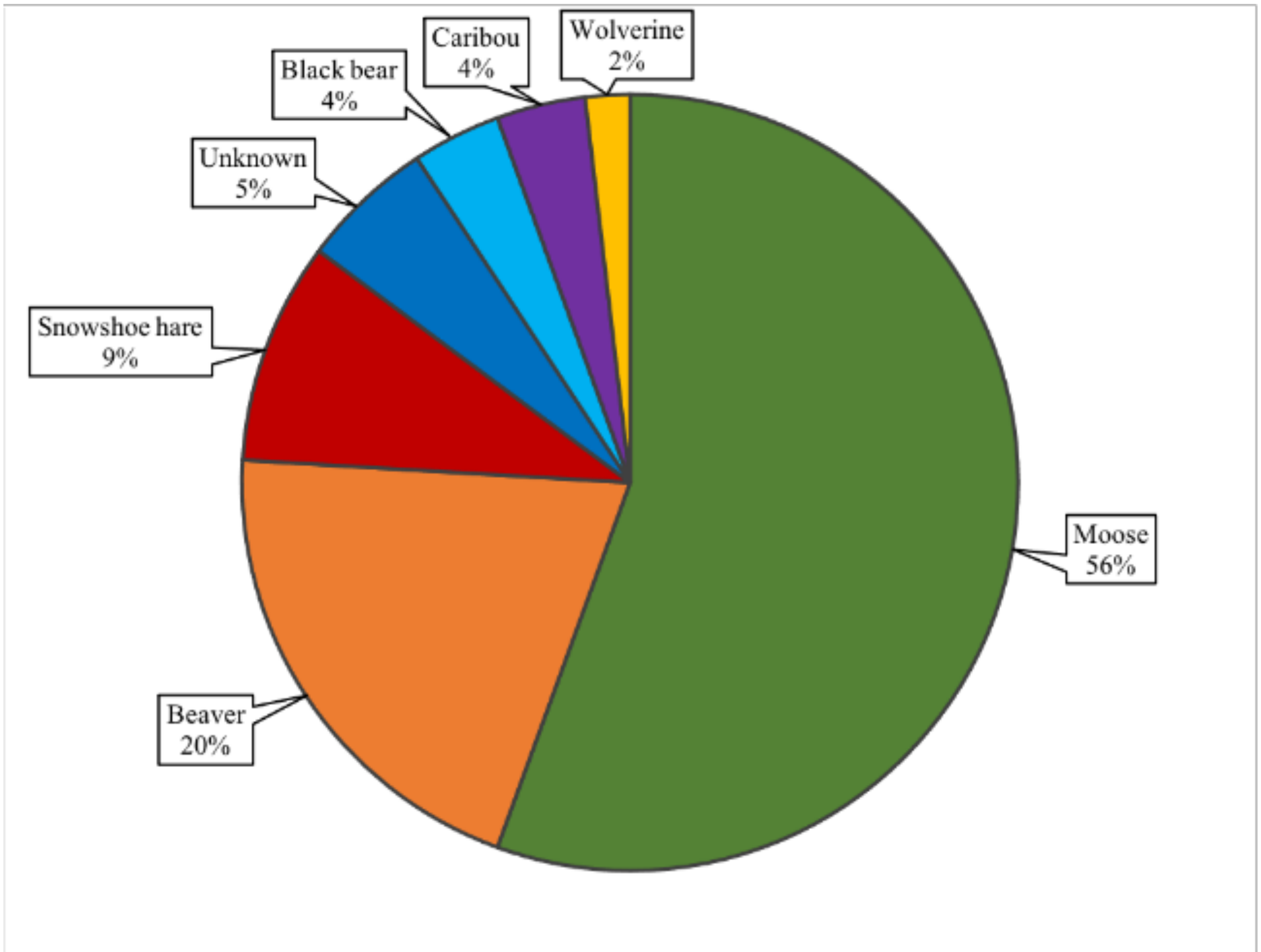

Figure 12. Breakdown of prey remains found at wolverine GPS clusters of foraging and scavenging.

