From: Grizzle, Betty
To: Caitlin Snyder
Subject: Documents
Date: Thursday, January 26, 2017 12:34:02 PM
Attachments: API et al Submitted Cmts Nov 17 2016.pdf
COSEWIC 2014 Wolverine Assessment and Status Report.pdf

See attached for API comment letter and the recent Canadian assessment/status report. Thanks for taking a look at these.

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November 17, 2016

Public Comments Processing, Attn: FWS-R6-ES-2016-0106
U.S. Fish and Wildlife Service
MS: BPHC
5275 Leesburg Pike
Falls Church, VA 22041-3803

RE: Comments on the reopening of the U.S. Fish and Wildlife Service's Proposed Listing of the North American Wolverine as a Threatened Species under the Endangered Species Act (FWS-R6-ES-2016-0106)
81 Fed. Reg. 71,670 (October 18, 2016)

Dear Sir/Madam:

The American Petroleum Institute ("API"), Western Energy Alliance ("Alliance"), and Utility Air Regulatory Group ("UARG") (jointly, "Trade Associations") submit these comments on the U.S. Fish & Wildlife Service's ("FWS's" or "the Service's") reopening of the comment period on its 2013 Proposed Listing of the North American Wolverine as a threatened species under the Endangered Species Act ("Proposed Listing"). API and UARG submitted extensive joint comments on this Proposed Listing in 2013, which we herein incorporate by reference.[1] API also intervened in support of the Service's 2014 decision to withdraw the Proposed Listing ("Withdrawal Decision") after it concluded that wolverines did not meet the Endangered Species Act's ("ESA's") definition of a threatened species.[2]

The Trade Associations and their members continue to believe that the Service's 2014 Withdrawal Decision was rational, supported by the best information available, and, in fact, the only determination that would have been permissible under the ESA. The Withdrawal Decision was supported by the record before FWS when it made its final determination. In addition, numerous subsequent studies and data that were completed after the Service's decision and/or which were not part of the administrative record at the time of the Proposed Rule or Withdrawal Decision, confirm the decision was proper. Some important new data even post-date the Montana district court's decision from April 2016. These comments focus on this new information, provide additional detail on key aspects of the 2014 Withdrawal Decision that were at issue in the District of Montana action, and recommend approaches to the Service's reconsideration to cure regulatory and procedural infirmities in the Service's initial status review and Proposed Listing.

[1] See Docket Nos. FWS-R-2012-0107-12410 (Dec. 2, 2013).
[2] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).

I. Summary of Comments

The Service's assessment of the conservation status of wolverines in the conterminous United States has evolved over the course of several years. The preliminary conclusions reached by FWS in 2013 were inaccurate at the time, superseded by the Withdrawal Decision, and are now profoundly outdated. The Trade Associations request that FWS withdraw the current Proposed Listing and reissue a notice in conjunction with a new evaluation of wolverine status, so that the public may comment on all the information that FWS has on hand for making its decision.

- The Proposed Listing is known to be inaccurate, based on incomplete information, and the product of drafting effort designed to reach a preselected finding.
- FWS cannot simply reinstate a Proposed Listing FWS knows to be substantively erroneous and procedurally flawed because FWS is also bound by the ESA, the APA, and the Information Quality Act ("IQA").
- FWS can, and should, subject a new proposed listing to a peer review process as set out by OMB and FWS itself.

FWS is compelled to conduct a new review of the status of wolverines in the conterminous United States and is further compelled to re-examine the threshold question of whether wolverines in the conterminous United States are properly classified as a Distinct Population Segment ("DPS"). This new status review must examine the best scientific information available, including a large amount of important data published or made available subsequent to the Service's prior rulemaking effort.

- The best scientific information available indicates that wolverines in the conterminous United States are not a DPS.
- There was no evidence to support the DPS analysis in 2010, and after six additional years of research on North American wolverines, the Service's outdated DPS analysis is even more questionable. FWS therefore had no basis to delineate the DPS along a political boundary, and any differences in abundance, habitat, or exploitation are simply the result of arbitrary line drawing.
- Even if wolverines in the conterminous United States were meaningfully distinct from wolverines in Canada, they are not likely to be driven to the brink of extinction within the foreseeable future.
- Two of the Service's own peer reviewers vociferously disagreed with the Proposed Listing's conclusion that projected future climate change impacts were likely to threaten wolverines with extinction.
- The Proposed Listing misinterpreted this distinction between correlation and dependence, and therefore erroneously concluded that suitable wolverine habitat was limited to that identified in Copeland (2010). That error was significantly compounded because McKelvey (2011) – the study on which FWS concluded that suitable habitat was likely to decline significantly – also relied on Copeland (2010) to define suitable habitat.
- Based on additional data and a superior understanding gained through the peer review process, FWS revised its interpretations of the key underpinnings of the alleged climate change threat and, based on that new understanding, determined that potential climate

change impacts were not likely to drive wolverines to the brink of extinction within the foreseeable future.

- New information calls into question the strength, and even the existence of, wolverines' obligate relationship with deep springtime snow.
- New information calls into question the accuracy and reliability of McKelvey (2011) and provides superior information on winter snowfall projections throughout the range of the wolverine.
- New information indicates that wolverines are capable of maintaining connectivity across longer distances and less suitable landscapes than had previously been understood.
- New information indicates that wolverines in the conterminous United States have no material genetic distinction from wolverines in Canada and that dispersals and genetic connectivity is occurring across the border.
- New information indicates that wolverines are not likely to be driven to the brink of extinction based on their relatively small population size. These population dynamics are inherit in populations on the periphery of their range and are mitigated by range expansion and population increases, as well as genetic exchanges with Canadian wolverines.

In light of this information, the Trade Associations strongly urge FWS to conduct a new review of the status of wolverines in the conterminous United States and to further examine the threshold question of whether wolverines in the conterminous United States are properly classified as a DPS. FWS must also provide stakeholders a subsequent opportunity to comment on the Service's current views on the conservation status of wolverines in the conterminous United States.

II. The Trade Associations

A. API

API is a national trade association representing over 625 member companies involved in all aspects of the oil and natural gas industry. API's members include producers, refiners, suppliers, pipeline operators, and marine transporters, as well as service and supply companies that support all segments of the industry. API member companies are leaders of a technology-driven industry that supplies most of America's energy, supports more than 9.8 million jobs and 8 percent of the U.S. economy, and since 2000, has invested nearly $2 trillion in U.S. capital projects to advance all forms of energy, including alternatives.

API members may be impacted by this Proposed Listing because, in the course of their business, they emit greenhouse gases ("GHGs"), including carbon dioxide ("CO_2"), which the Proposed Listing has alleged will cause climate change and the forecasted potential future impacts on the wolverine claimed in the proposed rule. API is also interested in this action because it represents members that operate, or plan to operate, within or near areas identified by FWS as wolverine habitat.

API submitted extensive comments on this Proposed Listing in 2013 and intervened in support of the Service's Withdrawal Decision when it was challenged in 2015. At all points during API's involvement on this issue, API has supported its positions with credible scientific data and analysis. The present comments reflect our continued interest in constructively contributing to the

dialogue and providing FWS the information it needs to make a defensible science-based evaluation of whether wolverines in the conterminous United States meet the ESA's definition of a threatened distinct population segment.

B. The Alliance

The Alliance represents over 300 companies engaged in all aspects of environmentally responsible exploration and production of oil and natural gas in the West. Alliance members are independents, the majority of which are small businesses with an average of fifteen employees.

C. Utility Air Regulatory Group

UARG is a not-for-profit association of individual electric generating companies and national trade associations. UARG's purpose is to participate on behalf of certain of its members in rulemakings and other regulatory proceedings that affect the interests of electric generators and in litigation arising from those proceedings. Although UARG typically comments on matters arising under the Clean Air Act, UARG is submitting comments on the Proposed Listing (as it did in 2013) because the issues presented in the proposal have the potential to impact the electric generating industry in Clean Air Act proceedings.

III. Procedural Overview

In 2000, several groups petitioned FWS arguing that wolverines in the conterminous United States were endangered due to loss of roadless areas and unsustainable forestry practices – the groups' top policy issues at the time.[3] After FWS published a 90-day finding that the petition failed to present sufficient scientific and commercial information,[4] four parties then sued FWS alleging that the Service had held the petition to an impermissibly high standard for evaluating petitions at the 90-day stage.[5] The court agreed that FWS had misapplied the standard for evaluating whether "substantial evidence" was presented, and ordered FWS to conduct a more comprehensive 12-month finding, stating that "[i]t does not mean that the wolverine must be listed but it does mean that a closer look is required."[6]

FWS published that 12-month finding in 2008, determining that listing was "not warranted" because wolverines in the conterminous United States were not a distinct population segment ("DPS"), and that the range in the contiguous United States did not constitute a significant portion of the range of the larger North American subspecies.[7] The groups sued FWS again,[8] and FWS agreed in a settlement to remand its 12-month finding, which led to dismissal of the case.[9]

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[3] 68 Fed. Reg. 60,112, 60,112–15 (Oct. 21, 2003).
[4] 68 Fed. Reg. 60,112 (Oct. 21, 2003).
[5] *See Defenders of Wildlife v. Kempthorne*, 9:05-cv-00099-DWM (D. Mont. Sept. 29, 2006).
[6] *Defenders of Wildlife v. Kempthorne*, 9:05-cv-00099-DWM, at 19.
[7] 73 Fed. Reg. 12,929 (Mar. 11, 2008).
[8] *Defenders of Wildlife v. Kempthorne*, No. CV-08-139-M-DWM (Sept. 30, 2008).
[9] 78 Fed. Reg. at 7,866.

On remand, FWS reversed its previous decision, determined that wolverines in the conterminous United States were now a DPS, and that the DPS warranted listing, but that listing was precluded by higher-priority listing actions.[10] Importantly, FWS based its threat analysis on the surmised impacts of climate change and the species' surmised response to potential climatological impacts decades into the future (not the threats plaintiffs had alleged).[11]

In 2011, as part of a settlement with the Center for Biological Diversity and Wild Earth Guardians,[12] FWS agreed to publish a proposed listing or withdraw the 12-month finding by the end of the 2013 fiscal year ("Settlement Agreements").[13] Importantly, even though the Settlement Agreements preserved the Service's authority to either propose a wolverine listing *or* determine that listing was no longer warranted, Dr. Shaun Sartorius, the Service's lead biologist on the wolverine listing, instructed dozens of staff, scientists, and state wildlife personnel that the Settlement Agreements required that FWS "publish a proposed listing rule . . . for wolverines during FY2013."[14] When questioned on this, Dr. Sartorius underscored his view of the Settlement Agreements' mandate: "Rest assured that in the current settlement proposal, wolverines are slated for a proposed rule in 2013."[15] According to Dr. Sartorius, the Service's ability to determine that wolverines did not meet the definition of threatened or endangered species would not arise until the final rule stage: "A final rule (or withdrawal) [sic] would follow 12 months later."[16]

The misconception that the Settlement Agreements compelled FWS to propose to list wolverines – and did not allow it to make a not-warranted finding until after proposing a listing – was seemingly never questioned. The Service's talking points on the Settlement Agreements plainly stated that "[t]he CBD agreement commits us to publishing a proposed listing rule in 2013."[17] The Service's "kick-off" call was to plan for "[t]he wolverine proposed listing," and asked for volunteers to draft a proposed listing: "Listing rule: who is in?"[18] And, within a few months of the Settlement Agreements, Dr. Sartorius and the wolverine listing team sought Department of Interior approval to publish a proposed rule to list the wolverine based on "habitat and range loss due to climate warming."[19] While it is not clear whether the misconceptions about the Settlement Agreements lead to the Proposed Listing's erroneous conclusions, it is significant that the key drafters of the Proposed Listing believed they were compelled by the Settlement Agreements to propose listing, even if facts and analysis suggested otherwise.

a. 2013 Proposed Listing

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[10] 75 Fed. Reg. 78,030.
[11] 75 Fed. Reg. at 78,042.
[12] *Endangered Species Act Section 4 Deadline Litigation*, Misc. Action No. 10-377 (EGS), MDL Docket No. 2165 (D.D.C.),
[13] 78 Fed. Reg. at 7,866.
[14] E-mail from Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service, to Robert M. Inman, et al., (July 12, 2011, 1:34 PM) (hereafter "Sartorius, Inman et al. (2011)")
[15] E-mail from Robert M. Inman, Director, Greater Yellowstone Wolverine Program, Wildlife Conservation Society, to Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service, (July 13, 2011, 10:55 AM).
[16] Sartorius, Inman et al. (2011).
[17] E-mails between Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service and Bridgette Fahey, U.S. Fish and Wildlife Service (May 03, 2011).
[18] E-mail from Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service, to Wolverine FWS, (August 15, 2011, 2:03 PM).
[19]Reg. Act. Alert E-mail from Shawn Sartorius to Justin Shoemaker on August 11, 2011.

Consistent with the Service's perceived mandate, FWS published the proposed "threatened" listing for the wolverine on February 4, 2013.[20] The Proposed Listing stated that "[t]he primary threat . . . is from habitat and range loss due to climate warming (Factor A)."[21] The Proposed Listing preliminarily concluded that "[o]ther threats are minor in comparison to the driving primary threat of climate change; however, cumulatively, they could become significant when working in concert with climate change if they further suppress an already stressed population."[22] In other words, all other threats, like trapping and genetic diversity, were only considered significant *if* viewed cumulatively *and* in conjunction with alleged climate change threats.

The Proposed Listing's preliminary conclusion that wolverines in the conterminous United States would likely be driven to the brink of extinction within the foreseeable future, was based on the projected impacts of climate change rested on two related conclusions reached by FWS that : (1) "[d]eep snow that persists into the month of May is essential for wolverine reproduction"; and (2)areas with "deep snow that persists into May" (May 15th to be exact) were projected to shrink by 31 percent by 2045 and 63 percent by 2070. [23]

The Service's preliminary conclusion that deep snow persisting into May is essential to wolverine survival was based on Copeland (2010), a study examining the "bioclimatic envelope" outside of which wolverines were unlikely to survive.[24] Copeland (2010) posited that the wolverine's bioclimatic envelope was limited to those areas proximate to where successful reproductive dens could be established.[25] Copeland (2010) isolated a single factor – deep persistent spring snow – as an obligate feature of successful denning and used it to define "suitable habitat."[26] "Suitable habitat" (areas with deep persistent spring snow) was identified as areas where snow cover on May 15th was visible from satellite images at least once within a seven year period.[27] FWS used the maps generated in Copeland (2010) to establish its bioclimatic envelope of suitable habitat, outside of which wolverine populations could not survive.[28]

The Service next looked to McKelvey (2011), which used the snow model in Copeland (2010) to identify the spatial extent of suitable wolverine habitat (*i.e.*, areas that contained snow in at least one of seven years on May 15th) and then modeled how climate change might reduce the size and number of areas containing snow in at least one of seven years on May 15th.[29] McKelvey (2011) projected that the suitable habitat defined by Copeland (2010) would be reduced by 32 percent by 2045 and 63 percent by 2085.[30] Based almost entirely on these two studies, the Proposed Listing concluded that climate change would so significantly reduce and fragment suitable wolverine

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[20] 78 Fed. Reg. 7,864.
[21] 78 Fed. Reg. 7,886.
[22] 78 Fed. Reg. 7,886.
[23] 78 Fed. Reg. at 7,880.
[24] J.P. Copeland, et al., *The Bioclimatic Envelope of the Wolverine (Gulo Gulo): Do Climatic Constraints Limit its Geographic Distribution?,* Can. J. Zool. 88:233-246 (2010) (hereafter "Copeland (2010)").
[25] Copeland (2010).
[26] Copeland (2010) at 235.
[27] Copeland (2010) at 233.
[28] 78 Fed. Reg. at 7,872.
[29] Kevin S. McKelvey, et al., *Climate Change Predicted to Shift Wolverine Distributions, Connectivity, and Dispersal Corridors*, 21(8) Ecological Applications 2882 (2011) (hereafter "McKelvey et al. (2011)").
[30] McKelvey et al. (2011) at p. 2882.

habitat that observed increases in wolverine range and abundance would be reversed, and that the wolverine would be driven to the brink of extinction throughout its range in the foreseeable future.[31]

b. 2014 Withdrawal Decision

After publishing the Proposed Listing, FWS sought out and obtained important new information. Most importantly, FWS submitted the Proposed Listing to seven peer reviewers.[32] Four of the seven peer reviewers were employed by the U.S. Forest Service ("USFS")[33] which manages the vast majority of wolverine habitat.[34] Six of the seven peer reviewers coauthored Copeland (2010)[35], and four of the seven peer reviewers coauthored McKelvey (2011).[36]

Notwithstanding the selection of peer reviewers seemingly inclined to approve a proposed listing reliant on their scholarship, two of the peer reviewers vociferously disagreed with the Proposed Listing's conclusion that projected future climate change impacts were likely to threaten wolverines with extinction.[37] Importantly, neither dissenting peer reviewer disagreed with wolverines' association with cold and snowy weather or the potential for climate change to impact those conditions. Instead, they contended that Copeland (2010), which they both coauthored, did not establish or delimit suitable wolverine habitat in the manner suggested in the Proposed Listing.[38] Those two peer reviewers concluded that Copeland (2010) provides an approximation of an underlying bioclimatic factor.[39] It effectively established a correlation between dens and spring snow and the wolverine's more general preference for cold and snowy conditions, but both peer reviewers concluded that this correlation failed to establish an obligate relationship, and further questioned the arbitrary selection of "snow on May 15th in at least one of seven years" as a measure of persistent spring snow or biological necessity.[40] As explained by Dr. Inman:

> While I am coauthor on that paper, I have, on further thought and new information, come to the conclusion that this hypothesis [obligate relationship with persistent

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[31] 78 Fed. Reg. at 7886.

[32] Memorandum from Dan Ashe, Director, U.S. Fish and Wildlife Service to Mike Connor, Deputy Assistant Secretary, U.S. Department of the Interior (July 29, 2014) (hereafter "Ashe (2014)").

[33] Letter from Brent Esmoil, Acting Field Supervisor, U.S. Fish and Wildlife Service, to Dr. Michael Schwartz, USDA Forest Service (March 06, 2013) (hereafter "Esmoil, Schwartz (2013)"); William J. Zielinski, Research Ecologist, USDA Forest Service (reviewing Notice of the Proposed Listing... and Establishment of Nonessential Experimental Population of the...Wolverine in CO, WY, and NM (April 9, 2013) (hereafter "Zielinski Review (2013)")); Keith B. Aubry, Research Wildlife Biology, USDA Forest Service (reviewing Notice of the Proposed Listing... and Establishment of Nonessential Experimental Population of the...Wolverine in CO, WY, and NM (May 11, 2013) (hereafter "Aubry (2013)")); E-mail from Brent Esmoil, Acting Field Supervisor, U.S. Fish and Wildlife Service, to John R. Squires, Research Wildlife Biologist, Rocky Mountain Research Station, (March 06, 2013, 10:39 AM);

[34] Ashe (2014).

[35] Copeland (2010).

[36] McKelvey et al. (2011).

[37] Memorandum from Dan Ashe, Director, U.S. Fish and Wildlife Service to Mike Connor, Deputy Assistant Secretary, U.S. Department of the Interior (July 29, 2014).

[38] Inman (2013) at p. 3; Dr. Audrey J. Magoun, Wildlife Research and Management, Comments on Extension of Comment Period on the Proposed Wolverine Listing Determination (October 31, 2013) (hereafter "Magoun (October 2013)").

[39] Inman (2013) at p. 3; Magoun (October 2013)

[40] Magoun (2013) at Attachment A p. 7; Inman (2013) at p. 3.

> spring snow] is not based on sound theory, is not actually supported by the observed correlation, and is not proving to be true upon subsequent real-world assessment. . . . Dens under snow may simply be a good place for wolverines to give birth in the location where their distribution is limited by the morphological, demographic, and behavioral adaptations that allow them to adequately compete for food. But this does not mean that dens under snow are the only place that wolverines can successfully reproduce . . . There is no reason to believe that wolverines are incapable of using non-snow structures as dens. In fact, there is now evidence of wild wolverines successfully using non-snow dens.[41]

As Dr. Magoun (also a coauthor of Copeland (2010)) explained:

> Although wolverines use snow dens in May in many areas of their distribution, one cannot conclude that they *must* have snow for dens in May, and certainly there need not be "persistent spring snow" as measured by [Copeland (2010)] because . . . wolverines live and den outside this spring snow coverage . . . Use of snow dens in May, and especially to 15 May, is clearly not obligatory, especially where boulders, blowdown, and avalanche debris provide alternate sites for protecting kids.[42]

In addition to failing to establish an obligate relationship to snow, Copeland (2010) failed to establish a relationship with reproduction – the sole purpose of denning. As Dr. Inman explained:

> The 15 May snow layer in Copeland et al. 2010 is not actually correlated with wolverine dens in a way that suggests an obligate relationship . . .The date used, 15 May, does not correspond to the period when wolverines would benefit significantly from thermal insulation for young provided by snow at dens. Young are born during February-mid March.[43]

Copeland (2010), the two dissenting peer reviewers argued, successfully identified a metric that effectively defines where wolverines den - the vast majority of den sites were unquestionably within the Copeland (2010) snow model - but this metric does not suggest that these areas are the only place wolverines can live.[44] The Proposed Listing misinterpreted this distinction between correlation and dependence, and therefore erroneously concluded that suitable wolverine habitat was limited to the habitat identified in Copeland (2010).[45] That error was significantly compounded, the dissenting peer reviewers explained, because McKelvey (2011) – the study on which FWS concluded that suitable habitat was likely to decline significantly – also relied on Copeland (2010) to define suitable habitat.[46]

Indeed, even though McKelvey (2011) was arguably the most sophisticated analysis of potential climate change impacts on wolverines to date, it was calibrated to measure a reduction in the

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[41] Inman (2013) at p. 3
[42] Magoun (2013) at Attachment A at p. 7.
[43] Inman (2013) at p. 4.
[44] Inman (2013) at p. 3; Magoun (2013) at Attachment A p. 7.
[45] 78 Fed. Reg. at 7,874.
[46] Inman (2013) at p. 5; Magoun (2013) at Attachment A p. 21.

number of areas that contain snow on May 15th in at least one of seven years – a metric that does not reflect habitat on which wolverines are dependent.[47] Even accepting that McKelvey (2011) reasonably estimated declines of 32 and 63 percent, those are projections of a habitat feature described by Copeland (2010) (snow on May 15th at least once every seven years) – not projections of a decline of suitable habitat.[48]

McKelvey (2011) had other flaws and limitations as well, many of which were disclaimed within the study,[49] and in communications with Dr. Sartorius.[50] Dr. Inman further noted that, even though McKelvey (2011) attempted to downscale large-scale climate models, it did not scale the analysis to high-elevation north-facing slopes, the only areas in the conterminous United States where wolverine dens have been documented, and the last places projected to be affected by climate change.[51]

Importantly, the dissenting peer reviewers raised these deficiencies with FWS and with the studies' lead authors to determine whether they understood Copeland (2010) to establish an obligate relationship between wolverines and deep persistent spring snow or whether FWS misinterpreted it as saying so. In the following excerpt from an exchange between Dr. Copeland, the lead author of Copeland (2010), and Dr. Magoun, Dr. Copeland struggled to define persistent deep snow from the perspective of depth or duration, but also suggests that the overstatements on the obligate nature of spring snow were the Service's alone.[52]

> Dr. Magoun: Jeff . . . I don't see the usefulness if [sic] the term "late spring snow" unless it is defined. What to you does "late spring" mean (when does late spring start and end?) and what "snow" in particular are you including in this term (snow cover regardless of depth, a certain snow depth, snow on north slopes, lingering snow patches, snow in 5-6 years out of 7, etc.) Until we have a term defined how can we discuss it [the obligation relationship]?[53]
> Dr. Copeland: I see your point. Where I think you have went astray is that you are mixing the 2 papers with the proposed listing rule. All of your questions may be valid and might be considered as a next step for refining our understanding of the wolverine/snow relationship. The bioclimatic envelope and climate papers didn't propose listing. They just investigated hypothesis and offered interpretations. What you should be addressing is the FWS's interpretation of those papers in regards to their decision to warrant listing. You are criticizing two papers of many that were used in their process when what you should be debating is their conclusion that these findings, along with others, warrant listing. You have stirred

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[47] Inman (2013) at p. 5; Magoun (2013) at Attachment A p. 21.
[48] Inman (2013) at p. 5; Magoun (2013) at Attachment A p. 21
[49] McKelvey et al. (2011) at pp. 2895-2896
[50] E-mail from Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service, to Nancy Green, U.S. Fish and Wildlife Service, Douglas Krofta, U.S. Fish and Wildlife Service, and Caitlin Snyder, U.S. Fish and Wildlife Service (September 24, 2012, 7:01 PM); E-mail response from Nancy Green, Climate Change Specialist, U.S. Fish and Wildlife Service, to Shawn Sartorius, Ph.D., U.S. Fish and Wildlife Service (September 24, 2012, 7:23 AM).
[51] Inman (2013) at p. 5
[52] E-mails between Jeff Copeland, and Dr. Audrey Magoun, Wildlife Research and Management (March 5, 2014-March 18, 2014). (hereafter "Copeland, Magoun (2014)").
[53] Copeland, Magoun (2014)

> up this big controversy about the validity of the science when the issue is the validity of the FWS finding – two very different things.
> I personally don't believe listing is warranted, and neither does Kevin McKelvey. I do believe though that the FWS has a compelling argument. THAT is what needs to be debated. Saying we can't discuss this until we know the answers to all the questions you pose suggests we probably can never discuss it. All the paper says is that late spring snow is important for denning, which you seem to agree with. Neither of these papers suggest that means the wolverine needs listed [sic].[54]

In addition to the insights gained during peer review, FWS obtained important new survey data and analysis on wolverine denning and habitat needs from state biologists and conservation experts on demonstrating that listing was not warranted.[55] API and UARG provided detailed comments (attached hereto) that McKelvey (2011) had used climate models to predict changes on spatial scales and temporal horizons beyond what the model builders claimed could credibly be predicted.[56] API and UARG further noted that that the Proposed Listing's reliance on projections of complex temperature and precipitation interactions on small geographically complex areas so far into the future exceeded what listing agencies claimed could credibly be predicted in other listing decisions.[57] The Service also gained a more refined understanding of the limits of climate modeling through its Regional Director for Science Applications, Dr. Torbit, who conferred with the National Oceanic and Atmospheric Administration (NOAA) about the limits of modeling precipitation changes in complex montane environments and learned that a more recent NOAA study modeled the persistence of snowpack at comparable levels in "the higher elevations of Colorado and the northern Rockies"[58] – the precise areas McKelvey (2011) deemed to be most at risk from projected climate change impacts.