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Figure 13. The remains of a black bear that M16 was eating.

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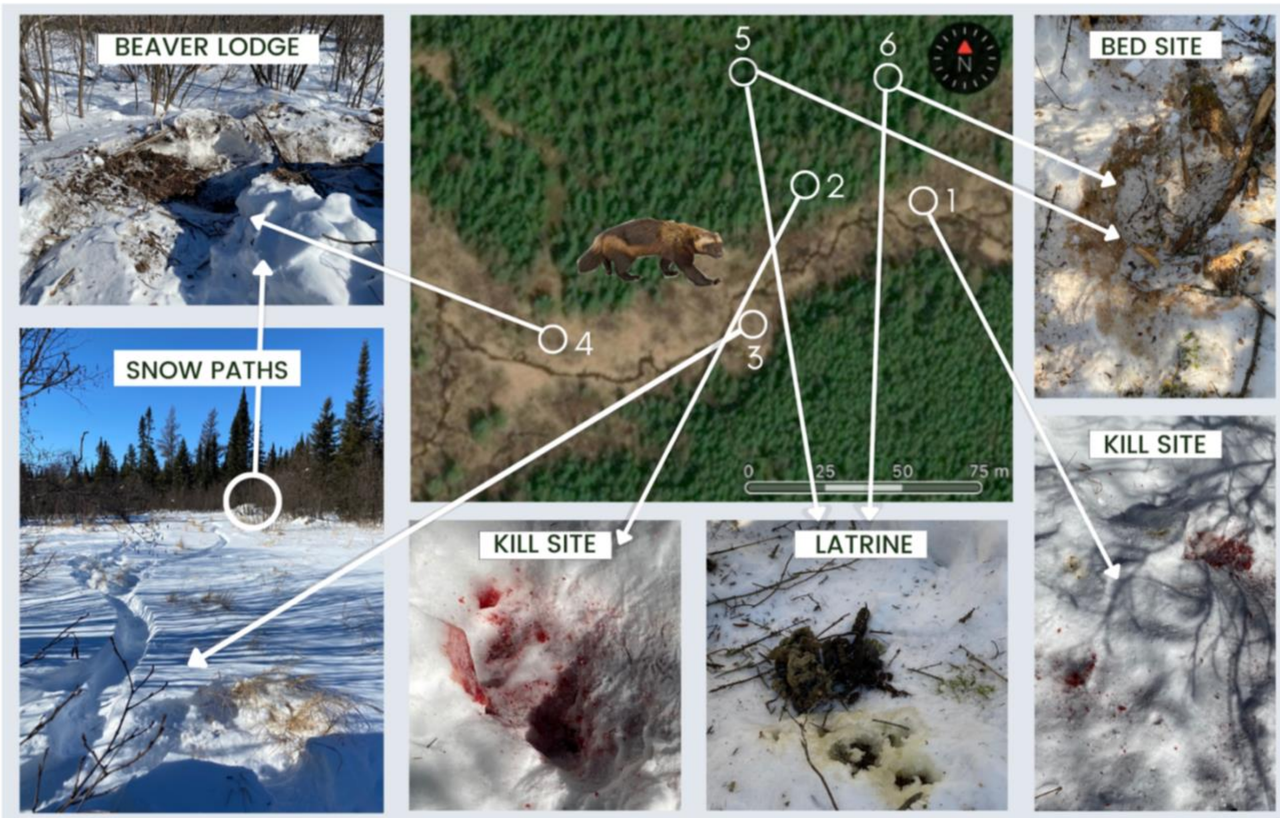

Figure 14. A satellite view with images of M16's cluster area on a creek off the west side of Willans Lake, Ontario. We hiked in from the east, and initially found site **#1**, a suspected beaver kill site due to blood on the snow. We then found site **#2**, another suspected beaver kill site due to blood and bone chards on the snow. These are both educated guesses, as there weren't many remains left. As we continued walking, there were numerous trails in the snow on top of the creek ice, such as site **#3**. We walked to the beaver lodge, site **#4**, and found that M16 had excavated one side of it. We then walked into the forest to sites **#5** and **#6**, where we found a latrine and bed site at each.