FWS also convened a panel of nine scientists with diverse, but relevant, expertise ("Science Panel").[59] Over two days in April 2014, FWS conducted a structured review on the relationship of wolverines to snow, and the prospect of the wolverine losing so much habitat that it would be placed at risk of extinction.[60] The panelists generally expressed support for the notion that wolverines need deep springtime snow for successful denning, but expressed a mixture of

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[54] Copeland, Magoun (2014) (March 15-16)

[55] Office of Species Conservation and the Idaho Department of Fish and Game, Comments on No. FWS–R6–ES–2012–0107 (May 6, 2014); Montana Fish, Wildlife & Parks, Comments on No. FWS–R6–ES–2012–0107 (May 6, 2014); Wyoming Game and Fish Department, Comments on No. FWS–R6–ES–2012–0107 (May 1, 2014); State of Utah, Comments on No. FWS–R6–ES–2012–0107 (December 2, 2013); Montana Fish, Wildlife & Parks, Comments on No. FWS–R6–ES–2012–0107 (December 2, 2013); Office of Species Conservation, State of Idaho, Comments on No. FWS–R6–ES–2012–0107 (December 2, 2013); Office of the Governor, State of Wyoming, Comments on No. FWS–R6–ES–2012–0107 (May 6, 2013); Office of Species Conservation on behalf of the State of Idaho, Comments on No. FWS–R6–ES–2012–0107 (May 6, 2013).

[56] See Docket Nos. FWS-R-2012-0107-12410 (Dec. 2, 2013).

[57] American Petroleum Institute and Utility Air Regulatory Group, Comments on No. FWS–R6–ES–2012–0107 (December 2, 2013) at pp. 7-8.

[58] Memorandum from Noreen E. Walsh, Regional Director, Region 6 to Assistant Regional Director, Ecological Services at p. 5. (May 30, 2014) (hereafter "Walsh (2014)").

[59] Michael Mitchell, Steve Morey, Teresa Woods, Wolverine Science Panel Workshop, Spokane, Washington (April 3-4, 2014) (hereafter "Mitchell et al. (2014)").

[60] Mitchell et al. (2014) at p. 3.

uncertainty and skepticism about the depth and duration of spring snow and its importance outside of denning.[61]

In spite of the new evidence, a handful of the primary drafters of the Proposed Listing continued to recommend to their Region 6 Director, Noreen Walsh, that its findings be finalized.[62] The directors of the two other Regional Offices with wolverine habitat recommended that the Proposed Listing be withdrawn.[63] Other field offices within Region 6 expressed similar skepticism about the conclusions reached in the Montana Field Office.[64] Regional Director Walsh, "a trained wildlife biologist [with] extensive experience in ESA" who was involved in the wolverine listing process,[65] drafted a painstakingly detailed explanation why she did not share the conclusions of the drafters of the Proposed Listing, and why she was recommending that FWS withdraw the Proposed Listing because they could not credibly conclude that wolverines would be at risk of extinction throughout all or a significant portion of the range in the foreseeable future.[66] Regional Director Walsh sent her recommendation and those of two other regional directors to the FWS Director. Thereafter, the head of the Montana Field Office and the Assistant Regional Director, who participated in the recommendation to Director Walsh, informed the FWS Director that Regional Director Walsh's conclusions were reasonable and objective, even if they differed from their own.[67]

The detailed recommendation provided by Regional Director Walsh was accepted by the FWS Director, and became the basis for the Service's decision to withdraw its Proposed Listing. The Service's ultimate Withdrawal Decision explained why FWS departed from the preliminary conclusions it reached in the Proposed Listing, incorporated and explained all new data and analysis, and provided detailed justifications for the final determination withdrawing the Proposed Listing.[68]

c. 2016 District Court Decision

On October 13, 2014, numerous advocacy groups filed multiple challenges to the Service's Withdrawal Decision. The groups argued (among other things) that the Withdrawal Decision: (1) did not appropriately consider the wolverine's obligate relationship with persistent spring snow as identified in Copeland (2010); (2) did not appropriately consider McKelvey (2011) and its modeled declines in snow as described by Copeland (2010), and; (3) did not appropriately consider whether

[61] Mitchell et al. (2014).
[62] Email from Michael Thabault, Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service to Noreen Walsh, Regional Director, Region 6 (May 14, 2014 2:37 PM).
[63] Memorandum from Regional Director, Pacific Southwest Region to Regional Director, Mountain Prairie Region; Memorandum from Regional Director, Region 1, Portland, Oregon to Regional Director, Region 6, Lakewood, Colorado (May 16, 2014).
[64] E-mails between Brian T. Kelly, State Supervisor, U.S. Fish and Wildlife Service, Hilary Cooley, U.S. Fish and Wildlife Service, and Theresa Rabot, U.S. Fish and Wildlife Service (November 5-6, 2013).
[65] E-mail from Matt Hogan to Noreen Walsh, Regional Director, Region 6 (August 12, 2014, 10:47 AM) (hereafter "Hogan (2014)").
[66] Walsh (2014).
[67] Hogan (2014).
[68] See 78 Fed. Reg. 47,522 *et. seq.*

wolverine population size (alone or in conjunction with climate change projections) threatens the species with extinction.[69]

The District of Montana agreed with the plaintiffs on these three issues, vacated the Withdrawal Decision, and remanded the issue to FWS for further consideration.[70] Notably, the court did not accept any of plaintiffs' arguments regarding threats from trapping, development, recreation, or inadequate regulatory protections, and therefore did not remand those issues to FWS for reconsideration.[71]

As such, while the court decision is lengthy, the matters remanded for further consideration were few and should be narrowly construed. And because FWS examined all the best available evidence identified by plaintiffs and discussed by the court, FWS can comply with the court order by more fully explaining how it derived its conclusions from that same information. Moreover, as explained in more detail below in Section IV, multiple studies that were not considered by FWS or were published after its Withdrawal Decision bolster FWS's determination.

IV. The Service Cannot Reopen the Comment Period on a Proposed Listing that It Knows to be Based on Outdated Information and Flawed Analysis

As discussed above, the Proposed Listing was not the product of an open-ended inquiry into the conservation status of wolverines. A misreading of the Service's obligations under the 2011 Settlement Agreements led FWS biologists to believe that they must draft a proposed rule to list wolverines as threatened.[72] As such, the proposed conclusion – that wolverines in the conterminous United States were likely to be driven to the brink of extinction within the foreseeable future – was largely preordained.

FWS, to its credit, subsequently subjected this conclusion to scrutiny and allowed the available data to dictate its ultimate determination, but the fact remains that the Proposed Listing was not the product of an open-ended scientific inquiry. While FWS is, in many ways, bound by the District of Montana's vacatur of the Service's Withdrawal Decision, the court *remanded* key aspects of the Service's analysis to FWS "for further consideration."[73] This "further consideration" can, and should, take the form of a status review or new proposal wherein FWS conducts a fresh analysis of the status of the wolverine as well as the fundamental question of whether wolverines in the conterminous United States actually constitute a DPS. FWS cannot simply reinstate a Proposed Listing FWS knows to be substantively erroneous and procedurally flawed because FWS is also bound by the ESA, the Administrative Procedure Act ("APA"), and the Information Quality Act ("IQA"). These statutes dictate that, on remand, FWS should begin from the proposed-rule stage – but not with the prior proposed rule that FWS knows to be substantively erroneous and procedurally flawed. The Service's proposed action violates the ESA, APA, and IQA for the following reasons:

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[69] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).
[70] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).
[71] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).
[72] Sartorius, Inman et al. (2011).
[73] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).

- ESA – Setting aside the Service's subsequent conclusion that the Proposed Listing recommended a conclusion that FWS later understood to be improper under the ESA, reinstating an outdated and erroneous proposed listing violates the ESA's requirement that both proposed and final listings utilize "the best scientific and commercial data available."[74] The Proposed Listing that FWS proposes to reinstate relies on the more limited scientific data that were available in 2013. There is no dispute that this information is incomplete and outdated. The Withdrawal Decision identified additional relevant new data and, as discussed further below, a tremendous amount of new wolverine research has become available since the time of this rulemaking that answer questions that were fundamental to the Proposed Listing and Withdrawal Decision. None of this information, nor the Service's characterization or interpretation of this information, has been made available. As such, in reading the court's order as requiring FWS to revert to the Proposed Listing as opposed to the proposed rule stage of rulemaking, FWS is violating the ESA's "Best Available Science" standard.
- IQA - The IQA and Office of Management and Budget ("OMB") rules implementing the IQA require that the federal government[75] take steps to maximize the quality, objectivity, and integrity of the information they disseminate, and to provide a mode of redress to correct flawed or incomplete information. Federal entities, including FWS, implement these objectives through individual guidelines.[76] These guidelines require that the information the Service disseminates meets standards for objectivity, utility, and integrity.[77] The "objectivity standard" focuses on whether the information is presented in an accurate, clear, complete, and unbiased manner.[78] The Proposed Listing is inaccurate, based on incomplete information, and the product of drafting effort designed to reach a preselected finding. As such, in reinstating the Proposed Listing without updating its inaccuracies or at least characterizing its limitations or disclaiming that it no longer represents the Service's full understanding of wolverines' conservation status, FWS is violating the IQA.
- OMB/FWS Peer Review Guidelines – FWS's Information Quality and Peer Review Guidelines instruct and emphasize that "When FWS is conducting a peer review of influential information, the reviewers must be both external and independent except in very rare circumstances where no external, independent experts can be found."[79] Similarly, OMB instructs that peer reviewers should be independent, that reviewers should not be "employed by the agency or office producing the document [that is

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[74] 16 U.S.C. § 1533(b)(1)(A).

[75] PL-106-554.

[76] https://www.fws.gov/informationquality/topics/FWS%20Information%20Quality%20Guidelines.pdf (accessed 11/4/2016).

[77] https://www.fws.gov/informationquality/topics/FWS%20Information%20Quality%20Guidelines.pdf (accessed 11/4/2016).

[78] https://www.fws.gov/informationquality/topics/FWS%20Information%20Quality%20Guidelines.pdf (accessed 11/4/2016).

[79] U.S. FISH & WILDLIFE SERVICE, INFORMATION QUALITY GUIDELINES AND PEER REVIEW 11 (June 2012).

to be reviewed]," and that conflicts of interest are to be avoided.[80] Notwithstanding this guidance, FWS submitted the Proposed Listing to seven peer reviewers - four of whom were employed by the USFS [81]which manages the vast majority of wolverine habitat,[82] six of whom coauthored Copeland (2010),[83] and four of whom coauthored McKelvey (2011).[84] The peer review process was central to prior debates on the conservation status of wolverines in the conterminous United States and was at issue in the ensuing legal action. On remand, FWS can, and should, subject a new proposed listing to a proper independent and external peer review.

- APA – The APA requires an agency to "provide sufficient factual detail and rationale for the rule to permit interested parties to comment meaningfully."[85] Such information should include the latest data on the wolverine's status as well as the Service's analyses and reflections on that data. By simply re-issuing its prior 2013 Proposed Listing, FWS has not provided the public with a meaningful opportunity to comment. The Proposed Listing does not provide the most current population data and analysis, and it does not correct the inaccuracies that were noted during litigation of the Withdrawal Decision. Stakeholders therefore have no way to meaningfully comment on whether FWS has evaluated the best available evidence for the status of the wolverines and whether they have reached the right conclusion from that evidence. The APA demands that FWS issue a proposal in conjunction with the Service's evaluation of the wolverine status, based on all the information available to the FWS and meaningful public comment

While vacatur of the Withdrawal Decision arguably requires the Service to revert to the proposed rule stage, the important statutory constraints discussed above prohibit FWS from simply reverting to the Proposed Listing that is outdated, substantively erroneous, and procedurally flawed. The court remanded this matter to FWS "for further consideration."[86] This "further consideration" can, and should, take the form of a status review or new proposal wherein FWS conducts a fresh analysis of the status of the wolverine, as well as the fundamental question whether wolverines in the conterminous United States constitute a DPS.

V. Wolverines in the Conterminous United States Are Not a Distinct Population Segment

The wolverines that are the subject of this Proposed Listing represent the southernmost extent of a larger North American subspecies of wolverines. The Service's classification of wolverines in the conterminous United States as a DPS has no biological basis and conflicts with the policies and practices for delineating DPS.

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[80] Memorandum from Joshua B. Bolton, Director, Executive Office of the President Office of Management and Budget, to Heads of Departments and Agencies, M-05-03, Issuance of OMB's "Final Information Quality Bulletin for Peer Review" 17–20 (Dec. 16, 2004).

[81]E-mail from Brent Esmoil, Acting Field Supervisor, U.S. Fish and Wild Life Service to John Squires, Research Wildlife Biologist (March 06, 2013, 10:39 AM); Zielinski Review (2013); Esmoil, Schwartz (2013); Aubry (2013).

[82] Ashe (2014).

[83] Copeland (2010).

[84] McKelvey et al. (2011).

[85] *Fla. Power & Light Co. v. United States*, 846 F.2d 765, 771 (D.C. Cir. 1988).

[86] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).

"The bulk of the range of North American wolverines is found in Canada and Alaska . . . ."[87] FWS estimates that there are between 15,089 and 18,967 wolverines in western Canada, and an uncertain number in eastern Canada.[88] The number of wolverines in Alaska is unknown, but they appear to exist at naturally low densities, and there is no evidence "to indicate that wolverine populations have been reduced in numbers or geographic range in Alaska."[89] "The southern portion of the species' range extends into the contiguous United States, including high-elevation alpine portions of Washington, Idaho, Montana, Wyoming, California, and Colorado."[90]

The number of wolverines in the southernmost extent of this larger North American population (the DPS) is not well understood, but likely measures in the hundreds.[91] While wolverines in the conterminous United States are increasing in abundance and expanding their range,[92] the fact that wolverines in the conterminous United States are not particularly abundant has caused some to question the conservation status of the wolverine DPS. To put it another way, absent the Service's artificial delineation of North American wolverines along the political boundary between the United States and Canada, the conservation status of the DPS would not be in question at all. While, as discussed below, we do not believe that the DPS alone meets the ESA's definition of a "threatened" or "endangered" species, the Trade Associations believe that an analysis of the status of the wolverine must start with the question of whether the DPS simply represents the ~300 wolverines that happen to fall below the US/Canadian border or whether those wolverines are markedly distinct in some important way.

a. DPS Designation Must be Used Sparingly and Only When Stringent Criteria Are Met

The ESA applies to distinct taxonomic species, "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature."[93] The aspects of this definition that relate to DPS were intensely scrutinized during congressional debate for fear that, through recognition of DPS, the ESA could be manipulated to disaggregate a species to such an extent that even healthy and abundant species could be found to be endangered.

The 1978 addition of the phrase "DPS" was, in fact, designed to constrain language in the ESA of 1973 which extended the statute to "any other group of fish or wildlife of the same species or smaller taxa in common special arrangement that interbreed when mature." Still, the U.S. General Accounting Office ("GAO") warned that use of a DPS could lead to unnecessary subdivision that did little more than lead to the listing of segments of healthy and abundant species.[94] In response to such concerns, Congress noted in the Conference Report on the ESA Reauthorization

[87] 78 Fed. Reg. at 7,868.
[88] 78 Fed. Reg. at 7,869.
[89] 78 Fed. Reg. at 7,869.
[90] 78 Fed. Reg. at 7,866–67.
[91] Robert M. Inman, et al., *Spatial Ecology of Wolverines at the Southern Periphery of Distribution.* 76(4): 778-792 (2011) (hereafter "Inman et al., (2011)")
[92] Inman et al., (2011).
[93] 16 U.S.C. § 1532(16).
[94] See U.S. General Accounting Office, Endangered Species: A Controversial Issue Needing Resolution (1979).

recognition that it "is aware of the great potential for abuse of this authority," and included an admonition that the listing agencies use their DPS authority "sparingly and only when then biological evidence indicates that such action is warranted."[95]

In the ensuing decades, the listing agencies have generally respected the high bar that Congress demanded be used to designate a DPS. In 1991, NMFS established a policy outlining criteria for designating Pacific salmon by DPS.[96] Under the policy, DPS status was restricted to "evolutionarily significant units" ("ESU") that are substantially reproductively isolated and which represent an important component of the evolutionary legacy of the species.[97] In 1996, NMFS and FWS established a new, more encompassing DPS policy that, like the ESU policy and consistent with congressional intent, maintained a high bar to designate a DPS.[98] For a population segment to be considered a DPS under the 1996 policy, the segment must meet two criteria: (1) it must be discrete; and (2) it must be significant.[99] Discreteness requires conspicuous separation from the remainder of the species, but separation alone is not enough to be a DPS.[100] Even if the species is markedly discrete, the listing services, at Congress's direction, instruct that the discrete segment be significant in some unique biological manner or that the segment provide some significant role in the species as a whole.[101] "When a species exists across a wide range of ecological settings, . . . the fact that it persists in one particular location . . . says little about whether the population in that location is important to the species as a whole."[102]

The "significance" element of the DPS Policy is critical to the evaluation of population segments for DPS status. Indeed, FWS has found several populations to be discrete, but declined to extend DPS status because the discrete segment was not significant.[103]

The DPS Policy provides a high hurdle – appropriately so. In developing the DPS Policy, FWS acknowledged that Congress instructed the Service to "use its authority with respect to designating DPSs 'sparingly' and only in instances 'when the biological evidence indicates that such action is warranted.'" Unlike ESA listing decisions wherein a listing agency is acting to avoid extinction of a species and therefore employs a precautionary approach, DPS designation involves the structuring of a species' population. The listing services must be careful to avoid a widespread deconstruction of taxonomic units, which would lead to an enormous drain on agency resources with little or no conservation benefit to the species.

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[95] S. Rep. No. 95-151, at 7 (1979), reprinted in ESA Legislative History, *supra* note 144, at 1397.
[96] 56 Fed. Reg. 58612 (Nov. 20, 1991).
[97] *Id* at 58518.
[98] 61 Fed. Reg. 4722 (Feb. 7, 1996).
[99] *Id* at 4725. If the species is both discrete and significant, it is considered a DPS, but that DPS is not then protected under the ESA unless and until the listing agency determines that the DPS is either threatened or endangered under the ESA.
[100] *Id.*
[101] *Id.*
[102] *Center for Biological Diversity v. Jewell*, No. CV-12-02296-PHX-DGC, 2014 WL 5703029, at *6 (D. Ariz. Nov. 5, 2014).
[103] *See, e.g.*, 67 Fed. Reg. 44133 (Jul. 1, 2002); 68 Fed. Reg. 11574 (Mar. 11, 2003); 68 Fed. Reg. 34628 (Jun 10, 2003); 77 Fed. Reg. 25792 (May 1, 2012).

This is exactly the situation with the North American wolverine. FWS should not be spending resources to evaluate the dynamics of a population that happens to be located south of a political boundary. As many biologists and studies have admonished, FWS would benefit wolverines in the conterminous United States far more by understanding that they are part of a larger North American subspecies and by managing this larger subspecies cooperatively with Canada.[104]

b. The Service's DPS Analysis

FWS finalized its DPS analysis for the wolverine in 2010, and despite repeated calls from API, UARG, and other commenters on the 2013 Proposed Listing[105] and by intervenors in the subsequent litigation,[106] FWS has refused to consider (or even respond to) relevant and credible questions about the validity of the DPS analysis. Given the exclusion of the DPS issue from the Federal Register notice reopening comment on the 2013 Proposed Listing, it appears that FWS is continuing to insulate its 2010 DPS analysis from scrutiny. As discussed below, there was no evidence to support the DPS analysis in 2010, and after six additional years of research on North American wolverines, the Service's outdated DPS analysis is even more questionable.

1. Discreteness

FWS determined that wolverines in the conterminous United States were discrete because their "conservation status" differed from wolverines in Canada.[107] Importantly, FWS did not base its "discreteness" analysis on any physical, physiological, ecological, behavioral, morphological, or genetic distinction. Nor could they - wolverines in the conterminous United States are no different than wolverines in Canada. While different meta-populations of wolverines have some genetic distinctiveness, that distinctiveness is inherent in all meta-populations, and necessary for overall genetic diversity.[108] Wolverines in the United States and Canada share a large number of haplotypes in common, not only because they share a common ancestry, but because they continue to intermix and breed across the border.[109]

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[104] Robert Inman *et al.*, *Wildlife as Public Domain: Endangered Status, Connectivity, and Critical Habitat of the Wolverine*, Manuscript; August 9, 2016 letter from the Western Association of Fish and Wildlife Agencies; November 3, 2016 Comment Letter from Wyoming Game & Fish Department.

[105] *See* American Petroleum Institute Comments (Dec. 2, 2013), Docket No. FWS-R6-ES-2012-0107-12410, at 14–16.

[106] *See Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016).

[107] 75 Fed. Reg. at 78,037.

[108] James Zigouris et al., *Phylogeography and Post-Glacial Recolonization in Wolverines (Gulo Gulo) from Across Their Circumpolar Distribution.* 8:12 1-17 (2013) (hereafter "Zigouris et al. (2013)"); Yessica Rico et al., *Lack of Spatial Immunogenetic Structure Among Wolverine (Gulo Gulo) Populations Suggestive of Broad Scale Balancing Selection.* 9: 1271-1284 (2015) (hereafter"Rico (2015)").

[109] Zigouris (2013); Rico (2015); Kevin S. McKelvey et al., *Recovery of Wolverines in the Western United States: Recent Extirpation and Recolonization or Range Retraction and Expansion?.* 78(2): 325-334 (2014) (hereafter "McKelvey (2014)"); Andrea Kortello and Doris Hausleitner, *Abundance and Distribution of Wolverine in the Kootenay Region.* (2014 Report) (hereafter "(Kortello, Hausleitner (2014)"); Inman, R., M. Riley, Z. Walker, B. Lanka, and G. White. Distribution of Female Wolverines in Wyoming, Progress Report- August 2015 (hereafter "(Progress Report 2015)").

The alleged difference in conservation status – again, the only distinction recognized by FWS – was based on differences in population size, available habitat, and harvest levels.[110] While FWS was correct to note that there are more wolverines, more wolverine habitat and more wolverine harvest north of the border, FWS fails to recognize that these distinctions are fictions created by the Service's DPS.

There are more wolverines in Canada than in the purported DPS because FWS decided to draw the DPS demarcation at the US/Canadian border and therefore on the periphery of the larger population. The wolverines below the boundary are not in peril simply because there are fewer of them than there are above the line.[111] Similarly, there is more habitat and larger habitat islands in Canada because wolverine habitat is defined by snow. In the northern hemisphere, northern latitudes are colder and hold more snow. Temperatures generally increase, and therefore snow cover generally decreases, the closer the location is to the equator. The exceptions to this well-understood principle are the higher elevation areas that wolverines tend to inhabit in the United States. As with population, there is more habitat outside the DPS than within the DPS because of where FWS decided to draw the line delineating the DPS. Wolverines in the United States are not in a perilous state simply because the Service's DPS delineation apportioned more habitat to one side of the line than the other.

The distinction FWS identified between harvest rates outside of and within the DPS are again a function of the Service's arbitrary line-drawing. More wolverines are harvested north of the line because there are more wolverines north of the line. Importantly, while FWS found differences between the levels of wolverine exploitation in Canada and the United States, it did not recognize any difference in the status of legal or regulatory protections for the wolverine.[112] Those regulatory protections remain very similar. Accordingly, the only distinctions that would justify delineating a population by political boundary – differences in laws and/or regulations – are not distinctions at all.

FWS therefore had no basis to delineate the DPS along a political boundary, and any differences in abundance, habitat, or exploitation are simply the result of arbitrary line drawing.[113]

2. Significance

Even if FWS could credibly show that wolverines in the conterminous United States were distinct from wolverines directly across the border in Canada, the Service would still need to demonstrate that the distinctiveness of the population segment is important to the taxon as a whole.[114] This "significance" consideration is important as FWS, applying the DPS Policy, has found several

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[110] 75 Fed. Reg. at 78,040

[111] Also note that individuals of a species almost always become more rare at the edges of their ranges because the habitat naturally has changed from more favorable to less favorable. Otherwise, they would be everywhere. Scarcity alone does not equate to ESA status. Here, it may simply mean that wolverines happen to be at the southernmost portion of their range.

[112] 73 Fed. Reg. at 12,929; 75 Fed. Reg. at 78,039.

[113] Indeed, under the analysis FWS employed in its 2010 DPS analysis, a DPS could be created from any species by simply drawing the DPS delineation close to the extent of the habitat.

[114] 61 Fed. Reg. 4725.

species to be distinct, but did not classify them as DPS because they were not important to the taxon as a whole.[115]

In assessing significance, FWS considered: (1) whether the population persists in a setting that is unique or unusual to the taxon; (2) whether loss of the population would result in a significant gap in the range of the taxon; and, (3) whether the population differs markedly from other populations in its genetic characteristics.[116] FWS concluded that wolverines in the conterminous United States do not exist in a unique or unusual setting and further concluded that there were no marked genetic differences between wolverine populations in the United States and Canada.[117] The Service's entire basis for determining that putative DPS was significant to the wolverine taxon as a whole was its view that loss of wolverines would result in a significant gap in the range of the species.[118]

The DPS Policy requires FWS to evaluate: (1) the size of the population segment relative to the taxon as a whole; (2) the size of the population segment's range relative to the range of the taxon as a whole; (3) the likelihood that other populations would immigrate and repopulate the extirpated range; (4) distinctive traits or genetic variations of the population segment; and (5) the role of the population segment's range relative to the taxon as a whole.[119] Each element is discussed below:

> Population Size – FWS deemed wolverines in the conterminous United States to be "discrete" because of their low abundance relative to wolverines in Canada and Alaska. As such, the Service appropriately did not rely on population size as a measure of the population's significance to the larger North American taxon.
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> Range Size – FWS appropriately noted that the conterminous United States contains a large area of wolverine range. However, this range is only a fraction of the North American wolverine's range in Canada and Alaska. Further, FWS did not conclude, as is required by the DPS Policy, that wolverine range in the conterminous United States is important to the taxon as a whole. Wolverines in Canada and Alaska would continue to thrive in the absence of wolverine habitat in the conterminous United States. We know this because wolverines in Canada and Alaska continued to thrive while wolverines were functionally extirpated in the conterminous United States up until the 1930s.[120]
>
> Likelihood of Repopulation - If wolverines in the conterminous United States were hypothetically extirpated, it is likely that the United States would be repopulated by wolverines from Canada. Again, we can accurately predict this response because it happened in recent history,[121] because wolverine territoriality requires range to expand as

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[115] *See e.g.*, 67 Fed. Reg. 44133 (Jul. 1, 2002); 68 Fed. Reg. 11574 (Mar. 11, 2003); 68 Fed. Reg. 34628 (Jun 10, 2003); 77 Fed. Reg. 25792 (May 1, 2012).
[116] 75 Fed. Reg. at 78,040.
[117] 75 Fed. Reg. at 78,040.
[118] 75 Fed. Reg. at 78,040.
[119] *Id.* at 25809.
[120] 75 Fed. Reg. at 78,041.
[121] 75 Fed. Reg. at 78,041.

population increases,[122] and because wolverines freely intermix and migrate across the US/Canadian border.[123]

Distinctive Traits – FWS concluded in multiple contexts that wolverines in the conterminous United States are physiologically indistinguishable and genetically similar to wolverines in Canada and Alaska.[124] FWS therefore appropriately declined to rely on distinctiveness in this analysis.

Role of the Population's Range - A specific population can be significant to the taxon as a whole if extirpation there caused other populations to be isolated from each other.[125] That is not the case in the conterminous United States. The conterminous United States represents the southern periphery of the North American wolverine subspecies and provides no linkage or bridge between two or more different wolverine populations. Nor does the conterminous United States provide exclusive feeding or breeding grounds for the taxon.[126] The conterminous United States is a relatively small, peripheral, and largely indistinguishable part of the North American wolverine's overall range. Consistent with the DPS policy, FWS has found such populations do not play significant roles for their overall taxon[127] and the Service should make a similar finding here as well.

A hypothetical (and very unlikely) loss of wolverines from the conterminous United States would not significantly reduce North American wolverine's population, range, physical, genetic, or behavioral diversity; or the health, abundance, or diversity of contiguous populations. Indeed, it is highly likely that the conterminous United States would be repopulated by Canadian wolverines as occurred in previous decades. As such, loss of wolverines from the conterminous United States would not lead to a significant gap in the range of the North American taxon.

Wolverines were not properly designated as a DPS in 2010 and the more we understand the cross-border behaviors and genetic similarities of wolverines, the more we have come to understand that the 2010 DPS designation is impermissible. The current DPS lacks any biological, legal, or regulatory basis. FWS cannot credibly reconsider the status of wolverines in the conterminous United States without first reconsidering whether it has selected the proper population to evaluate. The Trade Associations request FWS to reconsider its DPS determination and allow comment on this important issue.

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[122] Richard Bischof et al., *Noninvasive Genetic Sampling Reveals Intrasex Territoriality in Wolverines*. 6(5): 1527-1536 (2016).

[123] Raymond, Crystal L., Peterson, David L., Rochefort, Regina M. *Climate Change Vulnerability and Adaptation in the Northern Cascades Region, Washington.* (2014) U.S. Department of Agriculture, Forest Service (hereafter "USDA (2014)"); Northern Rockies Adaptation Partnership Climate Projection Report. P 3.

[124] 75 Fed. Reg. at 78,040.

[125] 61 Fed. Reg at 4724; *see also* 62 Fed. Reg. 10730 (Mar. 10, 1997).

[126] *See* 77 Fed. Reg. 25809.

[127] For example, in response to the petition to list the Washington population of the Western grey squirrel as a DPS, FWS found that even if all grey squirrel were extirpated from the entire state of Washington, such a gap would not be significant because they could not show that the Washington population had any biological or ecological significance to the overall taxon. 68 Fed. Reg. at 34637.

VI. Even if Wolverines in the United States Are Considered a DPS, that DPS Does Not Meet the ESA's Definition of a "Threatened Species."

While we do not believe there is any evidence that wolverines in the conterminous United States are distinct – significantly or otherwise – from the abundant wolverines across the Canadian border and in Alaska, an examination of even that periphery of the larger wolverine population that is found south of the Canada border shows that it fails to meet the ESA's definition of a threatened species. FWS correctly reached that same conclusion in its Withdrawal Decision. While the subsequent court decision ordered FWS to reconsider and more fully explain its conclusions, it cannot be interpreted as mandating that FWS reach a conclusion that is inconsistent with the available science or impermissible under the ESA.

The Trade Associations continue to view the Withdrawal Decision as the product of sound analysis and as the only outcome permissible under the ESA. Unfortunately, the District of Montana took a different view. In the subsections that follow, we discuss those aspects of the listing analysis that the court believed lacked sufficient support.[128] These issues, which include the wolverine's relationship to a specific type of snow, the ability to model future reductions of that specific type of snow, and the potential risks posed by genetic diversity, are complex. It is therefore important to more fully explain that the Service's conclusion that wolverines are not likely to be driven to the brink of extinction within the foreseeable future was not based on the rejection of climate modeling, an impermissible insistence on proving threats with certainty, or dismissal of the best available science.

Further, because it has been nearly four years since the Proposed Listing was published and over two years since the Withdrawal Decision was published, a significant amount of new information is available that is directly relevant to the Service's ESA listing analysis. A great deal of research has been conducted on wolverines since the 2013 Proposed Listing, and our understanding of climate modeling and genetic-level population dynamics is continually changing. As such, the subsection below will identify new data and new studies that add further support to the Service's conclusion that wolverines in the conterminous United States are not at risk of being driven to the brink of extinction within the foreseeable future.

a. The ESA Imposes a High Standard for Listing Species

The ESA sets a high standard for listing a species as threatened or endangered. An "endangered" species is statutorily defined as one that is presently in danger of extinction throughout all or a significant portion of its range.[129] A "threatened" species is one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.[130] When evaluating the status of a species, FWS must consider the following five factors:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;

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[128] For discussions of other factors like trapping, outdoor recreation, see API's prior comments on the 2013 Proposed Rule.
[129] 16 U.S.C. § 1532(6).
[130] *Id.* § 1532(20).

(2) overutilization for commercial, recreational, scientific, or educational purposes;

(3) disease or predation;

(4) the inadequacy of existing regulatory mechanisms; and

(5) other natural or manmade factors that affect the species' continued existence.[131]

In making these assessments, FWS must use "the best scientific and commercial data available" after conducting a review of the status of the species and taking into account the efforts being made by any nation or political subdivision of a nation to protect the species, including through predator control, protection of habitat and food supply, or other conservation practices.[132]

The best scientific and commercial data available indicate that wolverines in the conterminous United States are merely the southernmost portion of a larger, more widespread North American population and that, even within the conterminous United States, wolverines populations are at the highest levels ever recorded and continuing to expand in range and abundance. There is certainly no rational or scientifically supportable basis for interpreting the best available data to suggest that wolverines in the conterminous United States are likely to become in danger of extinction in the foreseeable future.

Courts have universally held that the decision to list a species as threatened or endangered is not to be based on speculation or a misplaced intent to err on the side of species conservation:

> Under Section 4, the default position for all species is that they are not protected under the ESA. A species receives the protections of the ESA only when it is added to the list of threatened species after an affirmative determination that it is "likely to become endangered within the foreseeable future." Although an agency must still use the best available science to make that determination, *Conner* [*v. Burford,* 848 F.2d 1441 (9th Cir. 1988)] cannot be read to require an agency to "give the benefit of the doubt to the species" under Section 4 if the data is uncertain or inconclusive. Such a reading would require listing a species as threatened if there is any possibility of it becoming endangered in the foreseeable future. This would result in all or nearly all species being listed as threatened.[133]

Whether a species should be listed under the ESA (or not) is not a question of whether the species is important, iconic, or deserving of conservation. Nor can species be listed based on a finding that they are being harmed, may be harmed in the future, or that certain threats are adversely

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[131] *Id.* § 1533(a)(1).

[132] *Id.* § 1533(b)(1)(A).

[133] *Trout Unlimited v. Lohn*, 645 F. Supp. 2d 929, 947 (D. Or. 2007); *see also Center for Biological Diversity v. Lubchenco*, 758 F. Supp. 2d 945, 955 (N.D. Cal. 2010) (finding that the "benefit of the doubt" concept does not apply in the Section 4 listing context); *Oregon Natural Resources Council v. Daley,* 6 F. Supp. 2d 1139, 1152 (D. Or. 1998) (ESA requires a determination as to the likelihood—rather than the mere prospect—that a species will or will not become endangered in the foreseeable future); *Federation of Fly Fishers v. Daley*, 131 F. Supp. 2d 1158, 1165 (N.D. Cal. 2000) ("The ESA cannot be administered on the basis of speculation or surmise.").

impacting their abundance. Listing status is measured by the prospect that the species will cease to exist. Assessing the prospect of extinction is necessarily imprecise, and the Service's judgments are entitled to deference if based on best available evidence and the five listing criteria, but the question the ESA requires FWS to answer does not change: Is this species at risk of extinction today, or is a risk of extinction likely to arise in the foreseeable future?

1. Foreseeable Future

The ESA does not define the term "foreseeable future." FWS, however, has interpreted it to mean "the horizon over which predictions about the conservation status of the species can be reasonably relied upon."[134] Because of the uncertainties inherent in attempting to predict the future, a forecast that is reasonably reliable—and thus encapsulates the "foreseeable future''—tends, at most, to look forward only a few decades. It does not allow for analyses based on speculation or those that are not grounded in facts and knowledge. "The timeframe over which the best available scientific data allow us to reliably assess the effect of threats on the species is the critical component for determining the foreseeable future."[135]

In other words, the foreseeable future extends only so far as FWS "can explain reliance on the data to formulate a reliable prediction."[136] What must be avoided is reliance on assumption, speculation, or preconception. Thus, for a particular species, FWS may conclude, based on the extent or nature of data currently available, that a trend has only a degree or period of reliability, but to extrapolate that trend beyond that point would constitute speculation.[137] For instance, the Service can, and should, credibly question the reliability of projecting the presence or absence of a particular type of precipitation (late spring snow) several decades into the future. Because so many variables must align for precipitation to occur (*e.g.* temperature, barometric pressure, moisture, wind patterns), it is one of the hardest climatological phenomenon to predict – especially in the topographically and meteorologically complex montane environment inhabited by wolverines.

Moreover, evaluating the foreseeable future requires analysis of not only "the foreseeability of threats, but also ... the foreseeability of the impact of the threats on the species."[138] The Solicitor's M-Opinion explained that "in each case the Secretary must be able to make reliable predictions about the future. The further into the future that is being considered, the greater the burden to explain how the future remains foreseeable for the period being assessed." [139] As relevant here, this directive means that, in order for threats to wolverines to be foreseeable, FWS must not only be able to reliably predict complex climatological changes specifically in wolverine habitat, it must be able to reliably predict the wolverine's response to those changes. If FWS is unable to reliably predict the changes to wolverine habitat, or wolverines' responses to those changes, the threat of extinction is not foreseeable.

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[134] 80 Fed. Reg. at 15,276 (emphasis added).
[135] 73 Fed. Reg. 28,212, 28,239 (May 15, 2008).
[136] Office of the Solicitor, U.S. Department of the Interior, *The Meaning of "Foreseeable Future" in Section 3(20) of the Endangered Species Act* at 8) ("M-Opinion").
[137] Memorandum from Solicitor, United States Department of the Interior, Office of the Solicitor to Acting Director, U.S. Fish and Wildlife Service at p. 8 (January 16, 2009) (hereafter "Solicitor (2009)").
[138] Solicitor (2009) at p. 10.
[139] Solicitor (2009) at p. 10

b. Abundance

In the 2013 Proposed Rule, FWS estimated that there are roughly 250 to 300 wolverines in the conterminous United States.[140] A study conducted by one of the Service's peer reviews but not relied on in the Proposed Rule estimated the conterminous United States population of wolverines at 318, with a 95% confidence interval of 249-926.[141]

While the precise number of wolverines in the conterminous United States remains difficult to estimate given the elusive nature of wolverines and the harsh, remote, and often dangerous landscapes they select as habitat, there is no dispute that wolverines' present abundance represents a significant increase from the species' functional extirpation in the first half of the twentieth century.[142] These increases in abundance correspond with increases in range because wolverines require low-density habitats and are well-known for their intense territoriality.[143] As such, increases in abundance can be expected from observed increases in range. And importantly, wolverine range in the conterminous United States is expanding and expected to continue to expand.[144]

Wolverines now occupy the northern Rocky Mountains in Idaho, Montana, Wyoming, and Oregon and the North Cascades in Washington.[145] More recently, wolverines have further dispersed into Colorado, California, and Utah.[146] The excursion into California represented the first verified wolverine siting in California since 1922 and the excursion into Colorado represented the first verified siting in Colorado since 1919.[147] Arguably, wolverines appear to be on a path toward self-recovery in the conterminous United States without the protections of the ESA.

Even more recently, as wolverine survey effort has increased and incorporated new technologies, even more wolverines are being detected – many in regions where wolverines were not previously found. In Wyoming, surveys conducted in the winter of 2014/2015 detected the first ever presence of a wolverine in the Gros Ventre mountain range in Wyoming.[148] Wolverine populations were detected in the Wind River, Absarokas, southern Absarokas, and Wind River ranges, as well.[149] Through a similar effort in the southwestern "Crown of the Continent" region of Montana, wolverine detections increased significant in survey years 2012, 2013, and 2014.[150] In 2014 alone, wolverines were detected in 38 different monitoring cells and nine unique wolverines were

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[140] 79 Fed. Reg. at 47,536.
[141] Inman et al., (2011).
[142] 78 Fed. Reg. at 7,871-72.
[143] Maurice G. Hornocker, Howard S. Hash. *Ecology of the Wolverine in Northwestern Montana.* Can. J. Zool. 59:1286-1301. (1980); Keith B. Aubry, Kevin S. McKelvey, Jeffrey P. Copeland. *Distribution and Broadscale Habitat Relations of the Wolverine in the Contiguous United States.* 71(7):2147-2158. (2007); Robert M. Inman, et al., *Wolverine Space Use in Greater Yellowstone.* Cumulative Report. (2007).
[144] 79 Fed. Reg at 47,536.
[145] *See* 78 Fed. Reg. at 7,871.
[146] *Id.* at 7,871; *see also* 79 Fed. Reg. at 47,539.
[147] 78 Fed. Reg. at 7,871.
[148] Progress Report 2015.
[149] Progress Report 2015.
[150] Forest Carnivore Monitoring in the Southwest Crown (Lieberg et al).

positively identified.[151] In the Cascades, survey data published earlier this year demonstrated for the first time that a resident population of wolverines is present in Washington State, that the population is connected to Canadian populations, and that wolverines in Washington are far more numerous and wide-ranging than had previously been estimated.[152]

In sum, when wolverine survey effort increased, so did the scientific community's understanding about the range and abundance of wolverines in the conterminous United States. We learned that wolverines are more abundant and wide-ranging than we previously understood. As stated in the Withdrawal Decision, wolverine range in the conterminous United States is expanding and will continue to expand.[153] On this fact alone, FWS should confirm that wolverines in the conterminous United States will be driven to the brink of extinction within the foreseeable future. FWS can only reach a contrary conclusion if the Service identifies a threat so credible and dire that it is likely to not only stop the wolverine's decades-long increase in abundance and range, but reverse it and cause wolverine abundance to plummet to such an extent that extinction is both likely and foreseeable. In the two subsections that follow, we discuss the ways in which the Proposed Listing erred in reaching such a conclusion in 2013 and the evidence – new and old – that demonstrate that the Service's conclusions in the Withdrawal Decision were sound.

c. Climate Change

As discussed above, the Proposed Listing preliminarily concluded that "[t]he primary threat . . . is from habitat and range loss due to climate warming . . .."[154] The Proposed Listing's preliminary conclusion that wolverines in the conterminous United States would likely be driven to the brink of extinction due to the projected impacts of climate change rested on two related conclusionsthat: (1)"[d]eep snow that persists into the month of May is essential for wolverine reproduction"; and (2)areas with "deep snow that persists into May" (May 15th to be exact) were projected to shrink by 31 percent by 2045 and 63 percent by 2070.[155]

Based on additional data and a superior understanding gained through the peer review process, FWS revised its interpretations of the key underpinnings of the alleged climate change threat and, determined that potential climate change impacts were not likely to endanger wolverines within the foreseeable future. While the District of Montana questioned the Withdrawal Decision's conclusions, much of the court's concern can be attributed to a need to more clearly explain how the Service's conclusions were derived from complex and incomplete information. In particular, the court seemed to struggle with the Service's interpretation of wolverines' relationship with snow at the denning scale and with the Service's interpretation of what Copeland (2010) revealed about this relationship.

FWS can address this issue by providing a more detailed explanation how it concluded that wolverines likely have an obligate relationship with springtime snow, but not necessarily an

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[151] Forest Carnivore Monitoring in the Southwest Crown (Lieberg et al).
[152] Aubry *et al.*, *Wolverine Distribution and Ecology in the North Cascades Ecosystem: Final Progress Report* (February 9, 2016) (hereafter "Aubry (2016)").
[153] 79 Fed. Reg. at 47,536.
[154] 78 Fed. Reg. at 7,886.
[155] 78 Fed. Reg. at 7,880.

obligate relationship with snow as described in Copeland (2010). Importantly, additional information outside of the administrative record or which was published after the 2013-2014 rulemaking support the Service's interpretation and questions whether wolverines have an obligate relationship with springtime snow at all. This new information demonstrates that FWS was correct to conclude that wolverines do not have an obligate relationship with snow as described by Copeland (2010) and that, in the absence of an obligate relationship with snow as described in Copeland (2010), there was no evidence of wolverine sensitivity to McKelvey (2011)'s modeled future losses of areas with snow as described in Copeland (2010).

New information also revealed that McKelvey (2011) may have overestimated the potential loss of habitat as described by Copeland (2010) and underestimated wolverine's ability to endure the future modeled by McKelvey (2011). While the District of Montana could not examine this new information when examining the Service's Withdrawal Decision, FWS can and should examine that information now and use it to inform a fresh analysis of the conservation status of wolverines in the conterminous United States.

1. Wolverines Do Not Have an Obligate Relationship with the Snow Described in Copeland (2010).

Copeland (2010) is an examination of the global distribution of wolverines and an attempt to describe wolverine distribution through the use of a single factor.[156] While the study authors acknowledged that multiple factors influence wolverine distribution, Copeland (2010) isolated a "bioclimatic envelope" as a single habitat feature defining wolverine habitat.[157]

Copeland (2010) posited that the wolverine's bioclimatic envelope was limited to those areas proximate to where successful reproductive dens could be established.[158] Copeland (2010) isolated a single factor – deep persistent spring snow – as an obligate feature of successful denning and used it to define "suitable habitat."[159] "Suitable habitat" (areas with deep persistent spring snow) were identified as areas where snow cover on May 15th was visible from satellite images at least once within a seven year period.[160] The study authors then compared a map of this habitat feature (areas with snow in satellite pictures on May 15th at least once every seven years) to a map of 562 known wolverine den sites and discovered that 97.9% of den sites were found within areas where satellite pictures identified snow on May 15th at least once every seven years.[161]

Importantly, while Copeland (2010) was the subject of a great deal of contentious scientific debate throughout the 2013-2014 rulemaking period, there was no dispute that Copeland (2010) succeeded in defining where wolverines live through a single habitat feature. Copeland (2010) was, and remains, an immensely important tool in understanding the distribution of wolverines – a species that is very difficult to observe in the field. In the absence of a depiction of wolverine distribution based on field observation, Copeland (2010) created a tool to precisely model

[156] Copeland (2010).
[157] Copeland (2010).
[158] Copeland (2010) at 234.
[159] Copeland (2010) at 235.
[160] Copeland (2010) at 235.
[161] Copeland (2010) at 233.

distribution using a remotely-observable habitat feature - areas with snow cover on May 15th at least every seven years. Not only did this finding help to better define wolverine distribution, it helped focus future wolverine research and field study on areas where wolverines were more likely to be found. The debate over Copeland (2010) was not whether the study successfully described wolverine habitat using a single habitat feature, but rather whether Copeland (2010) identified a habitat outside of which wolverines could not survive. Notwithstanding the court's decision, even the District of Montana agreed that Copeland (2010) was the product of an effort to identify a single habitat feature where most, but not all, known wolverine dens were found.[162] Importantly, Dr. Copeland agreed as well.

While Copeland (2010) defined wolverine distribution based on a hypothesized biological need, according to Dr. Copeland, "[t]he model is about distribution more so than biology. It only suggests that if you look in this area, there is a 98% probability that you are looking at wolverine denning habitat."[163] "The model only represents our best guess at the wolverine's world-wide distribution."[164]

This "best guess" at worldwide distribution was developed by defining "persistent spring snow" in a way that causes as many known den sites to fall within the model as possible without actually capturing 100% of all den sites.[165] If the model captured all sites, then it risked being over-inclusive, and therefore unhelpful in defining wolverine habitat.[166] For instance, if wolverine distribution was defined as areas that typically contain snow cover in February, when wolverines give birth, then it would have included huge areas wolverines have never occupied.

In order to make the model inclusive of known dens, but not too inclusive, Copeland (2010) defined areas "persistent spring snow" very specifically as areas with snow cover on May 15th at least once every seven years.[167] Copeland (2010) tested and rejected the "inclusiveness" of other dates other than May 15th.[168] According to Dr. Copeland, "the dates we used were simply a component of the model development process."[169]

Copeland (2010) drew a line around known wolverine denning sites and then defined "persistent spring snow" so that the line closely matched the line around the known sites. In other words, Copeland (2010) defined "persistent spring snow" as the type of snow in which wolverine dens are most frequently found. The oddly specific and nuanced definition of areas with persistent spring snow as those with snow cover on May 15th at least once every seven years was created to draw the most precise and useful line around known wolverine distribution. It "defined where wolverine habitat is not what wolverine habitat is."[170]

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[162] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016) at 66.
[163] Jeff Copeland, Supplemental Comments on Audrey Magoun Review (May 9, 2013) (hereafter "Copeland (2013)").
[164] E-mails between Jeff Copeland and Dr. Audrey J. Magoun, Wildlife Research and Management (March 10-14, 2014 (hereafter "Copeland, Magoun (2014)").
[165] Copeland, Magoun (2014); Copeland (2013).
[166] Copeland, Magoun (2014).
[167] Copeland, Magoun (2014); E-mails between Jeff Copeland and Dr. Audrey J. Magoun, Wildlife Research and Management (February 15, 2013).
[168] Copeland, Magoun (2014)
[169] Copeland (2013).
[170] Copeland, Magoun (2014)

Of course, the single variable structure of Copeland (2010) was based on a hypothesis that wolverines require persistent spring snow, so it is impossible to entirely separate the biology from the model, but Copeland (2010) did not define "persistent spring snow" in a way that sought to identify the obligate relationship or the precise needs that persistent spring snow served. Copeland (2010) defined "persistent spring snow" as the springtime snow found around most known wolverine dens—snow on May 15th at least once every seven years. Copeland (2010) correlated wolverine denning with this type of snow, but it did not show that this type of snow caused wolverines to select dens in it.

And, because den occurrence, and not an analysis of obligate snow conditions, drove the definition of "persistent spring snow," one can conclude that Copeland (2010) defined wolverine distribution very well, but that it did not provide the mechanism that drives wolverines to select areas that maintain snow cover into spring. The oft-cited "97% accuracy" of Copeland (2010) is important and noteworthy, but Copeland (2010)'s exceptional accuracy does not change the meaning of the study. Copeland (2010) fit wolverine occurrence very accurately into a snow model such that it became an effective tool for predicting wolverine distribution, but it did not suggest there is a biological basis for an obligate relationship with "areas with snow on May 15th at least once every seven years.