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Figure 15. A carpet of moose hair at the edge of a small lake off the Joyce road in Red Lake, Ontario. There was once a moose carcass here but is was thoroughly foraged by at least 3 known wolverines. There were no remnants left here, only hair and a small bone.

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Figure 16. Top: Caribou beds in the snow with scat in open understory 100 m from where F06 was feeding on a dead juvenile male caribou. **Bottom:** Juvenile male caribou carcass in a mature stand of spruce and jack pine. The carcass had mostly intact hind legs, neck, and head, with one antler broken off. The caribou was likely killed recently and F06 was carrying off large pieces of the carcass over multiple days.

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Figure 17. Dens from our previous field seasons. **Top:** F01's spring 2018 den in a tree root-ball; **Bottom left:** F07's spring 2020 den in a rock-crack on a sharp hill overlooking a swamp; **Bottom right:** F05's spring 2020 den in a decomposing slash pile.

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Figure 18. F01's winter 2021 den. This den was in the root-ball of a leaning tree in a lowland area with brushy alders and swampy ground. Nothing was visible except a small hole into the snow and a well-used trail in an out of the tunnel. F01 has previously denned in a similar lowland area just a few kilometers from here, also inside a root-ball of a fallen tree.

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Figure 19. Top: F06's natal den, which was a shallow cave in the root-ball of a fallen tree. This picture is from spring – this den was covered in snow while in use. **Bottom:** F06 returns to her secondary den hours after we found it. Her secondary den was also a shallow cave in a root-ball, ~ 50 m from her natal den.

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Figure 20. F06 standing over the body of F08, who was killed by wolves at the edge of a small lake off the Joyce road.

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Figure 21. The remains of M17, cached by an unknown predator to the east of Portal Lake, with just his collar and paw showing.

Figure 22. Top: M24 in a live trap on April 1st, 2021 with facial and ear lacerations, likely from fighting with another wolverine. We removed his collar to avoid it interfering with healing. **Bottom:** A new wolverine caught March 20th, 2021 also with significant lacerations to his head, face, and neck. We did not collar this wolverine because the collar could interfere with wound healing.

Figure 23. Other wildlife at live traps. **Top left:** Fisher. **Top right:** Wolf. **Bottom left:** Canada Lynx. **Bottom right:** Moose.