Importantly, while the Withdrawal Decision concluded that Copeland (2010) did not establish an obligate relationship between wolverines and the snow described in the study, FWS agreed that wolverines are associated with snow and that "[t]here is strong support for the existence of an obligate relationship between wolverines and deep spring snow at the den site."[171] FWS did not agree, however, that deep snow was necessary at the home range or species' range scales.[172] Nor did FWS agree that the habitat defined by Copeland (2010) (containing snow on May 15th in at least once every seven years) reflected the only habitat suitable for denning, and therefore wolverine survival.[173] FWS did not find any relationship between denning success and the metric for snow persistence in Copeland (2010) because:

> (1) Copeland (2010) was defined based on snow persistence that was infrequent (as little as 14% of years);
> (2) Copeland (2010) did not capture known denning sites with even less frequency (including those recognized in Copeland (2010) and those identified by state biologists); and,
> (3) May 15th was an arbitrary measure altogether as wolverines' reproduction typically occurs in February and denning needs conclude in April.[174]

New information supports the Service's analysis in the Withdrawal Decision and calls into question the strength, and even the existence of, wolverines' obligate relationship with deep springtime snow. As a threshold matter, many biologists have come to question the utility of using a single habitat characteristic, as was done in Copeland (2010), to define the suitability of a habitat

[171] 79 Fed. Reg at 47,539.
[172] 79 Fed. Reg at 47,533.
[173] 79 Fed. Reg at 47,534.
[174] 79 Fed. Reg at 47,534.

for a species.[175] Wolverines do not select den sites solely based on the prospect that the den will retain springtime snow. There is increasing data suggesting that wolverines select denning sites based on a wide variety of habitat attributes, and that the potential for deep persistent springtime snow is but one nonessential preference.[176]

- A May 2015 study of wolverines in the Canadian Crown of the Continent found that wolverine abundance was associated with areas that are far from, or otherwise protected from, human presence and anthropogenic development.[177]
- Multiple studies correlated wolverine occurrence with factors such as competition with other predators and the presence of humans or anthropogenic features.[178]
- A 2013 study suggested that the presence of spring snow was not a strong indicator of wolverine denning because these high elevation areas largely retained spring snow but wolverine presence varied considerably.[179] Instead, this study correlated wolverine dens with topographic ruggedness and steep slopes with large talus boulders suitable for denning.[180] These talus structures continue to provide protection and can aid in wolverine reproduction regardless of the presence of snow in spring.
- A 2015 study examined wolverine behavior at 164 remote cameras across 24,000 km^2 in the Rocky Mountains of Alberta and found that wolverine occurrence was much more associated with linear anthropogenic features than with spring snow.[181] The study examined wolverine behavior at bait stations in a variety of different habitats to determine which habitats caused wolverines to exhibit risk-avoidance behaviors.[182] As noted by the study authors, "The concordance between behavior response to linear features and large scale distribution lends support to human footprint as a driver of habitat suitability. If wolverines were driven only by snowpack, we would expect no behavioral signal at all."[183]
- A 2016 study published in the Journal of Wildlife Management found that there was no correlation between wolverine denning and springtime snow in the boreal forest region of Alberta, where wolverine harvest (and by inference, abundance) was highest.[184] Remote

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[175] Clevenger, Anthony P., *Mapping the Wolverine Way: Identifying Conservation Corridors and Transboundary Linkages in the Canadian Crown of the Continent.* 2015 Summary Report. (hereafter "Clevenger (2015)"); Graves, T. K Kendall, J. Royle, J. Stetz, A. Macleod. *Linking Landscape Characteristics to Local Grizzly Bear Abundance Using Multiple Detection Methods in a Hierarchical Model.* Animal Conservation 14:652-664 (2011)(hereafter "Graves (2011)").

[176] Clevenger (2015).

[177] Clevenger (2015).

[178] Fisher, J.T., et al. *Wolverines (Gulo gulo luscus) on the Rocky Mountain Slopes: Natural Heterogeneity and Landscape Alteration as Predictors of Distribution.* 91(10), 706-716 (2013) (hereafter "Fisher (2013)").; Heam, N. *Complex Effects of Human-Impacted Landscapes on the Spatial Patterns of Mammalian Carnivores.* MSc thesis, University of Victoria (2015) (hereafter "Heim (2015)").; Mattisson, J., H. Andren, J. Persson, and P. Segerstron. *Influence of Intraguild Interactions on Resource Use by Wolverines and Eurasian Lynx.* 92:1321-1330 (2011); Matthew Scrafford and Mark Boyce. *Effects of Industrial Development on Wolverine (Gulo Gulo) Ecology in the Boreal Forest of Northern Alberta.* Wolverine Project Progress Report (2014-2015).

[179] Fisher (2013).

[180] Fisher (2013).

[181] Frances E. C. Stewart et al., *Wolverine Behavior Varies Spatially with Anthropogenic Footprint: Implications for Conservation and Inferences About Declines.* 6(5): 1493-1503(2015) (hereafter "Steward (2015)").

[182] Stewart (2015).

[183] Webb, Shevenell M., et al., *Distribution of Female Wolverines Relative to Snow Cover, Alberta, Canada.* 80(8): 1461-1470 (2016) (hereafter "Webb (2016)").

[184] Webb (2016).

camera surveys revealed many instances of females (and lactating females) selecting den sites that were unlikely to hold snow in spring. While the study did observe a correlation with wolverine dens and springtime snow at higher elevations, it cautioned against using this as evidence of an obligate relationship because higher elevations are simply more prone to retaining snow into spring and because the colder, higher elevation areas that are more prone to retain spring snow may simply be less prone to development and anthropogenic disturbance.[185] The study authors questioned the findings in Copeland (2010), questioned whether the presence of springtime snow had any impacts on wolverine reproduction at all.[186] As noted by the study authors:

> Wildlife managers cannot assume that areas with patchy spring snow cover are not suitable for wolverines. Long-term fur harvests and documented reproduction in areas with low amounts of spring snowpack in the Boreal Forest of northern Alberta indicate that wolverines may be more flexible in their distribution that previously assumed. Studying wolverines in the snowpack fringe areas might demonstrate their resilience to climate change, which may not necessarily result in population declines, as long as other important resources exist (i.e., food, refuge, habitat connectivity). The next step is documenting the time period when dens are snow-covered in different habitat types in relation to demographic characteristics and reproductive success. Further research is needed to document the mechanism behind why wolverines require snow in spring before management decisions should be based on climate factors.[187]

- Multiple studies identified wolverines denning in areas without deep persistent spring snow, or which were not projected to retain snow into spring.[188]
- Multiple studies showed that wolverines did not use, and did not need to use material dens, well into May as Copeland (2010) suggested was necessary.[189]

As such, wolverines' habitat needs and distribution are better understood through a hierarchical modeling of multiple landscape attributes associated with wolverines.[190] Springtime snow is one of several features, but by no means the exclusive feature, that defines wolverine distribution. Increased evidence of non-snow denning and den abandonment well before May 15th indicates that wolverines may not have an obligate relationship with spring snow at all. The best available evidence is that spring snow is, at most a habitat preference. Therefore, the best available evidence

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[185] Webb (2016).
[186] Webb (2016).
[187] Webb (2016).
[188] Cleavinger (2015).; Fisher (2013).; Arronsen, M. and J. Persson. *Mismatch Between Goals and the Scale of Actions Constrains Adaptive Carnivore Management: The Case of the Wolverine in Sweden.* DOI 10.1111/act.12310.; Webb (2016); Matthrew Scrafford and Mark Boyce. *Effects of Industry on Wolverine (Gulo Gulo) Ecology in the Boreal Forest of Northern Alberta.* Progress Report- (2013-2014).; Aubry (2016); COSEWIC Assessment and Status Report of the Wolverine (*Gulo Gulo*) in Canada (2014) (hereafter "COSEWIC (2014)").
[189] Gervasi, Vincenzo., et al. *Sharing Data Improves Monitoring of Trans-boundary Populations: the Case of Wolverines in Central Scandinavia.* (22)3:95-106. (2016).; Webb (2016); Aubry 2016; COSEWIC (2014)
[190] Clevenger (2015); Graves (2011);

is that a potential reduction in spring snow is not likely to drive wolverines to the brink of extinction within the foreseeable future.

2. McKelvey

The Withdrawal Decision favorably viewed McKelvey (2011) as a sophisticated analysis of potential climatological impacts to those known denning sites.[191] But because Copeland (2010) defined only where wolverines live, and not what wolverines need to live, FWS determined that McKelvey (2011)'s modeling the potential loss of areas with snow cover on May 15th at least once every seven years did not provide evidence that wolverines will be at risk of extinction within the foreseeable future.[192] Notwithstanding the District of Montana's decision, there is no conflict between the Service's recognition that McKelvey (2011)'s modeling was sophisticated and its determination that McKelvey(2011) did not demonstrate a likelihood that wolverines would be on the brink of extinction in the foreseeable future. McKelvey (2011) is a sophisticated model that projects changes to a habitat feature found where wolverines den—it did not model the decline of a feature without which wolverines would be placed on the brink of extinction within the foreseeable future.

Even assuming that fewer areas containing snow on May 15th at least once every seven years would adversely impact wolverines, McKelvey (2011) may not accurately project the decline of that habitat feature.[193] The Withdrawal Decision, the NOAA study and an analysis conducted by experts at the Idaho Department of Fish & Game supported this conclusion. Regional climate change expert, Dr. Torbit, also supported the conclusion and documented discussions with an expert at NOAA in the Withdrawal Decision.[194] All three regional offices concurred.[195] We disagree with the district court's holding that the Withdrawal Decision did not offer sufficient data to justify the Service's decision to decline to adopt the declines in wolverine habitat modeled in McKelvey (2011). Subsequent studies support the conclusions reached in the Withdrawal Decision.

Perhaps most importantly, the emission scenarios relied upon in McKelvey (2011) have been abandoned by the Coupled Model Intercomparison Project (CMIP).[196] The previous scenarios – those relied upon in McKelvey (2011) – compiled multiple scenarios representing futures with different combinations of global population growth, energy policies, and conventional and alternative fuel portfolios.[197] Because these emission-based scenarios contained many variables that were difficult to predict and keep updated, their reliability was called into question.[198]

The CMIP replaced its "emission scenario" approach with a "representative concentration pathways" approach (CMIP5) that does not attempt to define specific emission scenarios, but rather defines an overall concentration of greenhouse gases and agents potentially influencing the

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[191] Walsh (2014) at p. 6.
[192] Walsh (2014) at p. 6.
[193] Walsh (2014) at p. 6
[194] Walsh (2014) at pp. 4-5.
[195] 79 Fed. Reg. at 47,539; Walsh (2014) at pp. 17-18; Walsh (2014) at p. 6.
[196] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.
[197] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.
[198] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.

climate system.[199] This new approach was used in the Intergovernmental Panel on Climate Change's ("IPCC's") fifth assessment report released last year,[200] and by the Northern Rockies Adaptation Partnership to assess climate impacts in the Northern Rocky Mountain ecosystem.[201]

- Northern Rockies

The report published by the Northern Rockies Adaptation Partnership this July provides another view of the Northern Rockies. The projections of temperature and precipitation contained therein were based on a much more granular analysis of five sub-regions with the Northern Rockies ecosystem. Across these regions, the Northern Rockies Adaptation Partnership projected temperature increases that were less severe than those projected in McKelvey (2011) and precipitation at higher levels than those projected by McKelvey (2011). While the Northern Rockies Adaptation Partnership did not attempt to model the presence or absence of snow on May 15th, it projected that wolverine habitat will be colder and wetter than McKelvey predicted, and it further showed that increases in precipitation will be the largest in the winter months.[202] As such, the available scientific information strongly suggest that the habitat changes modeled by McKelvey (2011) are overly pessimistic and outdated. Other studies published subsequent to the Proposed Listing and Withdrawal Decision call into question whether McKelvey (2011) provides a sufficiently reliable projection of reductions of snow as described in Copeland (2010).

- Northern Cascades

The United States Department of Agriculture ("USDA") published a similar climate change vulnerability assessment for the Northern Cascades region of Washington in 2014.[203] While this study used the same type of emission scenarios that were used in McKelvey (2011) and subsequently abandoned in CMIP5, it is noteworthy that study projected impacts on snow cover that are seemingly in conflict with McKelvey (2011). For instance, the USDA study predicted much more significant increases in winter precipitation in the Northern Cascades.[204]

The USDA Study also examined snowpack and snow persistence.[205] The USDA Study found that snowpack would generally decrease in the Northern Cascades region, but these reductions were largely projected in low-lying and warmer areas that are not frequently used by wolverines for denning.[206] Higher elevation areas (mean elevation of 1740 meters), that are known to be prime wolverine habitat areas were "projected to experience little (+/- 10 percent) change from historical patterns . . ."[207] In fact, the USDA Study projected that "Higher elevations will continue to retain snow cover in early summer."[208]

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[199] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.
[200] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.
[201] See Northern Rockies Adaptation Partnership Climate Projection Report. P3.
[202] See Northern Rockies Adaptation Partnership Climate Projection Report.
[203] USDA (2014).
[204] USDA (2014)at p. 37.
[205] USDA (2014)at p. 59.
[206] USDA (2014)at p. 59.
[207] USDA (2014)at p. 59.
[208] USDA (2014)at p. 59.

- Yellowstone National Park

A 2016 forecast of snowpack in Yellowstone National Park found that CMIP5 underestimated actual observed daily median "snow water equivalent" (SWE) by 30% to 80%.[209] The discrepancy between actual SWE and the SWE modeled by two CMIP5 representative concentration pathways was discovered when the authors tested the model against several decades of data from multiple snow-telemetry (SNO-TEL) stations throughout higher-elevation portions of Yellowstone National Park.

The study was being conducted to determine the future suitability of roads for over-snow travel so, unlike McKelvey (2011), multiple SNO-TEL stations alongside these roads were available to provide decades of data for ground-truthing the model predictions. In contrast, the models used in McKelvey (2011) were never tested against actual data on snowfall or snow accumulation, and were therefore never calibrated so that they would agree with historical data.[210] The only ground-truthing of the McKelvey (2011) models was through use of the satellite images supplied by Copeland (2010).[211] These satellite images only show whether snow was present or not.[212] As such, the authors of McKelvey (2011) were forced to undertake a separate modeling effort to project snow depth in the satellite images.[213] That modeling effort required the McKelvey (2011) authors to select a modeled snow depth calculation that was two weeks earlier than what McKelvey (2011) was attempting to measure and on scale that was 140 times smaller than the satellite imagery.[214] Thus, McKelvey (2011)'s models were only tested against other models.

Whether, and to what extent, the inability of McKelvey (2011)'s authors to test and calibrate their models caused McKelvey (2011) to underestimate future snow accumulation is unknown. However, Tercek (2016) examined one of the exact same areas as McKelvey (2011) and many of the exact same higher elevation landscapes, and found that the most advanced climate models could not capture the complexity and small-scale variability that drives snowfall in high elevation montane environments. Looking at a modeling approach that was more advanced than the approached used in McKelvey (2011), Tercek (2016) quantified the underestimation of snow accumulation as between 30% and 80%.

In sum, subsequent modeling efforts in every region examined in McKelvey (2011) either directly contradicted the findings in McKelvey (2011) or provided evidence that it underestimated snow persistence. Even assuming that areas containing snow on May 15th at least one of seven years were essential to wolverines, the weight of scientific evidence suggests that McKelvey (2011) did not reliably project the decline of that habitat feature at the relevant scale. The future state of wolverine habitat as defined by Copeland (2010) and modeled by McKelvey (2011) is not likely to materialize in the foreseeable future.

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[209] Tercek M., Rodman A., *Forecasts of 21st Century Snowpack and Implications for Snowmobile and Snowcoach Use in Yellowstone National Park.* 11(7):1-25 (2016).
[210] McKelvey et al. (2011).
[211] McKelvey et al. (2011) at p. 2885.
[212] McKelvey et al. (2011) at p. 2885.
[213] McKelvey et al. (2011) at p. 2885.
[214] McKelvey et al. (2011) at p. 2885. The variable infiltration capacity model McKelvey (2011) used provides projections on the first day of each month. The date McKelvey (2011) was modeling (May 15th) was the precise midpoint between the two model input options.

- Connectivity

In addition to projected loss of habitat, McKelvey (2011) projected that its modeled declines in snow as defined in Copeland (2010) would reduce connectivity between wolverine denning areas to such an extent that populations could become isolated and experience genetic depression.[215] Again, however, both the evidence available at the time of Withdrawal Decision and data subsequently published strongly suggest otherwise.

The Withdrawal Decision reached its conclusions about the enduring connectivity between wolverine populations by relying on McKelvey (2011)'s estimate that large areas of suitable habitat less prone to genetic depression would persist through the 21st century.[216] As such, the connectivity analysis utilized a very conservative and arguably unrealistic portrayal of the habitat areas between which wolverine connectivity was assessed. Even under this conservative scenario, FWS concluded that wolverines' well-documented ability to traverse long distances over areas that are unsuitable for habitat would allow the species to maintain genetic connectivity between subpopulations.

Indeed, the ability to traverse long distances in harsh conditions is one of the attributes most associated with wolverines and their reputation for tenacity.[217] Moreover, the presence of wolverines *anywhere* in the conterminous United States is the result of long-distance dispersals from Canada.[218]

Even at the time of the Withdrawal Decision, FWS possessed substantial and specific evidence about the long-distance dispersal capability of wolverines. Individual wolverines in the conterminous United States were observed dispersing into the Sierra Nevada Range in California, Colorado, and Wyoming.[219] The wolverine that dispersed into Colorado and Wyoming (M56) was documented crossing the Red Desert and multiple mountain ranges.[220] Earlier this year, M56 was killed in North Dakota. We cannot specifically recreate M56's dispersal path to North Dakota because his transmitter had failed, we know he traveled several hundred miles across terrain believed by some to be unsuitable for wolverines.[221]

Since the time of the Withdrawal, even more long-distance dispersals have been observed. A young female (Eowyn) tracked by researchers in Washington State was monitored traveling over 483 kilometers (km) in the United States and Canada over two months.[222] At the time of the

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[215] McKelvey et al. (2011) at p. 2882.
[216] 79 Fed. Reg. at 47,535.
[217] McClure, Meredith M., Hansen, Andrew J., Inman, Robert M., *Connecting Models to Movements: Testing Connectivity Model Predictions Against Empirical Migration and Dispersal Data.* (2016) (hereafter "McClure (2016)").
[218] Cite genetic study
[219] 79 Fed. Reg. at 47,535.
[220] Comments from Wyoming Fish & Game (Nov. 2016).
[221] Comments from Wyoming Fish & Game (Nov. 2016).
[222] Aubry (2016).

Proposed Listing and Withdrawal Decision, the longest known female wolverine dispersal was 233 km.[223]

In the same study, a young male (Chance) was monitored traveling over 564 km in the United States and Canada over five months.[224] Similarly, in 2014, the Committee on the Status of Endangered Wildlife in Canada ("COSEWIC") identified male wolverine dispersals of between 200 and 874 km over several months.[225] At the time of the Proposed Listing and Withdrawal Decision, FWS had data on male wolverine dispersals of 168 km, 178 km, 199 km, and 378 km.[226]

Like the Service's Proposed Listing and Withdrawal Decision, McKelvey (2011)'s depiction of wolverine connectivity (taken from Schwartz (2009) did not have the benefit of this more recent data demonstrating that wolverines can disperse far further than previously estimated and across landscapes considered far less favorable to wolverines. Based on this new understanding alone, the projections of genetic isolation in McKelvey (2011) are called into question.

Further, McKelvey (2011) and Schwartz (2009) relied on a less sophisticated "cost-distance" model to project potential dispersal paths.[227] Cost-distance models are designed to model "least cost" paths which minimize the tradeoff between travel distances among habitat patches and exposure to unsuitable habitat.[228]

Importantly, cost-distance models presume that the animal has sufficient knowledge about the landscape outside of their home range to be able to select the "least-cost" path.[229] This knowledge may be imputed to migratory animals with high fidelity to specific corridors and/or animals that move in herds.[230] This knowledge, however, cannot be imputed to wolverines because they are solitary and do not migrate.[231]

Potential wolverine dispersal pathways are more appropriately modeled through "circuit theory."[232] Circuit theory models "apply concepts related to the flow of charge through an electrical circuit to the movement of animals through a landscape. They differ from cost-distance models in that they explicitly incorporate the assumption that greater redundancy in travel routes between source and designation enhances flow between them."[233] As such, circuit theory models capture the exploratory-type movements of animals as they navigate novel landscape.[234]

A 2016 study published in the Journal of Landscape Ecology tested the suitability of cost-distance and circuit theory models on wolverines and elk by comparing the model output to known dispersal

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[223] 79 Fed. Reg. at 47,535.
[224] Aubry (2016).
[225] COSEWIC (2014).
[226] 79 Fed. Reg. at 47,535.
[227] McKelvey et al. (2011) and Michael K. Schwartz et al., *Wolverine Gene Flow Across a Narrow Climatic Niche.* 74 (2009) (hereafter "Schwartz (2009)").
[228] McClure (2016).
[229] McClure (2016).
[230] McClure (2016).
[231] McClure (2016).
[232] McClure (2016).
[233] McClure (2016).
[234] McClure (2016).

paths.[235] The study found that circuit theory models more consistently predicted wolverine dispersal paths than cost-distance models.[236] As such, the declines in connectivity modeled in McKelvey (2011) are likely unrealistic because they fail to account for wolverines' ability to disperse long distances and because it relied on a model that is poorly suited to model wolverine dispersal.

c. Threats from Population Size/ Genetic Diversity

As with the Withdrawal Decision's analysis of the potential threats posed by climate change, the District of Montana struggled with the Service's analysis of the threat posed by genetic diversity and the relatively small number of wolverines found in the conterminous United States. The court's concern is addressed by providing a more detailed explanation of the analysis FWS employed when examining the threat posed by the relatively low genetic diversity observed in wolverines in the conterminous United States. Further, new information provides persuasive new evidence that wolverines in the conterminous United States are not likely to be driven to the brink of extinction due to their relatively small population size and lower genetic diversity.

1. Genetic Diversity

The genetic diversity of wolverines in the conterminous United States is lower than the genetic diversity observed in wolverines in the Canadian wolverines that founded the US populations after they were functionally extirpated in the early 20th century.[237] The genetic diversity observed in wolverines in the conterminous United States is an artifact of the genetic bottleneck caused by being recolonized by a discrete number of individuals.[238] Importantly, while the genetic diversity of wolverines in the conterminous United States may be lower relative to wolverines in Canada, there is no data to suggest that the genetic diversity of wolverines in the conterminous United States is objectively low, or low enough to adversely impact wolverines' viability.[239]

Edge populations, such as the wolverines in the conterminous United States that are on the southern periphery of the larger North American subpopulation of wolverines, are expected to have lower genetic diversity.[240] This lower diversity is a function of wolverines' dispersal into more ecologically marginal habitats, but is not itself a threat to those edge populations.[241] Low genetic diversity only impacts the viability of species when it spirals into inbreeding depression. "Three conditions must hold for inbreeding depression to reduce the viability of populations: [1] Inbreeding must occur. [2] Inbreeding depression must occur. [3] the traits affected by inbreeding depression must reduce population viability."[242]

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[235] McClure (2016).
[236] McClure (2016).
[237] Schwartz (2009).
[238] 79 Fed. Reg. at 47,542.
[239] 79 Fed. Reg. at 47,542
[240] Zigouris (2013).
[241] Zigouris (2013).
[242] Fred W. Allendorf and Gordon Luikart. *Conservation and Genetics of Populations*. Malden (MA); Blackwell Publishing; 2007. pp. 338-339. (hereafter "Allendorf, Luikart (2007)").

Inbreeding is present in all small populations . . . "and some deleterious recessive alleles will be present in all populations . . ."[243] For inbreeding to negatively affect populations, however, it must "affect traits that influence population viability."[244] FWS correctly concluded in the Withdrawal Decision that wolverines in the conterminous United States do not exhibit any signs of decreased fitness or viability based on genetic diversity or population size.[245] Subsequently, a handful of the most cited wolverine experts similarly concluded that wolverines in the conterminous United States are closely related to wolverines in Canada and exhibit no genetic adaptations distinct from wolverines elsewhere.[246] Another study by the University of British Columbia Okanagan reached the same conclusion in 2015.[247] As such, the best scientific information available demonstrates that wolverines in the conterminous United States are not experiencing genetic depression or any decreased fitness based on genetic depression.

2. Prospect of Future Threats from Population Size/Genetic Diversity

The court expressed concern that, notwithstanding the absence of any present signs of genetic depression, such threats could arise because of the low "effective population size" of wolverines in the conterminous United States.[248] A species' "effective population size" is the number of individuals capable of breeding. It is a function of sexual maturity, proximity, and overall abundance.[249]

Schwartz (2009) estimated the effective population size of wolverines in the conterminous United States to be 35 individuals.[250] However, there are reasons to question the validity of this estimate. Schwartz (2009) used then-unpublished version of the disputed Copeland (2010) "bioclimatic envelope" to determine where wolverine territories overlap to identify reproduction opportunities.[251] As such, any underestimate in Copeland (2010)'s definition of suitable wolverine habitat would equate to an underestimate of the effective population size projected in Schwartz (2009).

Further, the study area in Schwartz (2009) is only a subset of the habitat identified in Copeland (2010),[252] and Schwartz (2009) did not have the benefit of more recent data on wolverines' ability to disperse long distances to pursue reproductive opportunities.[253]Thus, Schwartz (2009) may have underestimated the effective population size of wolverines in the conterminous United States by an even larger margin.

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[243] *Id.*
[244] *Id.*
[245] 79 Fed. Reg. at 47,542
[246] McKelvey (2014).
[247] Rico (2015).
[248] *Defenders of Wildlife v. Jewell*, CV 14-246-M-DLC (D. Mont., April 4, 2016) at p. 69.
[249] Schwartz (2009).
[250] Schwartz (2009).
[251] Schwartz (2009).
[252] Schwartz (2009).
[253] 79 Fed. Reg. at 47,541.

More fundamentally, even if Schwartz (2009) reasonably estimated effective population size in 2009, effective population size is not static.[254] Effective population size is positively correlated with overall abundance, and as overall abundance increases, so too does effective population size. The best scientific information available strongly suggests that wolverines in the conterminous United States have increased in abundance in the seven years since Schwartz (2009) estimated effective population size, and therefore the best available scientific information suggests that the effective population size of wolverines in the conterminous United States is now well above 35 individuals.

The effective population size of wolverines in the conterminous United States was an issue for the court because of a "rule-of-thumb" that effective populations of less than 50 will experience inbreeding depression in the short-term.[255] Notably, this "rule of thumb" was taken from a study that is over 35 years old and based on a generic species – *not* an animal that is low-density by nature.[256] Moreover, the study authors themselves described the "rule of thumb" as more of a "warning light" than an impending risk.[257]

Nonetheless, even if wolverines' effective populations have not yet exceeded the "rule-of-thumb," that does not make extinction likely or foreseeable. In fact, the potential risks from low genetic diversity are far from proximate, as evidenced by a study of houseflies that was cited, but not discussed, in the Withdrawal Decision.[258] In this study, the effective population of one cohort of houseflies was held constant and another population was started from very few founders (like wolverine in the conterminous United States).[259] The population with the static effective population went extinct between 37 and 64 generations from inception.[260] Given the longer generations of wolverines,[261] this amounts to a risk of extinction arising 126 to 218 years in the future—and only if no new connectivity is established with adjacent populations and only if effective population never changes. While the founder population of houseflies initially experienced low genetic diversity, and even genetic depression, they never went extinct.[262] The study was terminated after 68 generations (231 years as applied to the wolverine).[263]

3. Genetic Rescue from Canada

Even under the most pessimistic depictions of the threat to wolverines in the conterminous United States posed by genetic diversity, the concern can only exist if wolverines in the conterminous United States are genetically isolated from wolverines in Canada. If genetic exchange occurs

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[254] 79 Fed. Reg. at 47,541.
[255] Allendorf, Luikart (2007) at p. 345.
[256] Allendorf, Luikart (2007) at p. 345.
[257] Allendorf, Luikart (2007) at p. 345
[258] 79 Fed. Reg. at 47,542.
[259] David H. Reed and Edwin H. Bryant. *Experimental Test of Minimum Viable Population Size.* 3:7-14 (2000) (hereafter "Reed, Bryant (2000)").
[260] Reed, Bryant (2000) at p. 12.
[261] Jens Persson, et al., *Reproductive Characteristics of Female Wolverines (Gulo Gulo) in Scandanavia.* 87(1): 75-79. (2006) at p. 77.
[262] Reed, Bryant (2000) at p. 12.
[263] Reed, Bryant (2000) at p. 12.

between wolverines in the conterminous United States and the thousands of wolverines just north of the Canadian border, the risk of isolation and inbreeding is eliminated.

The Withdrawal Decision did not consider the prospect of genetic rescue in assessing the threat posed by genetic diversity.[264] In fact, FWS surmised that there was no evidence of a genetic connection between wolverines in Canada and wolverines in the conterminous United States.[265]

FWS based this conclusion solely on its interpretation of Schwartz (2009).[266] Schwartz (2009) suggested that there was a marked separation between wolverines in Canada and those in the United States because 13 haplotypes were discovered in Canada and only three were discovered in the U.S. Rocky Mountains.[267] In reality, Schwartz (2009) did not find a marked separation between Canada and the United States – it found the characteristics of a meta-population. Wolverines throughout their global range exist as meta-populations in which a network of subpopulations that are established around female denning areas and are connected by genetic exchange from highly vagile males.[268] As such, all wolverine subpopulations (within Canada and across the border) exhibit some level of structuring among the maternally inherited mitochondrial DNA studied in Schwartz (2009). The genetic structure identified in Schwartz (2006) identified little more than the well-known population dynamics of wolverines. Further, Schwartz (2009) only examined genetics in the Rockies – it never examined the genetics on either side of the well-known dispersion corridor in the Northern Cascades.

Many of the same authors of Swartz (2009) conducted a more extensive study of North American wolverine genetics and found: (1) strong evidence that wolverines in the Northern Cascades are being recolonized by wolverines from Canada; (2) that wolverines in Canada, Alaska, and the conterminous United States all share the most common haplotype; and (3) that "Most modern wolverine populations in North America are closely related; those in the contiguous U.S., whether of local or Canadian origin, are closely related to populations to the north.[269]

In addition to new data demonstrating the presence of genetic exchange between Canada and the conterminous United States, new surveys prove that wolverines are actually crossing the border through *every* high-elevation corridor between the United States and Canada.

- A study of female wolverine distribution in Wyoming identified cross-border movements of female wolverines;[270]
- The Forest Carnivore Monitoring effort in the Southwest Crown of the Continent Region identified wolverine populations straddling the border, found ongoing cross-border wolverine movements, and found a potential lack of strong connectivity between populations within Canada (but not between Canada and the United States).[271]

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[264] 79 Fed. Reg. at 47,529.
[265] 79 Fed. Reg. at 47,529.
[266] 79 Fed. Reg. at 47,529.
[267] Schwartz (2009) at p. 3229.
[268] See Zigouris (2013); See Rico (2015).
[269] McKelvey (2014).
[270] Progress Report 2015.
[271] Progress Report 2015.

- A 2013 Field Report on wolverine distribution in the Kootenay Region identified an active cross-border corridor in the Kootenay Pass, identified the dispersal of a female from the U.S. Rockies into the Purcell mountains in Canada, and identified a wolverines population south of Highway 3 in Canada, which was previously theorized to be a barrier to wolverine connectivity with Idaho and Montana.[272]
- A tracking study published in 2016 maintained 14 wolverines in the Northern Cascades through satellite monitoring.[273] Of the ten wolverines that the study successfully tracked, five made cross-border movements.[274]

The Withdrawal Decision's conclusion that wolverines in the conterminous United States are isolated from wolverines in Canada was unsupported at the time, belied by well-known information about wolverine population dynamics and dispersal capability, and unfortunately, a major reason the District of Montana questioned the Service's analysis of this factor. Absent the unsupported and illogical notion that wolverines observe political boundaries, there is no credible risk from small population size or genetic depression. We urge FWS to consider the best scientific information available, which shows that meta-populations in the United States are genetically linked to meta-populations in Canada in the same way that meta-populations are linked within the United States and that the genetic links between these meta-populations are maintained by actual observed cross-border movement through every high-elevation dispersion corridor that has been studied.

VII. Conclusion

The Trade Associations appreciate the opportunity to provide additional comments on the Service's 2013 Proposed Listing. While we welcome this opportunity to contribute to the scientific dialogue and provide FWS the information it needs to make a defensible science-based evaluation of the conservation status of wolverines in the conterminous United States, we believe that FWS erred in reinstating the Proposed Listing that it knows to be inaccurate and uninformed by the best scientific information available. FWS is compelled to conduct a new review of the status of wolverines in the conterminous United States and is further compelled to re-examine the threshold question of whether wolverines in the conterminous United States are properly classified as a DPS.

The Trade Associations have herein provided new data and analysis on the conservation status of wolverines and the specific questions at issue in the District of Montana action, but cannot comment in a more substantive way until FWS makes available a proposed new status assessment. Until then, stakeholders can only provide data to support the seemingly uncontroverted fact that the Service's three-year-old Proposed Listing is outdated and inaccurate.

Indeed, the best scientific information available indicates that wolverines in the conterminous United States are not a DPS. Even if wolverines in the conterminous United States were meaningfully distinct from wolverines in Canada, they are not likely to be driven to the brink of extinction within the foreseeable future. Wolverines in the conterminous United States have increased in range and abundance year after year for nearly a century. This growth is expected to

[272] Kortello, Hausleitner (2014).
[273] Inman (2016).
[274] Inman (2016).

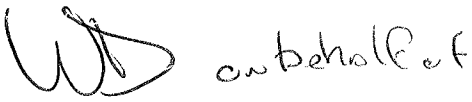
continue and will further existing connectivity and genetic exchange with wolverines in Canada. FWS is right to examine potential future changes to wolverine habitat, but the best scientific information available indicates that wolverines are not solely dependent on a single highly specialized habitat feature or that this feature will one day decline in a way that adversely impacts wolverines.

The Trade Associations strongly urge FWS to closely consider these comments as well as the comments previously submitted by API and UARG in 2014, and we further urge FWS to provide stakeholders a subsequent opportunity to comment on the Service's current views on the conservation status of wolverines in the conterminous United States. If you have any questions, please contact Wayne D'Angelo at 202.342.8525 or wdangelo@kelleydrye.com.

Very truly yours,



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COSEWIC
Assessment and Status Report

on the

Wolverine
Gulo gulo

in Canada



SPECIAL CONCERN
2014

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2014. COSEWIC assessment and status report on the Wolverine *Gulo gulo* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 76 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2003. COSEWIC assessment and update status report on the wolverine *Gulo gulo* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 41 pp.

Dauphiné, T.C. 1989. Update COSEWIC status report on the wolverine *Gulo gulo* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 31 pp.

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COSEWIC
Assessment Summary

Assessment Summary – May 2014

Common name
Wolverine

Scientific name
Gulo gulo

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.

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

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 de-activated. In May 2014, the Eastern and Western populations were considered as a single unit across the Canadian range and was designated Special Concern.

COSEWIC
Executive Summary

Wolverine
Gulo gulo

Wildlife Species Description and Significance

Wolverines are a stocky, medium-sized carnivore and the largest terrestrial member of the weasel family. They have long, glossy coarse fur, which varies from brown to black, often with a pale facial mask and stripes running laterally from the shoulders, crossing just above the tail. The skull structure is robust, allowing it to crush and consume bones and frozen carcasses. Adult males weigh 13 to 18 kg and adult females weigh 7.5 to 12.5 kg.

A single subspecies, *Gulo gulo luscus*, ranges across most of Canada. Further studies are required to determine if the Vancouver Island population is a separate subspecies, *G. gulo vancouverensis*. A single designatable unit is recognized for the Canadian population.

Wolverines may indicate ecosystem health, given their dependence on extensive connected ecosystems that support ungulates and large carnivores which create opportunities for scavenging. They are a valuable furbearer in the fur trade, and many furs that do not enter the fur trade are used locally, especially in the Arctic, where its frost-resistant fur is used for parka trim.

Distribution

Wolverines are found across northern Eurasia and North America. In Canada, they are found in northern and western forested areas, in alpine tundra of the western mountains, and in arctic tundra. It is not known whether Wolverines currently occupy Vancouver Island, Québec, or Labrador. Range reductions began in the 19th century, and subpopulations were extirpated from New Brunswick, southern Ontario, and from the aspen parkland of Manitoba, Saskatchewan and Alberta.

Habitat

A wide variety of forested and tundra vegetation associations are used by Wolverines. Habitats must have an adequate year-round supply of food, mainly consisting of smaller prey such as rodents and Snowshoe Hares, and the carcasses of large ungulates, like Moose, Caribou, and Muskox. Females den under snow-covered rocks, logs or within snow tunnels. Wolverines reproduce in areas where snow cover persists at least into April.

Biology

Most females breed after they are 2 or 3 years of age and produce on average 2 kits per litter. Wolverine home ranges are 50-400 km^2 for females (smallest during denning periods) and 230-1580 km^2 for males. Home ranges may overlap within and between sexes but home ranges of reproductive females do not overlap. Home range size in the eastern range is unknown. Wolverine densities are low and range from about 5 to 10/1,000 km^2. Wolverines are scavengers and predators, often caching food for future use. Wolverines face mortality from predation and starvation. Anthropogenic sources of mortality include trapping, hunting, and road kill.

Population Sizes and Trends

Confidence regarding population size and trend is debated because most population data are derived from harvest records and the proportion of unreported harvest varies across their range. The Canadian population size is unknown but likely > 10,000 adults. Wolverine have been extirpated (or likely extirpated) in much of southern and eastern Canada. Wolverine observations continue to be reported in the range of the eastern sub-population (Québec and Labrador), but no observation has been verified since 1978. The last verified record on Vancouver Island was in 1991 and it is likely that they have been extirpated. There is concern that decline may be occurring in BC and parts of Alberta where Southern and Central Mountain Caribou, their primary prey, continue to decline and habitats are fragmented. Field studies since 2003 suggest Wolverines are more abundant in parts of the Northwest Territories (NWT) and Nunavut than previously thought. The sub-population in the NWT barren ground region may be decreasing while recent records in western Arctic islands suggest population increase, although it is unknown if these are resident or transient animals. Population trends are unknown, but based on numerous sources such as field studies, ATK, and trapper surveys, they are believed to have been stable over parts of the northern range for the last 3 generations (22.5 years). Wolverines in northern Manitoba and Ontario may be increasing; aerial surveys in northern Ontario have shown an eastward range reoccupation towards James Bay and Québec.

Threats and Limiting Factors

The variability in trap effort, the uncertainty on actual harvest levels in some jurisdictions, and increased access and efficiency of hunting using snowmobiles raises concerns over potential overharvest and the ability to document population size and trends. Transportation corridors, forestry, hydroelectric developments, oil and gas and mineral exploration and development increase access for harvest and contribute to permanent, temporary or functional habitat losses (sensitivity to disturbance), which may destabilize populations.

The decline in Caribou as a source of scavenged meat, particularly in Québec and Labrador where few Wolverines may persist, may limit population recovery. Other factors that may limit populations include harvest, disturbance of denning areas, threats to habitats, and population fluctuations in Wolves and other carnivores that provide scavenging opportunities. The Threats Calculator calculated an overall threat impact of medium.

Protection, Status, and Ranks

This species was assessed as Endangered by COSEWIC in 2003 and is listed on Schedule 1 of the *Species at Risk Act* (SARA). The Western Population (labelled western sub-population in this report) was assessed as Special Concern by COSEWIC in 2003, but was not listed under SARA due to concerns expressed by the Nunavut Wildlife Management Board. Provincial designations are Endangered in Labrador, and Threatened in Ontario and Québec (note: 'Threatened' is equivalent to Endangered in Québec). Remaining provincial designations range from no ranking to Sensitive or Special Concern. NatureServe (2013) rankings are Critically Imperilled (S1) in Québec and Newfoundland and Labrador, and Imperilled (S2) in Ontario. The Vancouver Island population is Imperilled. Wolverines are protected from non-Aboriginal harvest in Québec, Newfoundland and Labrador, and Ontario, although unreported harvest may be occurring. Aboriginal harvest would be in the northern part of the range (*i.e.,* James Bay and Northern Québec Agreement area). Wolverines are trapped and hunted in most other areas of their confirmed range.

Habitat Protection and Ownership

Numerous protected areas exist within the Wolverine's range but refugia larger than 20,000 km^2 may be required to maintain a Wolverine population. Many northern national, provincial and territorial parks allow trapping. In southern parks, population recovery may be impacted by road developments that can act as barriers to movements, and activities such as skiing and snowmobiling that may disturb denning females.

TECHNICAL SUMMARY

Gulo gulo
Wolverine Carcajou

Range of occurrence in Canada: Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, Newfoundland and Labrador

Demographic Information

Generation time (estimated average age of breeding females in the population)	7.5 yrs
Is there an observed continuing decline in number of mature individuals? *Last verified record in eastern sub-population was in 1978, and Vancouver Island in 1991.*	No; declines in south and east have occurred but some sub-populations may be increasing in north
Estimated percent of continuing decline in total number of mature individuals within 2 generations (15 years). *Harvest indices in much of northern range suggest stable populations but value of trap data uncertain.*	Unknown, but possibly increasing in northern, and likely decreasing in southern range
Observed percent reduction in total number of mature individuals over the last 3 generations (22.5 years)	0
Projected percent reduction in total number of mature individuals over the next 3 generations (22.5 years).	Unknown
Observed percent increase in total number of mature individuals over any 3 generations period, over a time period including both the past and the future. *There are reports of possible population increases in Nunavut and NWT.*	Unknown
Are the causes of the decline clearly reversible and understood and ceased? *Declines in Vancouver Island and eastern sub-population are not understood and have not reversed.*	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence. *If unverified observations in eastern sub-population are used, EO is an additional 0.88 million km².*	>10 million km²
Index of area of occupancy (IAO).	>4,000 km²
Is the population severely fragmented?	No
Number of locations*	Many
Is there an observed continuing decline in extent of occurrence?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Is there an observed continuing decline in index of area of occupancy?	No
Is there an observed continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] continuing decline in number of locations*?	No
Is there an observed continuing decline in quality of habitat?	Yes, in some areas, notably in southern range, and areas of industrial development
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Western sub-population (ON, MB, NU, NWT, YK, SK, AB, BC)	Unknown, likely >10,000
Eastern sub-population (LAB, QU)	Unknown, likely near 0
Total	Unknown, likely >10,000 mature individuals

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not conducted, but likely a high probability in eastern sub-population range

Threats (actual or imminent, to populations or habitats)

Potential overharvest associated with unknown harvest levels and facilitated by extensive access associated with snowmobile use. Habitat loss (permanent, temporary and/or functional) and fragmentation due to forestry, agriculture, oil and gas development, hydroelectric reservoirs, and roads. In southern range, functional habitat loss due to disturbance caused by recreational activities, such as ATVs, snowmobiles, hiking and skiing during the denning period, along roads and trails. Declining ungulate (esp. Caribou) populations represent loss of important source of food. Climate change concerns in southern range.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? *Secure in Alaska; Alaskan population is adjacent to northern BC, YT. Sensitive or At Risk in the conterminous U.S. states and a candidate species for federal listing as Threatened; southern population is adjacent to BC and Alberta.*	Secure in Alaska; potentially Threatened in US states south of Canada
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? *Rescue possible from Alaska but unlikely from conterminous US.*	Yes/No

* See Definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Data-Sensitive Species

Is this a data-sensitive species?	No

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 de-activated. In May 2014, the Eastern and Western populations were considered as a single unit across the Canadian range and was designated Special Concern.

Status and Reasons for Designation:

Status:	**Alpha-numeric code**:
Special Concern	Not applicable

Reasons 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.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Unknown. Evidence for declines in some parts of its range, but may be increasing in others.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not Applicable. EO and IAO exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not Applicable. Population size likely exceeds 10,000 mature individuals.
Criterion D (Very Small or Restricted Population): Not Applicable. Population exceeds 1,000 mature individuals.
Criterion E (Quantitative Analysis): Not Applicable. Analysis has not been conducted for the Canadian population.

PREFACE

Notice: Some of the information used or referenced in this document is Government of the Northwest Territories Copyright, compiled on behalf of the Northwest Territories Species at Risk Committee under a contract with the Department of Environment and Natural Resources (Northwest Territories Species at Risk Committee (NWT SARC) 2013).

The original April 1982 COSEWIC status designation for Wolverines was Rare, which was synonymous with Special Concern prior to 1990 (Kelsall 1981). In April 1989, two populations were delineated, the Eastern Population of Québec and Labrador, and the Western Population of Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Yukon, Northwest Territories (NWT), and Nunavut (Dauphiné 1989). 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. Dauphiné (1989) suggested that the Eastern Population should be classified as Extirpated.

The COSEWIC status designations were Vulnerable for the Western Population (again, synonymous with Special Concern between 1990 and 1999), and Endangered for the Eastern Population. The status designations were confirmed in May 2003 for the Western Population (Special Concern) and Eastern Population (Endangered) (COSEWIC 2003). The Eastern Population is listed on Schedule 1 of the *Species at Risk Act* (SARA) as Endangered, but the Western Population was not added to the SARA list in order to further consult with the Nunavut Wildlife Management Board (NWMB) and the Nunavut government. Issues for the NWMB centred on the lack of ATK, inadequate consultation, issues with land claims agreement, and evidence of increasing population in Nunavut (Crystal pers. comm. 2014). The consultation process occurred in 2005; however, the Minister of Environment did not issue a recommendation.

A substantial number of Wolverine research projects underway at the time of writing the previous update status report on Wolverine (COSEWIC 2003) have since been completed. There have been publications on the effect of global warming on the Wolverines' habitat requirement of late spring snow cover, genetic structuring at the southwest and eastern peripheries of the Wolverine's range, distribution and abundance of Wolverine at the eastern edge of the species' range in Ontario, and population density estimates in the southern Arctic ecozone in the NWT and Nunavut, and in montane and foothill habitats in western Alberta.

Ecozones and ecoregions discussed in this report are based on the scheme presented by the Ecological Stratification Working Group (1995). The 8 COSEWIC 'National Ecological Areas' are amalgamations of the 15 terrestrial ecozones.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2014)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada | Environnement Canada
Canadian Wildlife Service | Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Wolverine

Gulo gulo

in Canada

2014

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Figure 3. North American distribution of Wolverine. Adapted from COSEWIC (2003), Magoun *et al.* (2004), Ray (2004, 2012), Aubry *et al.* (2007), Thibault unpubl. data (2013). Map produced by Bonnie Fournier, NWT. Increased presence refers to observations of Wolverine on various islands, but it is not known if these are established or vagrant individuals. 12

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Family: Mustelidae

Latin Name: *Gulo gulo*

English: Wolverine

French: Carcajou

Aboriginal: ʔaɬ̓pu (Ktunaxa), cišps (Salish), Kalvik / Qalviit (Inuktitut), Qavviit (Inuvialuit), kihkwahâkew (Plains Cree), Kuakuatsheu / kuekuatsheu (Innu), mámex-áy-shen (she shashishalhem), naghay (southern Tutchone), nàhtyä' (Hän), Nehttryooh/Nehtryuh (Gwich'in – Gwich'in Settlement Area), Nehttryuh / nèhtrùh (Gwich'in – North Yukon), Nogha / Nághai (Dene), Noolh'utughih (Dakelh – Southern Carrier), noosik' (Gitsenimx and Nisga'a), nóoskw (Tlingit), Noostel (Dakelh – Nadleh Whut'en), Noostel (Dakelh – Nak'azdli Dakelh), nòòwa (Kwadacha Tsek'ene) , nowa (Tse'K'hene), nuŝtil (Tsilhqot'in (Xeni Gwet'in)), nowe (Tsaa? Dene (Beaver People)), nustël (Wet'suwet'en), ogwiingwa'aage+g (Ojibwe), Piinotoyi (Blackfoot), Qavvik (Inuktitut – Inuit), quts'ik (Nuxalk), Qwílqwn (Secwepemc – Northern Státimcets), qwílqen ((Ḱilḱwat), shxwématsel (Upriver Halkomelem)).

Wolverines (*Gulo gulo*; Linnaeus 1758) in North America were formerly known as *Gulo luscus* until they were shown to be conspecific with Wolverine in Europe and Siberia (Kurtén and Rausch 1959). Up to four subspecies had been recognized in North America (Hall 1981), two of which occur in Canada; *G. g. luscus*, found across Canada, Alaska and the northwestern United States, and *G. g. vancouverensis*, found on Vancouver Island (see **Designatable Units** section). Taxonomists presently recognize only either a single subspecies (*G. g. luscus* in North America), or recognize *G. gulo* as a single Holarctic taxon (reviewed in Tomasik and Cook 2005).

Morphological Description

Wolverines are a medium-sized (*i.e.* 1-m long) carnivore and the largest terrestrial member of the weasel family in North America, appearing more like a small bear than a weasel (Figure 1; Inuvik Community Corporation (ICC) *et al.* 2006). It has long, glossy coarse fur, which varies from brown to black, often with a pale facial mask and yellowish or tan stripes running laterally from the shoulders, crossing just above the tail (Gwich'in Renewable Resources Board (GRRB) 2001; Cardinal 2004). Most individuals have a pale white or orange patch on the neck and chest. It has a large head, broad forehead, short stout neck, short stocky legs, and a heavy musculature. The feet are large, ears short and the tail is long and bushy. The skull structure is robust, allowing it to crush bones and consume frozen carcasses. Wolverines are sexually dimorphic with adult females ranging in size from 7.5 to 12.5 kg and males weighing 13 to 18 kg (Magoun

1985; Banci 1994; Copeland 1996; Mulders 2000; GRRB 2001; Lofroth 2001; Cardinal 2004; Golden unpubl. data 2013).



Figure 1. Illustration of the Wolverine. (Credit: Lee Mennell).

Population Spatial Structure and Variability

The amount of population genetic structuring varies by scale. At the continental scale, Wolverine have limited structuring in the core range but increasing structure at the southwestern and eastern range peripheries (Wilson *et al.* 2000; Kyle and Strobeck 2001; 2002; Chappell *et al.* 2004; Zigouris *et al.* 2012). These studies are based on nuclear DNA markers. The largely panmictic condition in the core is believed to be due to long-range dispersal behaviour by males (see **Dispersal and Migration** section). The increased structure at the peripheries is believed to be due to isolation, and possibly separate origins from multiple glacial refugia (see **Designatable Units** section). At the local scale, increased genetic structuring has been recorded using mitochondrial DNA (mtDNA) analyses (Tomasik and Cook 2005; Cegelski *et al.* 2006; Schwartz *et al.* 2007; Zigouris *et al.* 2012; 2013). This local structuring is believed to be due to a strong preference by females to remain near their natal territories (Tomasik and Cook 2005; Cegelski *et al.* 2006; Schwartz *et al.* 2007; Zigouris *et al.* 2012).

Designatable Units

A single subspecies is presently recognized for Wolverine in North America (Tomasik and Cook 2005). Earlier classifications had recognized a separate subspecies on Vancouver Island but its status is debated; the 1935 proposal was based on a sample of only two skulls (Cowan and Guiguet 1960) and Banci (1982) concludes there is little evidence for classifying the Vancouver Island population as a distinct subspecies, based on morphometrics. Adequate samples are not available for significant genetic analyses; however, the one sample that had been processed for the control region of mtDNA revealed a genetic type found throughout the contemporary range of wolverines (Zigouris pers. comm. 2013), suggesting a lack of uniqueness from mainland Wolverine. Until further work is done, this report does not recognize the Vancouver Island population as a designatable unit (DU). According to knowledge holders in the ATK report on Wolverine (Cardinal 2004), ATK across most of the range does not differentiate Wolverine into more than one type. However, there is ATK from the Kivalliq region of Nunavut noting two types; one variety that is larger and lighter-coloured ("greater wolverine"), and another variety that is smaller and darker ("lesser wolverine"), and more common towards Yellowknife. Some participants stated that the greater wolverine variety may just be older individuals and the lesser wolverines are younger ones. However, one knowledge holder in Arviat stated that the teeth and claws of some of the lesser variety that he had caught indicated that they were older individuals, suggesting two types. Cardinal (2004) notes that without more research, it is difficult to discern whether there are actually two different varieties, or whether the differences can be attributed to another factor such as age or sex.

COSEWIC had produced a Status Report (COSEWIC 2003) with two populations ('Eastern'; Québec and Labrador, and 'Western'; Ontario westward and northward), but the reasons for separating those populations would not be relevant to present guidelines on DUs. The initial recognition by COSEWIC of the Eastern Population was based on its low population size and isolation from the Western population (Dauphiné 1989). The existing criteria for DU are discreteness and significance (Appendix F5 Operation and Procedures Manual), and the Eastern population, as presently delineated by population size, would not be recognized by COSEWIC.