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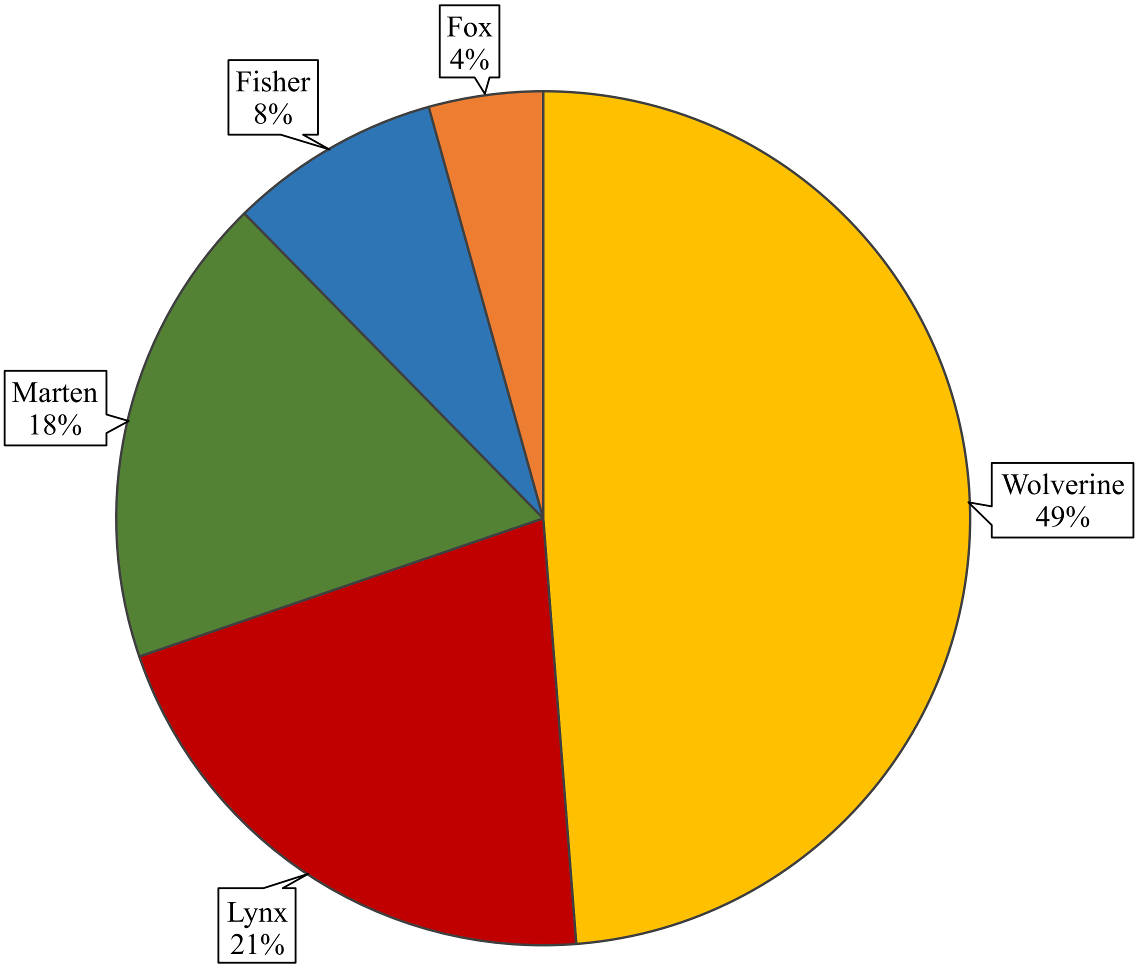

Figure 24. Breakdown of species captured in live traps in Red Lake, Ontario over the winter of 2020/2021. 49% of our captures were wolverines and 51% were other species.

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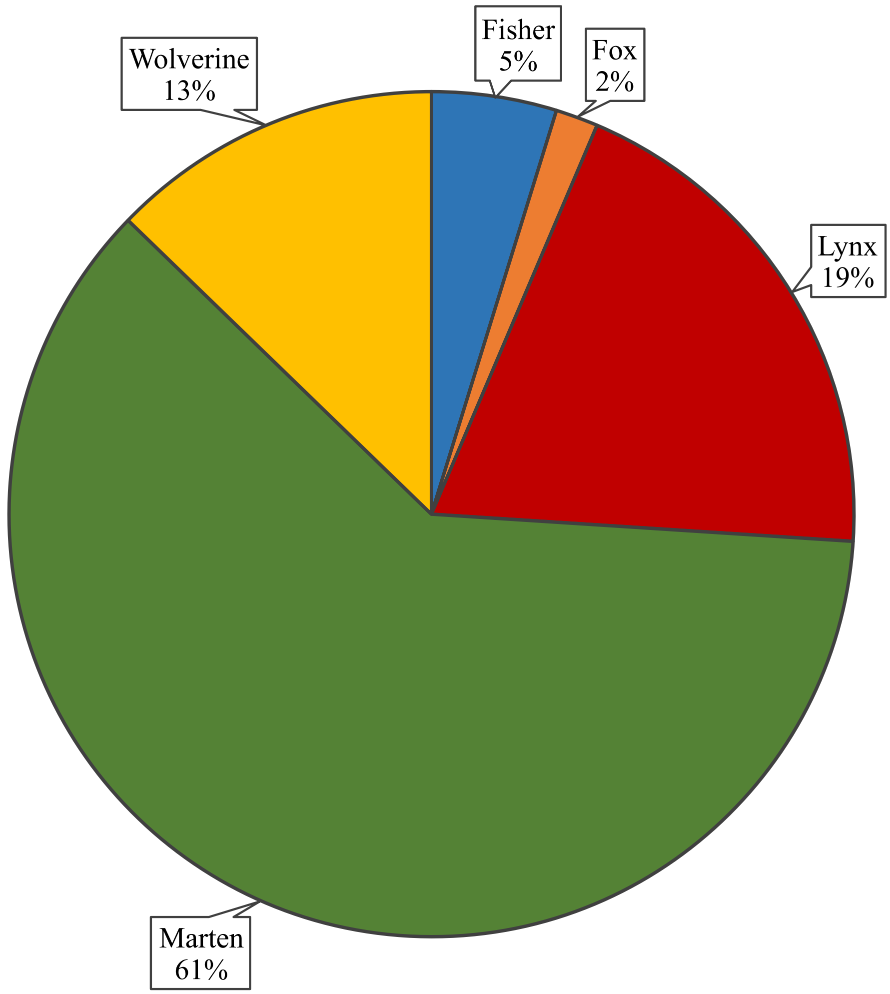