Evidence for Discreteness

COSEWIC identifies discreteness, in part, by evidence of inherited traits (*e.g.,* morphology, life history, behaviour) and/or neutral genetic markers (*e.g.,* allozymes, DNA microsatellites, DNA restriction fragment length polymorphisms (RFLPs), DNA sequences). Using mtDNA analyses on 183 specimens and nuclear DNA on 246 specimens from Ontario, Manitoba, Saskatchewan, Nunavut and NWT, Zigouris *et al.* 2012 recognized two main sub-populations in Canada. Wolverines from NWT, Nunavut and Saskatchewan are part of a large panmictic core population. Wolverines in the Manitoba/Ontario region were unique; the genetic composition of Wolverine (n = 40 mtDNA; n = 82 nuclear DNA) from the Manitoba/Ontario region was different from the western samples, potentially reflective of long-standing differences between regions

(Zigouris *et al.* 2012). The Q values were relatively weak, however, indicating a mixing of haplotypes between the Manitoba/Ontario and remaining samples. Also, these analyses lacked samples from Quebec/Labrador and the southwestern US, which could influence the relative discreteness of the Manitoba/Ontario samples (Zigouris *et al.* 2012).

Additional mtDNA-based work on a larger, species-wide sample (n = 230 Eurasia; 148 Alaska; 188 contiguous US) identified 4 genetic clusters in Canada (Zigouris *et al.* 2013). The clusters, based mainly on haplotype frequencies, were in: 1) western Canada (BC, YK, AB, n = 161); 2) northern Canada (northern SK, NU, NWT, n = 151); 3) eastern Canada (ON, QC, Labrador, n = 67); and 4) Manitoba (n = 30). The Manitoba samples were distinct from all others. This expanded dataset provides more context for the relative amount of mtDNA control region genetic structure between ON, MB, NU, and NWT, where significant genetic structure was observed among other northern and western populations found to be nearly panmictic with nuclear DNA microsatellites.

Evidence for Significance

An additional criterion for DU is significance, which is represented as: 1) a gap in the population's range, or (2) the need for genetic differences reflecting deep divergence. The Eastern population is on the edge of the species' range and its removal as a DU would not be a gap within the population. Deep divergence implies genetic differences are the result of local evolutionary selection, typically because of long periods of isolation from other populations, often as a result of glacial refugia. The difficulty in interpreting present haplotype distribution is whether it is the product of a single refugia (which would not support deep divergence) with subsequent population bottlenecks and genetic drift, or multiple refugia (which would support deep divergence, and multiple DUs). The issue is compounded further by relative lack of genetic samples from the eastern population. Finally, uncertainty exists because deep phylogentic breaks cannot be assessed using only a small portion of the control region of the mitochondrial genome that is not under strong natural selection (see Zigouris *et al.* 2012; 2013; McKelvey *et al.* 2013). Data from other mitochondrial genes or mitogenomes and nuclear DNA analyses may bring additional clarity; however, these analyses will continue to be limited by sample sizes of this low-density and highly vagile creature in eastern regions.

The cause of the genetic structuring between regions is unknown. One model posits that Wolverine were isolated in multiple glacial refugia followed by long-range dispersal events, which allowed re-population of vacant areas and eventual contact between different genotypes (Zigouris *et al.* 2012; McKelvey *et al.* 2013). Unique haplotypes found in peripheral populations led McKelvey *et al.* (2013) to conclude that a population in the United States (as far south as California) persisted in refugia south of the last glacial sheet (approx. 18000 YBP) and then were extirpated in the 1800s. The unique 'California' haplotype is closely associated with genotype from Eurasia, and the authors consider this as evidence of common ancestry associated with early invasion by Wolverine into North America. Based on haplotypes common to Wolverine found today in western Canada and the northwestern US, McKelvey concludes Wolverine then

restocked the northwestern US from Canada in the early 1900s. The different genotype reflects their origins as a separate, isolated population that moved south after persisting in refugia in Alaska. In this model, the discreteness of Wolverine haplotype in the Manitoba/Ontario region may represent the boundary where two genotypes from separate glacial refugia presently meet.

A second model posits that there was a single refugium and any subsequent genetic differences are due to local breeding dynamics (Zigouris *et al.* 2013). In this model, the discrete haplotype distribution in Manitoba/Ontario is an artifact of a severely reduced population in the east and a concurrent loss of haplotypes. It is possible that some genetic types were eliminated by genetic drift and others increased in frequency relative to the north and west; the unique haplotypes could be remnants in a biased sample relative to other regions that retain larger, more genetically diverse populations (Kyle pers. comm. 2014). Female philopatry would also result in creation of some degree of local genotype.

It is unlikely that the discrete genotype in the Manitoba/Ontario region is an adaptation to local environment or habitats. Zigouris *et al.* (2012) notes that the Manitoba/Ontario region is dominated by extensive wetlands of the Hudson Plains Ecozone, whereas the core western population inhabits Taiga and Boreal Shield Ecozones (CFS 2013). There is some evidence of biogeographic influences on Wolverine genotype; differences in spring snow cover along dispersal routes were shown to explain genetic distance in Wolverines in the US Rocky Mountains (Schwartz *et al.* 2009). However, Wolverines are highly vagile and are found in many habitat types, suggesting local conditions would not be reflected in a species with extensive movement by males (see **Dispersal and Migration** section)

Four hypotheses explaining genotype distribution of Wolverines in North America were tested by Zigouris *et al.* (2013). None of the models were strongly supported but the strongest was the model wherein Wolverines arrived in North America in a single event from Siberia, then colonized the continent from west to east. The pattern would be consistent with that of a single refugium and subsequent expansion during glacial retreat. Also, the pattern of haplotype distribution in North America (Figure 2) is more likely the result of a single refugium model than a multiple refugia model; in a multiple refugia model, haplotypes would be clustered in several groups, rather than being distributed in a star radiation pattern typical of rapid expansion from a single source across most of the range, as indicated (Zigouris *et al.* 2013).

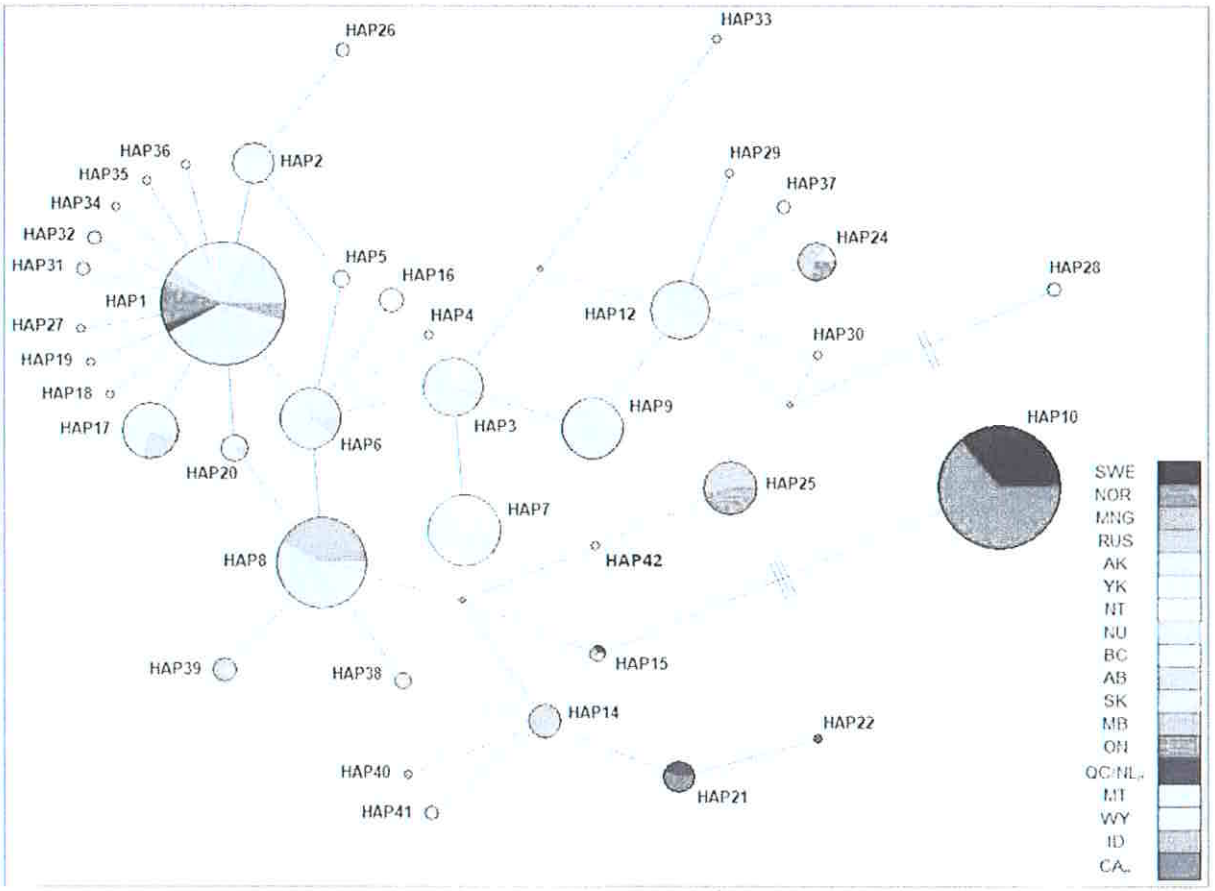


Figure 2. Median-joining network of mtDNA control region haplotypes of samples originating from Eurasia (Sweden, Norway, Mongolia, Russia) and North America (see Zigouris *et al.* 2013 for jurisdictions used in key). Each branch represents one mutation step. (Source: Zigouris *et al.* 2013 [doi:10.1371/journal.pone.0083837.g004], used with permission).

In summary, although the two populations in COSEWIC (2003) did not include genetic information, recent genetic analyses have established the presence of discrete genetic units. Essentially, there is a small fragment of mtDNA that evolves quickly and indicates female philopatry across the range, some evidence of two genetic groups, and slightly more differentiation of Manitoba/Ontario from the north and west. NuclearDNA shows near panmixia, with the exception of Manitoba/Ontario. The cause of the discrete genotype in the Manitoba/Ontario region is unknown.

The criteria of significance for a designatable unit has not been met. The Q values for discreteness are relatively weak. The discrete haplotypes in the Manitoba/Ontario region are more likely the product of a reduced population than an adaptation to local conditions. The mtDNA data largely represent the maternal genetic structure of Wolverines where clear breaks in frequency distributions of common haplotypes are found throughout their range, and, given the observation of near panmixia using neutral nuclear microsatellite loci for most of the range, the mtDNA results most likely are

reflective of male-biased dispersal and female philopatry and not locally adapted subpopulations. Evidence to date suggests a single refugium model, and thus a lack of deep divergence. Also, a similar genotype distribution is apparent in other large Holarctic carnivores (*i.e.*, Grizzly Bear, Polar Bear). Similar to Wolverine, these species possess high vagility in males and female philopatry and are considered a single DU across their Canadian range (COSEWIC 2008, 2012a). A single DU for Wolverine is recognized in this report.

Information is presented for the Canadian range, or when necessary, separated into western and eastern sub-populations. The eastern sub-population (Québec and Labrador) is isolated from the western sub-population and subject to different threats.

Special Significance

Wolverines are potential indicators of ecological integrity and disturbance due to biological characteristics and their dependence on large, connected and intact ecosystems (Carroll *et al.* 2001; GRRB 2001; Cluff and Paquet 2003; Cardinal 2004). Wolverines are viewed as one of several species of carnivores, which should be used in multi-species conservation planning in the Rocky Mountain region (Carroll *et al.* 2001) and northern Canada (Cluff and Paquet 2003). In Ontario, it is also suggested as an indicator for forest management practices and impacts from Far North development (Thompson pers. comm. 2013).

Wolverines are a much sought after and economically valuable furbearer (North Slave Metis Alliance (NSMA) 1999; WMAC(NS) and Aklavik HTC 2003; Cardinal 2004; Banci *et al.* 2005; ICC *et al.* 2006; GRRB 2014), and are trapped or hunted over much of their range in Canada (Table 1). The fur is frequently used for trim for garments due to its durability and frost-resistant characteristics (ICC *et al.* 2006).

Table 1. Wolverine pelts produced in the western sub-population, Canada, 1992/93 to 2010/11[1].

Season	ON	MB	SK	AB	BC	YT	NT[2]	NU[3,4]	Canada
1992/93	4	48	2	44	236	176	93	34	637
1993/94	6	76	12	27	97	117	121	29	485
1994/95	8	52	11	23	186	145	119	15	559
1995/96	18	45	7	9	135	72	59	5	350
1996/97	14	46	14	27	225	161	86	26	599
1997/98	12	66	10	50	152	118	175	24	607
1998/99	4	33	4	40	123	104	62	15	385
1999/00	4	18	6	10	160	157	99	22	476
2000/01	7	53	23	37	162	188	56	19	545
2001/02	7	39	14	19	183	110	111	33	516
2002/03	8	39	29	35	120	131	106	29	497
2003/04	6	43	17	23	119	138	132	41	518
2004/05	11	47	18	29	161	104	118	24	512
2005/06	6	32	14	24	123	106	126	54	485

Season	ON	MB	SK	AB	BC	YT	NT[2]	NU[3,4]	Canada
2006/07	2	24	18	43	120	106	154	30	497
2007/08	8	25	10	26	68	150	76	32	395
2008/09	7	52	18	26	123	142	133	39	540
2009/10	1	39	11	51	168	137	103	49	559
Total	133	777	243	543	2661	2362	1929	520	9162

1. Source: Statistics Canada, Fur Statistics. Statistics Canada does not publish Fur Statistics – Wildlife Pelts (Publication 23-013-X) after 2009/10. Data from 2010/11 and 2011/12 were not available from all jurisdictions at the time of writing. Minor provincial modifications to Wolverine harvest data were provided by BC (Weir unpubl. data 2012), SK (Koback 2012) and MB (Berezanski unpubl. data).
   These data include all Wolverines harvested (BC, YT, ON), or furs entering the fur trade (all others). In the latter case, fur held over to another season, furs used privately (personal or locally produced handicrafts), or furs taken by out-of-province/territory trappers are not accounted for. These discrepancies are believed to be small in the provinces, but large in some remote communities in NT and NU. See text for more information.
2. Wolverine harvest that goes through the fur auction is documented but Wolverine taken by sport hunters or use by Aboriginals are less reliably reported (*e.g.*, 19.2% reported in the Inuvialuit communities between 2001/02 and 2011/12) (Branigan and Pongracz unpubl. data 2012; Mulders unpubl. data 2013; Rossouw unpubl. data 2012; data summarized in NWT SARC 2013). Unreported Wolverine harvest also occurs in the Rennie Lake area by trappers from Saskatchewan who, between 2000/01 and 2008/09, exported an annual average of 38.7 pelts, or 25.6% of the combined harvest (Mulders unpubl. data 2013; data summarized in NWT SRC 2013). Mandatory reporting of hunted wolverine in the MacKenzie Mountains, NWT shows 31 harvested from 1991-2012 (Larter and Allaire 2013).
3. 19.3% of Wolverine harvest entered fur trade 1996-2001 in NU (Government of Nunavut 2007; Spencer unpubl. data 2012).
4. Statistics Canada pelt data collection began for Nunavut in 1992/93 for political reasons related to an Inuit land claim, in preparation for the establishment of Nunavut as a territory, which occurred on April 1, 1999.

Wolverines are important to the culture and mythology of numerous First Nations (*i.e.,* Gwich'in stories on naming Nehtryuh (Wolverine); GRRB 2001, 2014). Wolverines often are given derogatory names, such as Devil Bear and Skunk Bear, because of their propensity to rob food caches and cabins and then mark the area with their musky scent (Fortin *et al.* 2005). They frequently consume animals in a trap, and trap-wise Wolverines can be difficult to catch, earning them a range of responses from respect to contempt from trappers (GRRB 2001; Thorpe *et al.* 2001; Cardinal 2004; Ray 2004; Paul F. Wilkinson and Associates 2009). They are rarely seen, especially in forested areas (Cardinal 2004). Legendary attributes, such as ferocity and cunning, are common in mythology and folklore surrounding Wolverines (Holbrow 1976; Cardinal 2004; ICC *et al.* 2006; Paul F. Wilkinson and Associates 2009).

DISTRIBUTION

Global Range

Wolverines are found across the boreal regions of northern Eurasia and North America. The Eurasian range of the Wolverine includes Norway, Sweden, Finland, the Russian Federation, Estonia, Mongolia, and China. Range reductions have occurred in the European range south of 60°N.

Wolverine range in the conterminous United States has declined with human developments since the mid-19th century. They have been extirpated from the Great Lakes region, and from much of their range in the western mountains, where populations were naturally fragmented (Aubry *et al.* 2007). They ranged as far south as Colorado, Utah and California; however, small populations currently inhabit montane regions in Washington, Idaho, Montana and Wyoming (Figure 3; Aubry *et al.* 2007), with recent verified occurrences in Colorado (Inman *et al.* 2009), California (Moriarty *et al.* 2009), and Oregon (Magoun *et al.* 2013).

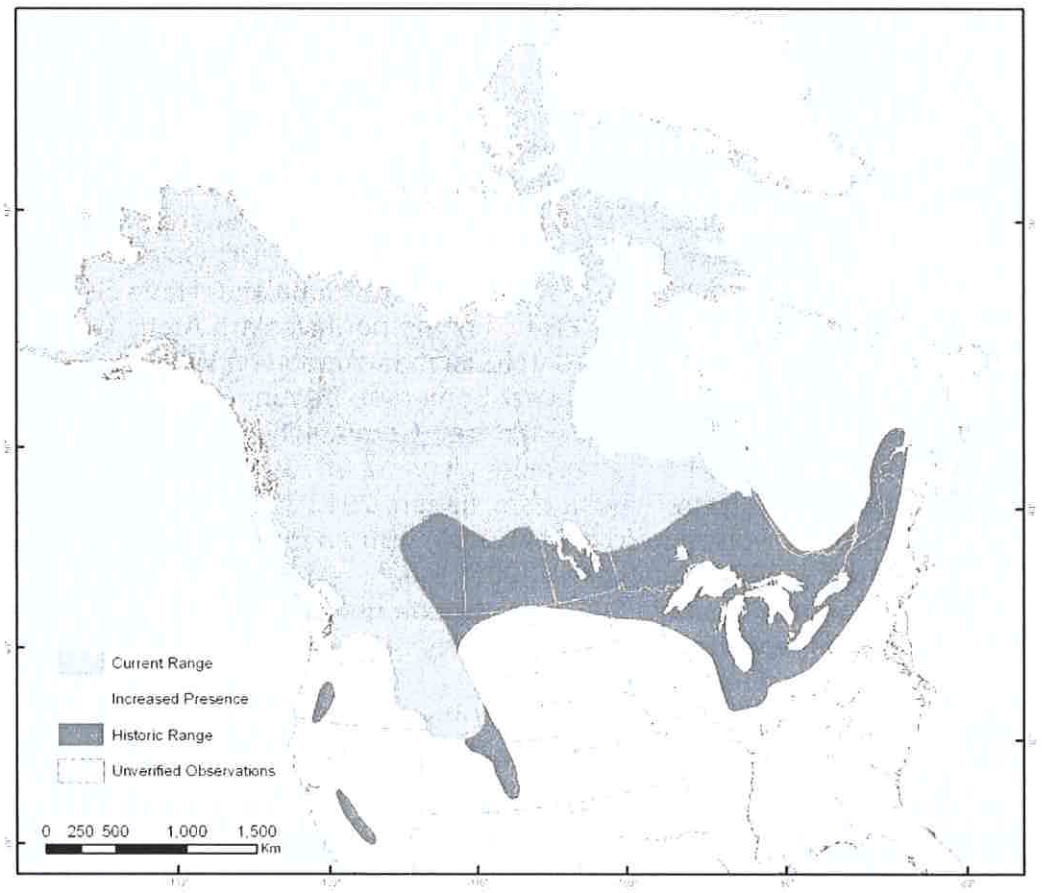


Figure 3. North American distribution of Wolverine. Adapted from COSEWIC (2003), Magoun *et al.* (2004), Ray (2004, 2012), Aubry *et al.* (2007), Thibault unpubl. data (2013). Map produced by Bonnie Fournier, NWT. Increased presence refers to observations of Wolverine on various islands, but it is not known if these are established or vagrant individuals.

The historical range of Wolverines in North America was compiled from anecdotal evidence such as personal accounts and the interpretation of fur returns. The two major fur trading companies, Hudson's Bay Company and the North West Company, traded over large areas (Novak *et al.* 1987; Obbard *et al.* 1987) and harvest locations cannot be confidently assigned to the community at which they were traded, or where they were trapped. Most of the southern areas from which Wolverines were presumably extirpated never produced significant numbers of Wolverine pelts (see Aubry *et al.* 2007). Human activities and habitat changes may have influenced the range contraction in the United States and Canada, but a northward shift in spring snow cover that persists through the reproductive denning period may be a critical factor as well (Copeland *et al.* 2010; see Habitat Trends section).

Canadian Range

Wolverine occur across much of the length of Canada, inhabiting forested areas, alpine tundra of the western mountains and arctic tundra (Figure 3). On the West Coast, Wolverines occur on Pitt (MacLeod 1950) and Princess Royale (Shardlow 2013) Islands, and were last confirmed on Vancouver Island in 1991 (BC Government 2013). Wolverines have not been reported on the island of Newfoundland, Nova Scotia, Prince Edward Island, Haida Gwaii, and some islands of the northwestern Arctic Archipelago in the NWT and Nunavut (Dauphiné 1989). Arctic islands supporting Wolverine include Victoria, Banks, Stefansson, Prince of Wales, Somerset, Devon, Cornwallis, Amund Ringnes, Ellesmere, Baffin, Bylot, Coates, Mansel (Community of Sachs Harbour *et al.* 2008; Environment Canada 2013; Carrière pers. comm. 2013), and it has recently been confirmed on Southampton Island (Awan pers. comm. 2013). Harvesters report a northwards expansion of wolverine (Cardinal 2004) with an increase in Wolverine on Victoria Island (Cardinal 2004; Banci *et al.* 2005), Baffin Island (Mallory *et al.* 2001), and Banks Island (Environment Canada 2013). Wolverine residency on some Arctic islands is unclear and is likely dependent on the availability of food resources.

Range reductions began in the mid-19th century, where it was extirpated from New Brunswick, and the southern half of Ontario and Québec, and from the aspen parkland of Manitoba, Saskatchewan and Alberta (Dauphiné 1989). In Labrador, range reduction began in the 1890s; between 1891-1910, 732 pelts were received at Fort Chimo and Davis Inlet, compared to 75 pelts between 1910-1930. The last verified record for Labrador was of two animals trapped in 1965 (Dagenais 1988). However, it is just as likely they persisted until the late 1970s because the last record for the entire eastern population was an animal trapped in 1978 in Schefferville, Québec, which is on the border with Labrador (Dagenais 1988; Fortin *et al.* 2005). Pelts were traded in Québec until 1980, but it is not known if they originated in Québec (Fortin *et al.* 2005).

Evidence from aerial surveys and trapper reports suggests a reoccupation of eastward range may be occurring in northern Ontario (Figure 4; Magoun *et al.* 2004; Ray *et al.* 2005; Koen *et al.* 2008; Ray 2012; Ontario Wolverine Recovery Team 2013; Ontario Ministry of Natural Resources, unpubl. data).

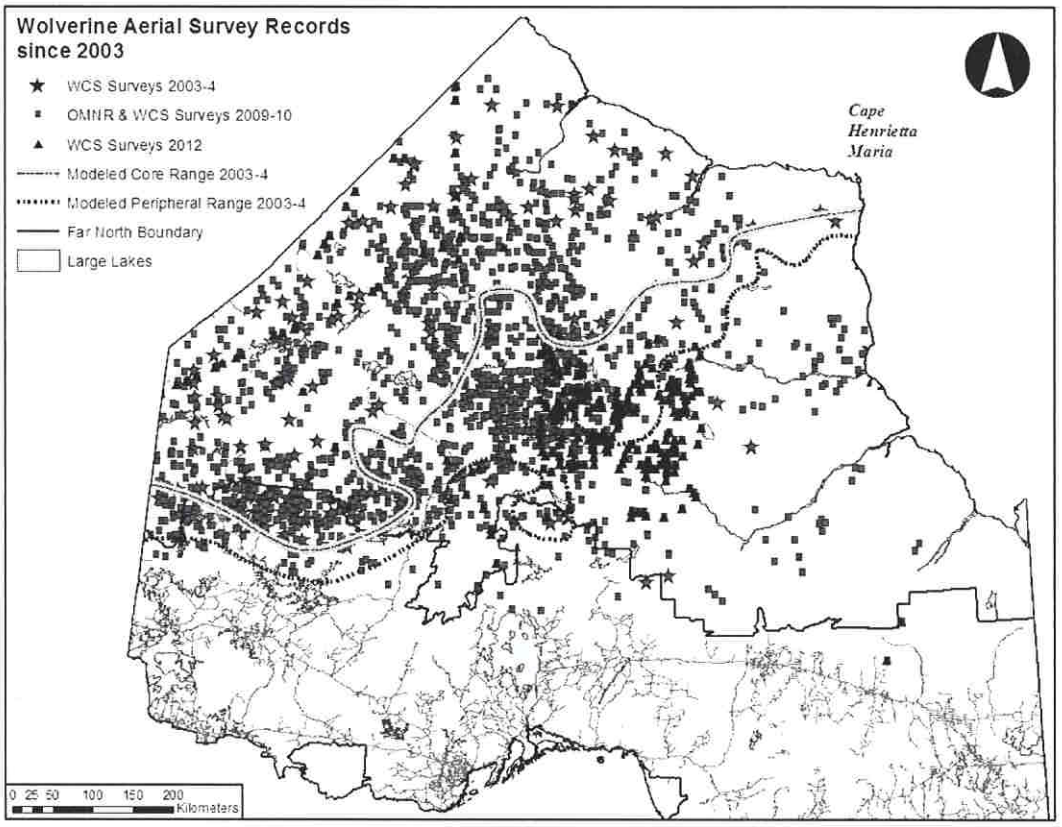


Figure 4. Locations of Wolverine records based on aerial surveys conducted by Wildlife Conservation Society (WCS) and Ontario Ministry of Natural Resources (OMNR). The area west of the modelled core and peripheral range represents the main and peripheral locations of Wolverine before 2004. The large number of recent (>2009) records indicates an eastern expansion of the sub-population. (Source: Ontario Wolverine Recovery Team 2013; Ray unpubl. data.)