Figure 25. Breakdown of the number of days each species spent at live traps. We acquired these data from cameras at live trap over the winter of 2020/2021. 61% of detection events were martens and 13% were wolverines.

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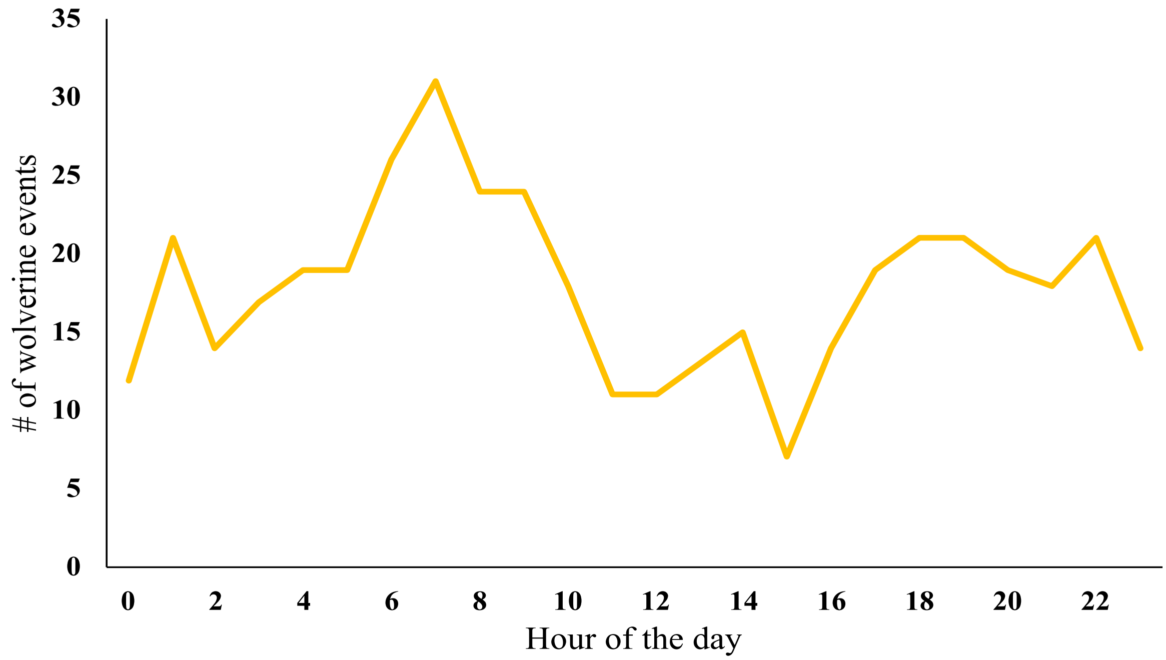

Figure 26. Number of wolverine events on camera at live traps by hour of the day in Red Lake, Ontario over the winter of 2020/2021. Wolverines were most frequently present at live traps at 07:00.

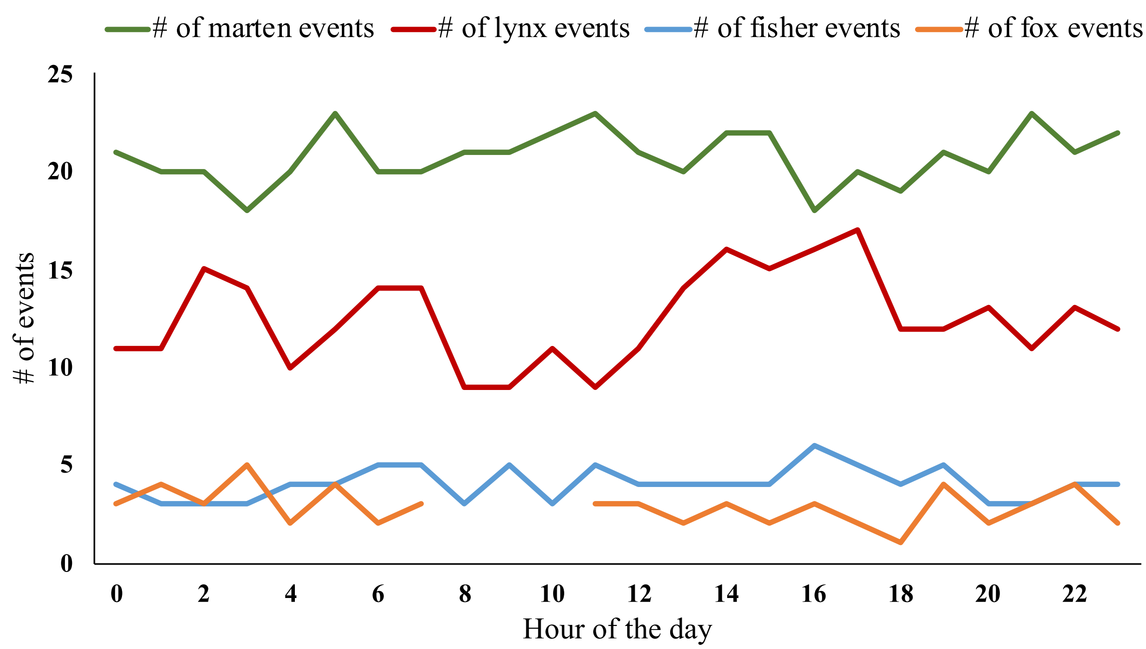

Figure 27. Number of marten, lynx, fisher, and fox events on camera at live traps by hour of the day in Red Lake, Ontario over the winter of 2020/2021.

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Figure 28. Wolverine tracks in fluffy snow in Red Lake, Ontario. Wolverines have distinct markings of five toes in their tracks, compared to four toes for lynx and wolves.

TABLES

Table 1. Average physical measurements from wolverines in Red Lake, Ontario, taken during chemical immobilizations.

Measurement	Female wolverine (n = 14)	Male wolverine (n = 30)
Weight (kg)	9.69	13.56
Neck circumference (cm)	29.34	35.34
Head circumference (cm)	34.30	37.83
Body length (cm)	82.35	87.64
Tail length (cm)	18.30	19.00
Chest circumference (cm)	42.01	47.22
Forearm length (cm)	15.10	16.25
Paw length (cm)	10.87	11.77

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Table 2. The field seasons that individual wolverines were detected (either by camera or capture) at live traps and run poles in Red Lake, Ontario. An "F" before the number indicates a female wolverine, an "M" indicates a male wolverine, and a "NW#" indicates a new wolverine that has been identified on camera with a unique chest pattern but is not yet tagged. Red font indicates mortalities.