Extent of Occurrence and Area of Occupancy

'Extent of occurrence' (EO) is defined as the area included in a convex polygon that encompasses the geographic distribution of all verified (scientific and ATK) occurrences of the Wolverine. The EO of the Western Population of the Wolverine in Canada is > 10 million km². The EO of the eastern sub-population, based on recent, but unverified observations, would be 0.88 million km².

'Index of area of occupancy' (IAO) is defined as the area within the EO that is occupied by Wolverines, excluding cases of vagrancy. It is calculated based on 2 km x 2 km grid cells that intersect the actual area occupied by Wolverines. This measure reflects the fact that the EO may contain some unsuitable or unoccupied habitats. The IAO of Wolverines in Canada is > 4,000 km^2 for the western sub-population, and has not been determined for the unverified records in the eastern sub-population.

Search Effort

Wolverine distribution in Canada has been documented from several sources of information. Most data are derived from trapping activities. Registered trapping concessions or open trapping areas in BC, Alberta, and the Yukon correspond with area-specific harvest designation (Slough and Jessop 1996; Cardinal 2004; Jung *et al.* 2005; Arctic Borderlands Ecological Knowledge Coop Society (ABEKC) 2008; Slough 2009). In other jurisdictions, location of trap activity is recorded by nearest government office, trade centre, or through trapper surveys. ATK notes Wolverine are usually recorded during periods of snow cover but this likely relates to the period of trapping activities, which is biased to fall and winter. Most Wolverines are trapped incidentally (Cardinal 2004) and capture locations are rarely shared (ICC *et al.* 2006).

Techniques have been developed to determine the probability of Wolverine occurrence in a sample unit based on a hierarchical spatial modelling of Wolverine tracks in the snow (Schmelzer 2006; Magoun *et al.* 2007). Remote cameras have been used in many jurisdictions (Magoun *et al.* 2011a, b). Standard live-capture and radio-telemetry has been used in some area-specific studies to determine biological characteristics, such as home range size and movements, habitat use and density. Parks Canada and Department of National Defence maintain a database on Wolverine observations at their sites (Nantel pers. comm. 2012; Nernberg pers. comm. 2012).

Field studies to determine Wolverine population characteristics and/or density were conducted in the south-central Yukon from 1982 to 1985 (Banci 1987) and in the northern Yukon in 2004 (Golden *et al.* 2007). Wolverine DNA mark-recapture sampling has been undertaken in the diamond mining and exploration region northeast of Yellowknife since 2005 (Mulders *et al.* 2007; Boulanger and Mulders 2008, 2013a, b). Incidental observations are recorded at diamond mines in the NWT and Nunavut (NWT SARC 2013).

Diamond mining companies in the NWT (*e.g.*, Diavik Diamond Mines Inc., BHP Billiton-Ekati, De Beers-Snap Lake) have Environmental Agreements and Wildlife Effects Monitoring Plans. The recording of observations and winter track-counts began at Snap Lake in 1999 (Golder Associates 2010). The track-count technique was modified in 2003 to use multiple, 4 km long transects. At Ekati, a regional DNA-based study replaced the Wolverine snow track survey that was conducted from 1997 to 2004 (Rescan 2012). Snow track surveys began at Diavik in 2003, and the methods were revised in 2008, using standard 4 km straight line transects (Diavik Diamond Mines Inc. (DDMI) 2012). Wolverine sightings have been documented at Kennady Lake since 1998, and winter track-counts began in 2004 (Golder 2010).

The survey effort in Nunavut is very similar to that in the NWT; Wolverines are monitored using fur harvest data, carcass collections, field studies, and ATK. Wolverine fur is prized in Nunavut, where most of the pelts are used locally. Wolverine densities are being monitored at diamond mining areas at High Lake (near Coronation Gulf) and Izok Lake (near the NWT border) using the DNA mark-recapture technique (Poole unpubl. data 2013). Both of these study areas are in the Southern Arctic ecozone.

British Columbia monitors Wolverines using harvest data and a compulsory reporting system for trappers and hunters, which receives low compliance (Krebs pers. comm. 2013). Two field studies of Wolverine ecology took place in the Omineca Mountains of north-central BC between 1995 and 2001, and the Columbia Mountains of the southeast (Lofroth and Krebs 2007).

Alberta has used opinion surveys of trappers (Petersen 1997) and fur harvest data analyses (Webb *et al.* 2013). Fisher *et al.* (2013) used genetic tagging to document Wolverine density in the Willmore Wilderness Park in the Rocky Mountains (2006 to 2008) and in the foothills near Hinton and Grande Cache (2005 to 2006). Genetic tagging has been used in Banff and Yoho National Parks since 2010 (Clevenger *et al.* 2011a). Camera trapping has been used in the central Rocky Mountains (Kananaskis Country) since 2010 (Fisher and Heim 2012) and in Banff and Yoho National Parks since 2009 (Clevenger *et al.* 2011b).

Wolverine distribution and abundance in Saskatchewan are monitored using fur harvest statistics (Siemens Worsley 2011), trapper questionnaire responses (Gollop 2012), and ATK (Berezanski 2004).

In 2000/01 a zero quota was placed on non-aboriginal trappers in Ontario; however, legal trapping continued until 2009 when the Wolverine season was closed. First Nation trappers may still harvest Wolverine via treaty rights but have not be able to sell the pelts since 2009. Most information on Wolverine distribution and abundance has come from fur harvest reports (incidental and Aboriginal harvest), ATK (Ray 2004) and aerial surveys (Ontario Wolverine Recovery Strategy). Recent aerial surveys have improved our knowledge of Wolverine range in Ontario (Figure 4) (Magoun *et al.* 2004, 2007; Ray *et al.* 2005; Koen *et al.* 2008; Ray 2012; Ontario Wolverine Recovery Team 2013). The 2005 Ontario Wolverine Project study area covered approximately 60,000 km^2 in the Boreal Shield Ecozone in northern Ontario (Ray *et al.* 2005; Magoun *et al.* 2007; Bowman *et al.* 2010). Incidental Wolverine observations were recorded during a Caribou recruitment survey made across northern Ontario along a total transect length of 14,740 km in 2012 (Ray 2012). Knowledge of distribution is deemed robust, although incomplete along the range periphery (Ray pers. comm. 2013).

A study of Wolverine home range characteristics and ecology was conducted in lowland boreal forest near Red Lake, in northwestern Ontario in 2003-2004 (Dawson *et al.* 2010) along with a DNA mark-capture study, conducted in the same study area in 2004 by the Ontario Wolverine Project Team (Dawson *et al.* unpubl. data 2013). Data from these two studies have been used to estimate Wolverine density.

In Québec, Wolverine observations submitted since 2000 are numerous but unverified (Figure 5; Thibault unpubl. data 2013). An aerial survey for Wolverines in a 4,274 km^2 area of the proposed Monts-Torngat-et-de-la-Rivière-Koroc National Park where Wolverine had once been present did not find evidence of the species (Fortin 2004). Another survey in the Abitibi and James Bay lowlands (100,000 km^2) reported observations of two tracks in the area <100 km east of the Ontario border, but these

have not been verified (Fortin 2006; Thibault unpubl. data 2013). A Wolverine camera trapping project initiated in the Abitibi lowlands and Laurentian Mountains in 2012 has not recorded Wolverine, to date (Thibault pers. comm. 2012).

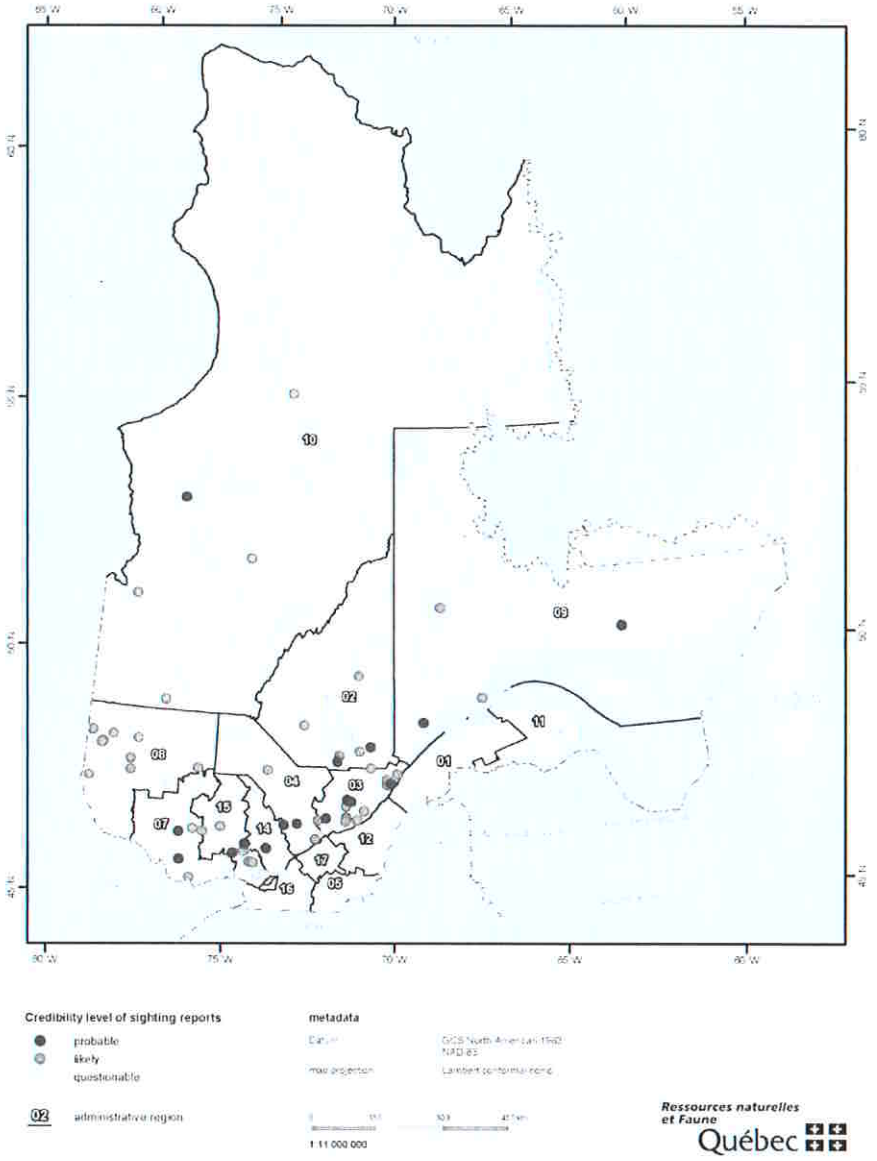


Figure 5. Locations of Wolverine sighting reports in Québec, 2000 to 2012, according to their relative level of credibility. No sightings have been verified. Adapted from Thibault unpubl. data (2013).

Johnson *et al.* (2012) assessed the Monts Groulx and Monts Otish in southeastern Québec for Wolverine denning habitat potential using GIS-based modelling of habitat variables, such as snow cover, summer snow persistence, the alpine-treeline ecotone, topographic ruggedness and distance from human activity. They concluded that the western massif of the Monts Groulx represented the highest quality reproductive habitat in sub-arctic Québec. A province-wide survey of Wolverine habitat potential in Québec also identified the Torngat Mountains, a large part of the Côte-Nord, the southeast section of the Nord-du-Québec, and part of the Charlevoix region as having potential to support Wolverines (Gallais and Messier 2012).

In Labrador, historical accounts are based on Hudson's Bay Company fur trade data from posts in Davis Inlet and Moravian Missions of Hebron and Okak from 1884 to 1923 Schmelzer (unpubl. data 2012). The harvest of Wolverines was banned in Labrador (mainland Newfoundland and Labrador) in 1950. Aerial surveys, using 1,000-km^2 hexagons, were conducted in 2005. The total transect length was 6,630 km, covering an area of 195,000 km^2 between 54°N and 60°N and approximately 80% of Labrador and much of the range of the eastern population (Schmelzer 2006). Anecdotal observations continue to be reported; however, none have been verified by photographs or genetic analysis. A follow-up protocol, including search for hair samples, exists to attempt to verify observations (Moores pers. comm.). Inuit and Metis Aboriginal communities conduct ground detection monitoring using hair snag stations and remote cameras to try to verify reported sightings in the Cartwright area, and in northern Labrador (*e.g.,* Habitat Stewardship Project by NunatuKavut Community Council; MacDonald pers. comm. 2013; Moores pers. comm.).

Anecdotal observations, including sightings of Wolverines and Wolverine tracks, are often ranked according to their reliability (*e.g.,* Aubry and Houston 1992). A reliability ranking method is employed in the range of Eastern Wolverine Population in Québec (Thibault pers. comm. 2012).

HABITAT

Habitat Requirements

Wolverines inhabit a variety of treed and treeless vegetation associations (ICC *et al.* 2006), at all elevations, although some Aboriginal harvesters suggest that they find more Wolverines in higher elevation areas (Wildlife Management Advisory Council (North Slope) (WMAC (NS)) and the Aklavik Hunters and Trappers Committee (HTC) 2003; Cardinal 2004; GRRB 2014) and fewer in open tundra (Cardinal 2004). They thrive in ecologically intact areas, where prey and other carnivore species are common and diverse. Wolverine habitat components include food (Cardinal 2004) and suitable physical features for natal and maternal den sites, and rendezvous sites, where kits are left during foraging periods by the female. In a multi-scale habitat use study in two multi-use regions of British Columbia, male Wolverines chose vegetation associations primarily based on food availability in summer and winter, while females were influenced by food, predation risk, and disturbance (Krebs *et al.* 2007).

Wolverine locations recorded by Mulders (2000) in the Southern Arctic ecozone in the NWT were correlated with vegetation density and patches, especially sedge density (Johnson *et al.* 2005). The reason for this association is unclear, but Wolverines were also associated with Wolves (*Canis lupus*), Caribou (*Rangifer tarandus*) and Grizzly Bears (*Ursus arctos*). Viable populations of large carnivores such as Grizzly Bears and Wolves are important as involuntary providers of ungulate carrion.

In mountainous areas, adult females used higher elevation alpine vegetation associations and steeper terrain more than males or other age classes (GRRB 2001; Cardinal 2004), while adult males and subadults of both sexes made extensive use of low elevation forested areas (Krebs *et al.* 2007). Lower elevations are used more in winter by males, and both sexes use all elevations in summer (Landa *et al.* 1998; Copeland *et al.* 2007; Krebs *et al.* 2007). Banci and Harestad (1990) found that Wolverines in the Kluane Game Sanctuary used vegetation associations according to availability, although males used coniferous subalpine areas more frequently than other vegetation associations in winter.

Den Sites

Wolverines have specific physical requirements for den sites. Dens are constructed either in talus boulders, along eskers, under deadfall, under logs in avalanche debris, or in snow tunnels at higher elevations and tundra (Copeland 1996; Magoun and Copeland 1998; GRRB 2001; WMAC and Aklavik HTC 2003; Cardinal 2004; Inman *et al.* 2007). Wolverine dens are also associated with large boulders and downed trees at lowland boreal sites in Ontario and Yukon (Dawson *et al.* 2010; Slough unpubl. data). In the eastern Arctic, Wolverines den in rocky areas with boulders, while in the western Arctic, knowledge holders describe finding dens in snow banks, under tree roots and along streams throughout the boreal region (GRRB 2001; Lutsël K'e Dene First Nation *et al.* 2001; WMAC(NS) and Aklavik HTC 2003; Cardinal 2004). It was reported that reproductive dens are often found in similar areas as dens used for other purposes (Cardinal 2004), although reproductive dens were usually less accessible and more isolated (GRRB 2001; ICC *et al.* 2006).

The availability of adequate insulating snow cover (*i.e.* ≥1.0 m deep) late into spring appears to be an important habitat feature for denning (Magoun and Copeland 1998). Copeland *et al.* (2010) found that 97.9% of 562 reproductive dens that they investigated in Fennoscandia and North America occurred at sites with persistent spring snow cover in at least 1 of 7 years. Female Wolverines must leave their kits for lengthy foraging trips, and often select natal den sites in talus or avalanche debris with snow cover late into spring (Copeland 1996; Inman *et al.* 2007) or under remnant snowdrifts (Magoun 1985). Such snow accumulation typically occurs in ravines and on leeward slopes. Dens with spring snow cover allow Wolverines to construct snow tunnels that provide thermoregulatory benefits for kits, are secure from excavation by predators, while dens are located in areas used by few other carnivores, and also provide an abundance of small-mammal prey for feeding kits (Magoun and Copeland 1998).

Individual Wolverines may reoccupy den sites or denning areas for several consecutive years (Magoun 1985; Inuit hunters, as reported by Lee and Niptanatiak 1996). Wolverine reliance on food caching in cold, structured microsites to inhibit competition with insects, bacteria, and other scavengers is likely a critical behavioural adaptation due to the limited availability of food resources. Inman *et al.* (2012) suggest that habitat features that facilitate caching, including low ambient temperatures, are likely important and related to the distributional limits of the Wolverine.

Habitat Trends

Considerable Wolverine habitat was permanently lost or fragmented with the extensive human development that occurred in the late 19th and 20th centuries at the southern edge of the range (van Zyll de Jong 1975). Much of the habitat lost may have been low quality habitat (as evidenced by low fur harvest returns), and numerical losses of Wolverines may have also been low. Losses were due primarily to human settlement and agriculture, with associated reductions due to hunting and trapping. Many Wolverines likely were non-target kills from poison baits used during predator control directed at wolves.

The reduction of ungulates, an important winter prey base, also likely contributed to their range contraction. Reduced numbers of prey remains a significant threat to Wolverine populations today, especially where Central and Southern Mountain, and southern Boreal Caribou herds are declining (Lofroth *et al.* 2007). Increases in Moose (*Alces alces*) and deer (*Odocoileus* spp.) populations in logged areas may, in part, compensate for losses in Caribou numbers. Wolverines may suffer from the recent declines of many Barren-ground Caribou herds (Vors and Boyce 2009). For example, the Bathurst herd declined from 203,800 to 16,400 breeding females from 1986 to 2009 (Boulanger *et al.* 2011). The Eastern Migratory George River herd of northern Québec and Labrador has declined from a high of > 600,000 in the 1980s to 27,600 animals in 2012 (Newfoundland and Labrador Department of Environment and Conservation 2012).

A positive correlation between Wolf and Wolverine harvests at trading posts in Québec and Labrador suggests that current-day Wolf population dynamics may be a useful tool to evaluate Wolverine recovery potential (Schmelzer unpubl. data 2012). However, Wolves in Labrador/Québec slowly recovered in the last century following the collapse and subsequent recovery of Eastern Migratory Caribou in the region, while Wolverines did not. The increase in Caribou that favoured the Wolf should also favour the Wolverine; reasons for the lack of a recovery by Wolverine in this region remain unknown.

Habitat fragmentation has resulted in isolated and threatened Wolverine populations in the western conterminous US (Banci 1994), and this process may be occurring in southern BC and Alberta, and in Manitoba and Ontario (Kyle and Strobeck 2002; Zigouris *et al.* 2012). Across parts of Wolverine range, forestry, oil and gas and mineral exploration and development, and large hydroelectric reservoirs threaten habitat with permanent, temporary and functional losses. Transportation corridors can act as barriers to movement and fragment habitats and isolate populations. Direct mortality may be a factor along transportation corridors in southern range, and elsewhere roads facilitate indirect mortality through improved motorized access for hunters, trappers and recreational users into remote areas. Travel and dispersal corridors of suitable vegetation associations must be maintained to facilitate connectivity of populations (*e.g.,* Schwartz *et al.* 2009).

Kelsall (1981) and Dauphiné (1989) assumed that the relatively large number of parks and protected areas, which act as refugia from trapping and development in western Canada, had secured Wolverine populations. Trapping by Aboriginals, however, is allowed in most northern protected areas, and many Wolverines range outside protected area boundaries where they are vulnerable to trapping (Squires *et al.* 2007). Furthermore, human recreation, such as snowmobiling and other forms of snow travel allowed in some parks, may disturb Wolverines, particularly during the denning season in February-March (Heinemeyer and Squires 2012).

A study of the cumulative effects of developments on Arctic wildlife (Johnson *et al.* 2005) found that mines and other major developments had the largest negative effect on species occurrence, followed by exploration activities, and outfitter camps. The species most affected were Grizzly Bears and Wolves, followed by Barren-ground Caribou and Wolverines. The response by Wolverine was based on relocated Wolverine in the Slave lake area (Mulders 2000) which experienced a 2.4% decrease in use of summer habitat, likely because of a strong interaction between Wolverine and Caribou during the summer, when Caribou strongly avoided developments.

The extent of habitat loss from climate change is uncertain. Wolverine den in snowpack areas (see **Den Sites** section) and spring snow cover during the denning period is closely related to historical Wolverine distribution in the contiguous United States (Aubry *et al.* 2007). Brodie and Post (2010a, 2010b) hypothesized that the declining snowpack in western Canada for the years 1974-2004 negatively affected Wolverine population dynamics, as evidenced by declining harvests. However, numerous biases could also explain declining harvests, such as trapping effort, declining pelt prices and licence sales, changes in trapping regulations, and trapper success, which raised questions about the validity of their conclusions (DeVink *et al.* 2010; McKelvey *et al.* 2010). A recent panel of experts generally agreed that snow is important at the scale of the den site, but did not agree if snow was limiting at the home-range, or species-range scales (Wolverine Science Panel 2014).

A climate-driven decline is not evident at this time in much of Wolverine range because Wolverine population trends in the northern range, while largely unknown, are possibly stable or increasing in many areas (COSEWIC 2003; Krebs *et al.* 2004; Lofroth and Krebs 2007; Slough 2007; see **Abundance and Trends** section). There is greater concern for southern areas of BC, and mountainous areas of the northern US (Weir pers. comm.; Wolverine Science Panel 2014); reductions in spring snow cover associated with climatic warming will likely reduce the extent of Wolverine habitat in the U.S. (McKelvey *et al.* 2011). Reductions in spring snow cover for lowland or mountain habitats in Canada have not been assessed specifically for Wolverine, but significant declines in sub-boreal and high altitude ecosystems are expected due to climate shifts (Wang *et al.* 2012).

BIOLOGY

Biological factors, such as a relatively low intrinsic rate of increase, low natural densities, and large home ranges limit population growth rates and affect the Wolverine's ability to recolonize vacant habitats and recover from trapping (Banci and Proulx 1999). Re-population may take several decades but is possible in areas where factors (such as cessation of predator poisoning, trapping regulations, and ungulate population growth) favour Wolverine survival (Johnson 1990; Vangen *et al.* 2001).

Life Cycle and Reproduction

Wolverines have a polygamous mating system, with males mating with more than one female. Most Wolverines become sexually mature at 2 years of age, but few breed at this age (Banci 1994). Wolverines are thought to breed in the summer, from June through August (Magoun and Valkenburg 1983; Krott and Gardner 1985), and ATK suggests they breed during a few weeks in March and April during a period of active movement (GRRB 2001; Cardinal 2004; Deh Cho First Nation 2006). The proportion of adult female that were pregnant ranged from 74% (Banci and Harestad 1988) to 92% (Rausch and Pearson 1972) in studies in Yukon and Alaska. The pregnancy rate of subadults (1-2 years old) was 7% in the Yukon (Banci and Harestad 1988) and 50% for a combined Alaska/Yukon sample (Rausch and Pearson 1972). The latter study might have included some adults (Banci 1994). The pregnancy rate declined from 92% for 2-3 year olds to 53% for 5-6 year olds and 37% for combined 6 year old and older age classes. Recent (2005/06-2011/12) analyses of Wolverine carcasses from the Yukon showed a pregnancy rate of 0% for juveniles, 31% for yearlings, and 80% for adults. The highest pregnancy rates (90%) were in 3-5 year old animals (Jung and Kukka 2013).

The average number of fetuses ranged from 2.8 (2-3 year olds) to 3.4 (6+) in a 1980s Yukon study (Banci and Harestad 1988). Litter size was greatest for females over the age of 6 (Banci and Harestad 1988; Rauset 2013), but the pregnancy rate for that age class was lower. Overall reproductive rates observed in Alaska and Idaho were 0.69 and 0.89 kits per female per year, respectively (Magoun 1985; Copeland 1996); the low values reflect that females often breed every other year. Litter size was closely tied to primary productivity (Rauset 2013).

Active gestation takes 30-40 days (Rausch and Pearson 1972). Litters of four or less are born between January and April (Banci and Harestad 1988), or as late as June or July (GRRB 2001; Cardinal 2004). Wolverine kits reach adult body size by 7 months of age (Magoun 1985) and are weaned at 9-10 weeks (Banci 1994).

In this report, generation time is based on the average age of reproductive females in the population. The maximum age reported for Wolverines is 16 years in the Inuvik Region, NWT (Branigan and Pongracz unpubl. data 2012). Maximum ages of 11 were reported in the Kitikmeot Region, Nunavut (Lee 1998), and 12.9 in the Yukon (Jung and Kukka 2013). Most females do not breed until the age of 3, and the average age of females that are 3 or older is likely 7 or 8 years of age. The generation time for Wolverines is likely 7.5 years.