Wolverine ID	Season 1 (2018)	Season 2 (2018/19)	Season 3 (2019/20)	Season 4 (2020/21)
F01	x	x	x	x
F02		x		
F03			x	
F04			x	x
F05			x	x
F06	x		x	x
F07			x	x
F08			x	x
F09			x	x
F10			x	x
F11				x
F12				x
F13				x
F14				x
M01	x			
M02		x	x	x
M03		x	x	
M04		x	x	
M05		x	x	
M06		x	x	
M07		x		x
M08		x		
M09			x	
M10			x	
M11			x	
M12			x	
M13			x	
M14			x	
M15			x	
M16			x	x
M17			x	x
M18			x	x
M19			x	
M20			x	
M21			x	x
M22				x
M23				x
M24				x

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M25				x
M26				x
M27				x
M28				x
M29				x
M30				x
M31				x
NW01		x		
NW03		x		
NW04		x		
NW06			x	
NW07			x	
NW08			x	
NW09			x	
NW10				x
NW11				x
NW12				x
NW13				x
NW14				x
NW15				x
NW16				x

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Table 3. Overall home range size (95% minimum convex polygon) of female and male wolverines seen in Figures 6 and 7, calculated from multiple years of data.

Female wolverine	Home-range size (km^2)
F01	1046.5
F04	667.2
F05	128.8
F06	639.1
F07	792.2
F08	578.2
F09	801.1
F10	786.4
F11	531.2
F12	3048.7
F13	652.8
F14	1320.8
Average	**916.1**
Male wolverine	**Home-range size (km^2)**
M02	1082.5
M04	1022.3
M05	1971.3
M06	191.0
M07	197.9
M13	1418.7
M14	2054.9
M16	1395.5
M17	1680.7
M18	598.0
M19	2373.9
M21	3039.6
M22	132.4
M24	205.5
M25	2307.6
M26	2712.8
M27	83.0
M28	1535.7
M29	988.3
M30	964.6
Average	**1297.8**

Table 4. Change in resident wolverine home-range (HR) size between consecutive winters (November – April) and summers (May – October). HRs were calculated as 95% Minimum Convex Polygons of all wolverine GPS relocations. All HRs are in km^2. Change in home-range size was plotted for resident females in **Figures 8A and B** and for resident males in **Figures 9A and B**. Year 1 represents the first consecutive year, and year 2 the second.

Wolverine	Season	Year 1	Year 2	HR size year 1	HR size year 2	% change in HR size	Area of HR 1 used in year 2	% of HR 1 used in year 2
F01	Winter	2019-20	2020-21	1,063	783	- 26	783	74
F05	Winter	2019-20	2020-21	66	869	+ 1,216	60	91
F06	Winter	2019-20	2020-21	323	625	+ 93	313	97
F08	Winter	2019-20	2020-21	584	369	- 37	357	61
F10	Winter	2019-20	2020-21	519	786	+ 52	422	81
M02	Winter	2018-19	2019-20	826	363	- 56	350	42
M03	Winter	2018-19	2019-20	719	11,087	+ 1,442	447	62
M16	Winter	2019-20	2020-21	1,021	1,444	+ 41	988	97
M17	Winter	2019-20	2020-21	787	1,463	+ 86	40	5
M18	Winter	2019-20	2020-21	484	585	+ 21	436	90
M21	Winter	2019-20	2020-21	1,275	1,335	+ 5	752	59
F01	Summer	2020	2021	781	748	- 4	653	84
F05	Summer	2020	2021	52	84	+ 62	34	65
F06	Summer	2020	2021	386	367	- 5	212	55
M02	Summer	2019	2020	813	296	- 64	291	36
M16	Summer	2020	2021	943	1,428	+ 51	923	98
M21	Summer	2020	2021	1,416	2,168	+ 53	815	58