Physiology and Adaptability

Wolverines typically occupy home ranges that vary from about 50-400 km^2 for females, and 230-1580 km^2 for males (Hornocker and Hash 1981; Gardner 1985; Magoun 1985; Whitman *et al.* 1986; Banci and Harestad 1990; Copeland 1996; Krebs *et al.* 2007; Dawson *et al.* 2010; Persson *et al.* 2010). Lofroth (2001) documented an average home range of 1,230 km^2 for subadult females, and a range of 3,500 km^2 for dispersing subadult males. WMAC(NS) and Aklavik HTC (2003) report that fresh tracks of solitary Wolverine are observed in about every 40-80 km of snowmobiling in April and May. There may be home range overlap between members of the same and opposite sexes, with the latter being more common (Krebs and Lewis 2000). Cardinal (2004) reported that male home ranges would include the ranges of 4-5 females. Aboriginal and Inuit harvesters indicate that wolverine move extremely large distances (NSMA 1999; Cardinal 2004; ICC *et al.* 2006; Henry 2007) and that they are unclear if they have a home range or territory because they never seem to stay in the same area (Cardinal 2004). Some knowledge holders believe that older Wolverines establish home ranges, but younger individuals do not (Cardinal 2004; Henry 2007).

Wolverines show some adaptability to humans, being attracted to wilderness camps, traplines, and snowmobile trails by virtue of their scavenging habits. There is also a negative impact of disturbance, leading to the loss of functional habitat, possibly affecting the reproductive success of females (see **Threats and Limiting Factors** section).

Dispersal and Migration

A proportion of the population, typically yearlings, is transient at any given time. Yearling females tend to establish home ranges nearer their natal ranges than do yearling males, although both sexes are capable of long-distance movements. Male dispersal records include 200-874 km over several months (Gardner *et al.* 1986; Inman *et al.* 2004). A dispersal distance of 100 km was reported for a juvenile male in Ontario (Dawson *et al.* unpubl. data 2013). Maximum movements by females of 225-300 km have been recorded (Mulders 2000; Aubry *et al.* 2012).

Wolverines are able to traverse rugged terrain, including tundra and glaciers that would act as barriers to the dispersal of many other species of mammals. Long-distance dispersal abilities likely gave Wolverines the capacity to recolonize gaps in their distribution in Scandinavia (Vangen *et al.* 2001; Flagstad *et al.* 2004).

Interspecific Interactions

Wolverines are scavengers and predators, opportunistically feeding on abundant or readily procurable food (Cardinal 2004; Clément 2009; Benson 2011; Inman *et al.* 2012). Food is frequently cached for later use. Diets of Wolverine typically vary between seasons and years, as they switch between food sources depending on availability (Dalerum *et al.* 2009). Fresh prey are eaten more during summer and carrion, including cached items, is used more in winter (Magoun 1987). Many species of small mammal and ground-nesting bird are depredated. The most common sources of carrion are whichever large ungulate species are present (Gardner 1985; Banci 1987; Magoun 1987; Johnson and Ruttan 1993; NSMA 1999; Mulders 2000; GRRB 2001; Thorpe *et al.* 2001; Cardinal 2004; Ray 2004; Banci *et al.* 2005; Dumond 2007; Henry 2007; Lofroth *et al.* 2007; Clément 2009; Carriere 2010; Benson 2011).

In the Kitikmeot Region, Nunavut, Mulders (2000) reported that Caribou remains were found in 62% of stomachs of winter-trapped Wolverines, and Muskox were found in 11%. Minor food items included Arctic Ground Squirrels (*Spermophilus parryii*), voles and lemmings, and ptarmigan. Caribou were also the most common prey in the Inuvik Region, NWT (Branigan and Pongracz unpubl. data 2012), where they were found in 58% of Wolverine stomachs. Barren-ground Caribou were found in 56% of all stomachs in the North Slave Region, NWT (Mulders unpubl. data 2013), but were found in 12 to 32% of Wolverine stomachs from other regions. Snowshoe Hare (*Lepus americanus*) (and presumably Arctic Hare (*L. arcticus*) in tundra regions) is an important food for Wolverine in the north (Banci 1987; Branigan and Pongracz unpubl. data 2012) and a delayed numerical response of a 2-3 year time lag in Hare abundance has been documented (Bulmer 1975). Arctic Ground Squirrels are an important summer food in the Arctic (Magoun 1987). Several fish and seal species are scavenged (Golder Associates 2003; Cardinal 2004; Banci *et al.* 2005; Clement 2009). Porcupine (*Erethizon dorsatum*) are noted as a common food item in the Gwich'in Settlement region of the Mackenzie Delta (GRRB 2001, 2014).

Large carnivores generate carrion, which is an important food source for Wolverines, especially during the winter months (Wright and Ernst 2004). Carnivores also may compete with Wolverines at kill sites, and are a potential source of Wolverine mortality (White *et al.* 2002; Krebs *et al.* 2004; Jung and Kukka 2013). Johnson *et al.* (2005) found that Wolverines were positively associated with Wolves, Grizzly Bears and Caribou on the Slave study area, near Daring Lake, NWT, although a traditional knowledge study in the area of Wood Buffalo National Park did not report any cases of Wolverine preying on Caribou (Gunn 2009).

Wolverines are preyed on by Grizzly Bear, Polar Bear (*Ursus maritimus*), Wolves, Mountain Lions (*Puma concolor*), Golden Eagles (*Aquila chrysaetos*), and other Wolverines (Cardinal 2004). They may encounter large carnivores with greater frequency when scavenging carrion. Krebs *et al.* (2004) found that human-caused mortality from trapping and road/rail kill accounted for 46% of deaths in a review of 12 studies using radio-collared animals. Natural sources of mortality included predation by Wolves, Mountain Lions and conspecifics (30% of non-human causes), and starvation (49% of non-human causes).

Parasitic nematode roundworms (*Trichinella* spp.) were found in 88% of Wolverine samples tested from Nunavut (Reichard *et al.* 2008a) and 26% (n=43) of samples from the lower MacKenzie region (Larter pers. comm), and none (n=38) from the upper Mackenzie region (Addison and Boles 1978). Six other species of helminth parasites (trematodes, cestodes and nematodes) were recorded in the digestive tracts of Wolverine from the lower Mackenzie River valley (Addison and Boles 1978). Protozoan parasites (*Sacrosystis* spp.) infected 80% of Wolverines from Nunavut (Dubey *et al.* 2010). Another protozoan parasite, *Toxoplasma gondii*, was detected in 41% of Wolverines from Nunavut (Reichard *et al.* 2008b). The prevalence of clinical disease symptoms is unknown, but this parasite is transmissible to humans through skinning and fur handling. A rabid Wolverine (infected with a strain of Arctic Fox (*Alopex lagopus*) rabies) was recorded in Alaska (Beckman pers. comm. 2012). Rabies was not recorded in 71 Wolverine tested for rabies in the Yukon during recent years (Jung pers. comm. 2013).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Establishing population abundance and trends is difficult because most numeric data are derived from harvest activity. It is unknown in large parts of the range whether harvest actually reflects total harvest levels. Fur harvest is susceptible to many factors other than the population size of furbearers, including environmental, social, cultural and economic factors (Slough and Jessup 1996). Trends are difficult to establish if trap effort and reporting varies over time and by jurisdiction. For example, Lee (1994a) believed that the harvest was underestimated by 50-90% in Nunavut/NWT. Some reports suggest that <20% of the harvest enters the fur trade (Government of Nunavut 2007;

Spencer unpubl. data 2012). Based on carcass collection programs, the unreported harvest may be underestimated by 35% overall, and greater than 80% in Inuvialuit/Inuit coastal communities (Branigan and Pongracz unpubl. data 2012; Rossouw unpubl. data 2012; Mulders unpubl. data 2013; summarized in NWT SARC 2013). Lee (1994a) estimated that the actual harvest was underestimated by 50-90% in the Coppermine, Bay Chimo, and Bathurst Inlet area. (Note: although reporting is low, extra information on harvest is obtained with community-based carcass collections using cash incentives and may give an improved estimation of total area-specific Wolverine harvest (Lee 1994a, 1994b, 1998; Elliot and Dumond 2005; Branigan and Pongracz unpubl. data 2012; Mulders unpubl. data 2013)).

Although it is common to infer trend from harvest statistics, it may be problematic to base trend data upon the premise that current harvest is sustainable. In BC, for example, application of such a population model would have calculated population estimates in the 1970s near 10,000 Wolverine, rather than the 3,500 actually present (Lofroth pers. comm. 2012).

Provinces and territories which allow trapping and hunting of Wolverines maintain harvest records, but laws regarding the reporting of harvests vary greatly among jurisdictions. In the best cases, all harvested Wolverines are accounted for by one or more methods—mandatory pelt sealing, compulsory reporting, fur export permits or fur dealer records—and the harvest location of each animal is recorded. Jurisdictions using this type of harvest monitoring are BC, Alberta and Yukon.

Other jurisdictions monitor harvest using fur dealer records and export permits, which only capture furs exported to fur auctions. Depending on the local culture and traditions of the harvesters, varying proportions of the harvested pelts are retained for personal use, or for use in locally produced handicrafts. For example, much of the Inuvialuit/Inuit harvest of Wolverines across the Arctic (Yukon, NWT and Nunavut) is not sold at auction (Branigan and Pongracz unpubl. data 2012; Rossouw unpubl. data 2012; Mulders unpubl. data 2013).

Trapper questionnaire responses are sometimes converted to numerical values and compiled as Wolverine abundance and trend indices to provide a way to compare trappers' interpretations of species abundance and trends in a given area over time (Slough 2009). Some of the data limitations originate from the lack of standardization of trappers' perceptions, and animal behaviour patterns independent of population densities which affect perceptions of abundance (Jung *et al.* 2005). Verification with other data such as fur harvest and population surveys is recommended.

Abundance and Trends

ATK suggests that Wolverine are widespread, but not abundant (Cardinal 2004). The Gwich'in considered Wolverine to be scarce, both today, and in the past, and Wolverine do not appear to have the same population cycles seen in other furbearers (GRRB 2014). Most information from non-ATK sources is based on harvest data from

within the last 200 years. The earliest Wolverine harvest data attributed to specific Canadian jurisdictions indicate that populations, based on harvest success, may have been declining in the Prairie Provinces in the 1920s and 1930s (Novak *et al.* 1987). Ontario, Québec and Labrador harvests were already low by that time. Wolverine harvests in northern Québec and Labrador declined in the 1914-1923 period (Schmelzer unpubl. data 2012). Wolverines had been extirpated from New Brunswick by the early 1800s.

Wolverine densities vary across ecological areas, to a maximum of about 10 Wolverines/1,000 km^2 in North America (Table 2). The highest densities occur in Northern Mountain, northern Boreal and eastern Southern Mountain ecological areas and in the Southern Arctic Ecozone (5 to 10/1,000 km^2), where vegetation associations, prey species, ungulates, and large carnivores are most diverse and abundant. Moderate densities occur in the southern Boreal ecological area (1 to 3/1,000 km^2). There have been no field studies in the Pacific and western Southern Mountain ecological areas and Northern Arctic Ecozone, where densities are presumed to be low.

Table 2. Wolverine density estimates from North American studies.

Density (per 1,000 km^2)	Location	Study Area (km^2)	Relative Habitat Quality	National Ecological Area or Ecozone	Methods	Reference
6.5 (SE = 1.9)	Omineca Mountains, northern BC	8,900 km^2	High	Northern and Southern Mountain	Mark-recapture and mark-resight (cameras)	Lofroth and Krebs 2007
5.8 (SE = 1.1)	Columbia Mountains, southern BC	7,000 km^2	High	Southern Mountain	Mark-recapture and mark-resight (cameras)	Lofroth and Krebs 2007
0.3 - 2.0 - 4.1	BC	na	Rare, Low and Moderate	Pacific, Boreal, and Southern Mountain (plateau regions)	Predictions based on habitat quality ratings	Lofroth and Krebs 2007
4.8	Northeast BC	51,200	Moderate	Boreal	Trapper catch and snow tracking	Quick 1953
6.8	Willmore Wilderness Park, AB	4,600	High	Southern Mountain	DNA mark-recapture (NGT, non-invasive genetic tagging)	Fisher *et al.* 2009
3.0	Foothills, AB	6,400	Moderate	Boreal	DNA mark-recapture (NGT, non-invasive genetic tagging)	Fisher *et al.* 2009
5.6	Kluane Wildlife Sanctuary, YT	1,800	High	Northern Mountain	Based on known residents only, identified by live capture and telemetry	Banci and Harestad 1990
10.8	Kluane Wildlife Sanctuary, YT	1,800	High	Northern Mountain	Calculated from mean home range size and assuming saturated habitat	Banci and Harestad 1990
9.7 (CV 6.5%)[2]	Old Crow Flats, YT	3,375	High	Northern Mountain	Quadrat sampling of tracks in snow using sample-unit probability estimator (SUPE)	Golden *et al.* 2007

Density (per 1,000 km^2)	Location	Study Area (km^2)	Relative Habitat Quality	National Ecological Area or Ecozone	Methods	Reference
Declining 10.73 (CV 10.9%) to 3.72 (CV 15.4%)	Daring Lake, NT	2,556	Moderate to high	Southern Arctic Ecozone	DNA mark-recapture	Mulders *et al.* 2013b
Declining 11.43 (CV 18%) to 3.87 (CV16%)	Diavik, NT	1,269	High	Southern Arctic Ecozone	DNA mark-recapture	Boulanger and Mulders 2013a
Declining 10.05 (CV 19%) to 6.14 (CV 15 %)	Ekati, NT	1,062 to 1,647	High	Southern Arctic Ecozone	DNA mark-recapture	Boulanger and Mulders 2013a
4.6-5.2 (SE=1.3 F-2.4 M)[1]	Kennady Lake, NT	1,575	Moderate to High	Southern Arctic Ecozone	DNA mark-recapture	Boulanger and Mulders 2008
6.85 (SE=1.05) 3.5 F, 3.3 M	High Lake, NU	3,000	High	Southern Arctic Ecozone	DNA mark-recapture	Poole unpubl. data 2013
4.80 (SE=0.8) 1.5 F 3.3 M	Izok Lake, NU	3,000	Moderate to High	Southern Arctic Ecozone	DNA mark-recapture	Poole unpubl. data 2013
0.7-1.4	Red Lake, ON	7,626	Low to Moderate	Boreal	DNA mark-recapture and mean home range size	Dawson, Magoun, Ray and Bowman unpubl. data 2004 and 2013
USA						
9.7 (5.9–15.0)	Southeast Alaska (AK)	2,140	High	Pacific	Camera trapping and spatial capture-recapture model	Royle *et al.* 2011
3.0 (CV 12.0%)[2]	South-central AK	4,340	Moderate	Maritime montane (N. Kenai Mtns)	SUPE	Golden *et al.* 2007
5.2 (CV 20.3%)[2]	South-central AK	1,871	High	Maritime montane (N. Chugach Mtns)	Transect intersect probability sampling (TIPS)	Becker 1991
4.7 (CV 13.0%)[2]	South-central AK		Moderate	Montane (E. Talkeetna Mtns)	TIPS	Becker and Gardner 1992
4..0 – 7.4	South-central AK		Moderate to high	Montane (Susitna River Basin)	Home range/telemetry	Gardner and Ballard 1982
4.9 (CV 8.9%)[2]	South-central AK	3,663	Moderate	Maritime montane (W. Chugach Mtns)	SUPE	Becker and Golden 2008
4.6[2] (no variance est.)	South-central AK	1,050	Moderate	Maritime montane (W. Chugach and N. Kenai Mtns)	Total count of small study area	Golden 2010
5.0 (CV 17.1%)[2]	South-central AK	1,939	Moderate to high	Maritime montane (N. Kenai Mtns)	SUPE	Golden unpubl. data 2013
7.2	Arctic AK	~5,000	High	Arctic, western Brooks Range	Home range/telemetry	Magoun 1985
20.8 (fall estimate)	Arctic AK	2,400	High	Arctic, western Brooks Range	Home range/telemetry	Magoun 1985
4.0-11.1	Idaho	8,000	Moderate to High	Montane	Live capture, telemetry and reproductive potential	Copeland 1996
15.4[3]	Montana	1,300	High	Montane	Capture and snow tracking	Hornocker and Hash 1981

1. Standard errors given for density estimates for males and females in 2004, 2005 and 2006.
2. Surveys based on the TIPS or SUPE techniques should be considered minimum population estimates, because they are conducted in late winter/early spring, after trapping mortality and dispersal have occurred (Golden unpubl. data 2012).
3. May be overestimated due to edge effect of small study area (Lofroth and Krebs 2007) and may have included juveniles (Banci and Harestad 1990).

The following discussion of Wolverine population status is organized by jurisdiction, where sources of information from management programs and research projects vary greatly. Population estimates are provided but their accuracy may vary by jurisdiction.

Yukon Territory

All Wolverine pelts taken by Yukon trappers and hunters must be sealed, including pelts held over or used in the territory. Available evidence points to a stable population in all regions of the territory and a full recovery from the large-scale Wolf control programs (poisoning through the 1970s and aerial shooting through the 1990s). Trappers and/or Aboriginal knowledge holders report Wolverines to be generally common (Cardinal 2004; Henry 2004; ABEK 2008), and harvests are not declining relative to trapping pressure (Table 1). WMAC (NS) (2008) reported a harvest of about 10 Wolverines per year by Inuvialuit trappers from Aklavik, NWT.

Banci and Harestad (1990) estimated Wolverine density to be 10.75/1,000 km^2 in continuous and saturated habitat in the south-central Yukon. Golden *et al.* (2007) estimated a population density of 9.7 Wolverines/1,000 km^2 on the Old Crow Flats, Yukon. The estimate was 5.65/1,000 km^2 when using known Wolverines (assuming variable habitat quality and not all habitat is saturated). They estimated the resident population for about 85% of the territory to be 2,503 Wolverines, and a fall population of 4,171, including juveniles and transients (Banci 1987). The estimate was based on habitat suitability estimates (area trapped, trapper-years and numbers of Wolverines harvested), which likely underestimated Wolverines in remote areas where trapping effort is less than near communities. A more realistic Wolverine population estimate for the Yukon, based on 100% coverage of the territory and more homogeneous densities in high quality habitats, is 3,500 to 4,000 residents.

Northwest Territories

Wolverines are described as widespread, but not numerous in the NWT (WMAC(NS) and Aklavik HTC 2003; Community of Inuvik *et al.* 2008; Community of Paulatuk *et al.* 2008; Community of Tuktoyaktuk *et al.* 2008). Large numbers of Barren-ground Caribou and Wolves in the taiga and tundra associations indicated that Wolverines may be as common as they are elsewhere (Cardinal 2004; Mulders *et al.* 2007).

Wolverine densities declined on three study areas in the NWT between 2004-2005 and 2011 (Boulanger and Mulders 2013a, b). At Daring Lake, the density declined 35% (10.73/1,000 km^2 to 3.72/1000 km^2, between 2004 and 2011) (Boulanger and Mulders 2013b). At Diavik, the density declined 34% (11.43 to 3.87/1,000 km^2, between 2005 and 2011), and at Ekati, the density declined 61% (10.05 to 6.14/1,000 km^2 over the same period) (Boulanger and Mulders 2013a). Wolverine densities were stable at

Kennady Lake between 2005 and 2006 where there were 4.6 to 5.2/1,000 km^2 (Boulanger and Mulders 2008). Wolverine declines were concurrent with declines in the Bathurst Caribou herd (Boulanger *et al.* 2011; Mulders pers. comm. 2013). These densities, even at their reduced levels, are in the range of moderate to high densities relative to other areas where Wolverines have been studied in North America (Table 2).

Coastal communities exported fewer Wolverine pelts than other communities, with Paulatuk exporting none from 87 carcasses, and Tuktoyuktuk exporting 6.6% from 136 carcasses between 2004/05 and 2011/12 (Branigan and Pongracz 2012; Rossouw unpubl. data 2012; data summarized in NWT SARC 2013). The Inuvik regional average pelt export rate was 19.2%. The carcass collections from other regions (Dehcho, Sahtu, South Slave and North Slave) rarely exceeded reported harvests annually between 2001/02 and 2011/12, and the total pelt exports exceeded the carcass collections over that period (Rossouw unpubl. data 2012; Mulders unpubl. data 2013). An unknown proportion of furs from these regions may be retained for personal use and do not enter the fur trade. Another source of unreported Wolverine harvest occurs in the Rennie Lake, NWT area by trappers from Saskatchewan (Mulders unpubl. data 2013). Between 2000/01 and 2008/09, an annual average of 38.7 pelts, representing 25.6% of the combined harvest, was recorded on export permits by Saskatchewan Conservation Officers.

The mean annual harvest over 20 years in the NWT is 109, and long-term harvest data are stable (Table 1, 2). The mean annual harvest estimate is approximately 200 Wolverines (Note: data corrected for furs not entering the fur trade in the Inuvik and other regions, and in the Saskatchewan/Alberta border region (NWT SARC 2013). The unreported harvest from other regions is difficult to estimate from available data and so was not used to augment the harvest estimate further. At the NWT population estimate of 5,100, the harvest rate is well below (< 3.9%) the intrinsic rate of growth of 6.4% per year in untrapped populations (sustainable if refugia and trapped areas are equal in size; Krebs *et al.* 2004). Cardinal (2004) identified several refugia from trapping in the NWT.

According to ATK holders, Wolverine population trends are variable across space and time but there is no clear indication of decline. From 2002-2004 studies, the majority of knowledge holders across the Northwest Territories reported Wolverine as stable or increasing (Autsÿl K'e Dene First Nation 2002; Nagy *et al.* 2002; WMAC and Aklavik HTC 2003; ABEKC 2004; Cardinal 2004), with the possibility of a decline near Yellowknife in 2004 (Cardinal 2004). In 2005, Inuvialuit hunters from Aklavik, Inuvik and Tuktoyaktuk indicated that Wolverines were more difficult to find (ICC *et al.* 2006), but in 2006-2007, Wolverine in Aklavik were said to be more abundant (ABEK 2007). More recent ATK is unavailable. There is evidence from harvest patterns and local knowledge that Wolverines are increasing in numbers on Victoria Island (Cardinal 2004; Banci *et al.* 2005), and Banks Island (Environment Canada 2013).

The Wolverine population of the NWT in 2003 was estimated at 3,500 to 4,000 residents, based on the range of statistical and non-statistical density estimates, and expert opinion, from other North American studies, and from a crude assessment of habitat quality (COSEWIC 2003; Slough 2007). More recent data on Wolverine densities suggests that an estimated 3,430-7,325 Wolverines may be present in the NWT (NWT SARC 2013). An additional 220-470 juveniles, many being transients, are estimated to be present in the fall (pre-trapping) population (based on an annual growth rate of 6.4%; Krebs *et al.* 2004).

Nunavut

The fur trade statistics for Nunavut are based on furs exported to fur auction (Table 1), which is an underestimate of total harvest (Cardinal 2004). Wolverine harvest has also been monitored with the Nunavut Wildlife Harvest Study (Nunavut Wildlife Management Board (NWMB) 2004).

Wolverine densities are moderate in the west and low on the arctic islands and the northeast and eastern mainland, where numbers are believed to be stable or increasing (Awan pers. comm. 2012). Between 2002-2004, Wolverine populations in the Kitikmeot region of Nunavut were reported to be fairly stable and robust with a slight cyclic pattern related to local food availability (Cardinal 2004; Banci *et al.* 2005); comparatively, this region also reported some of the highest levels of harvest in Canada (Cardinal 2004; NWMB 2004; ICC *et al.* 2006). Similar comments were provided for Herschel Island, the Yukon North Slope (WMAC and Aklavik HTC 2003), North Slave Region, NWT (Cardinal 2004; Henry 2004), the Kakinyne region (Autsÿl K'e Dene First Nation 2002) and around Old Crow, Yukon (Cardinal 2004; Henry 2004) during the same time period. Comments provided to the Canadian Wildlife Service during 2005 community meetings on the SARA listing of Wolverine and the Government of Nunavut management planning process described an increasing Wolverine population (Han pers. comm. 2012). Communities involved included Gjoa Haven (King William Island), Kugaaruk, Cambridge Bay (Victoria Island), Arviat and Rankin Inlet. Awan *et al.* (2012) reported opinions of 65 Nunavut hunters; 58% believed that the Wolverine population in their area was increasing, 40% believed that it was stable, and 2% believed it was decreasing.

Wolverine densities at High Lake (near Coronation Gulf) and Izok Lake (near the NWT border), were estimated at 6.85/1,000 km^2 and 4.80/1,000 km^2, respectively, in 2008 (Poole unpubl. data 2013). Both of these study areas were 3,000 km^2 and are in the Southern Arctic Ecozones.

The Nunavut Wildlife Harvest Study reported annual harvests from Nunavut communities in Wolverine range were < 5-20 Wolverines per year, except in Kugluktuk, where the harvest was estimated at 80-100 per year (NWMB 2004). In the Nunavut carcass collection program, the average annual reported harvest in Kugluktuk from 1986-2012 was 63 Wolverines. Wolverines were harvested (2009/10 to 2011/12) near most Nunavut communities including Coral Harbour (Southampton Island), Gjoa Haven, Cambridge Bay, and other locations on Victoria Island. No harvest was reported from Baffin Island, although Wolverine tracks were reported near Clyde River on northeastern Baffin Island in the winter of 2011/12 (Awan pers. comm. 2012). The only Wolverine harvest reported from the Qikiqtaaluk (Baffin) Region was from Hall Beach, Melville Peninsula, and Igloolik. The local overharvest of Wolverines may take place near communities and concentrations of Barren-ground and Dolphin and Union Caribou, depending on re-population from neighbouring refugia.

British Columbia

Lofroth and Krebs (2007) used a habitat quality rating system empirically derived from estimates of Wolverine density to predict Wolverine distribution and abundance at a provincial scale. Density and habitat association data were obtained from two study areas, the Columbia Mountains (7,000 km^2, 1994-2002) and Omineca Mountains (8,900 km^2, 1995-2001), where densities were estimated at 5.8 and 6.5/1000 km^2, respectively. Wolverine numbers for the province were estimated at 3,530 (95% C.I. 2,700–4,760) (Lofroth and Krebs 2007). The lack of density data for low and rare areas could introduce error in the overall estimate. Mean densities were estimated at 0.3/1,000 km^2 in rare-quality habitat, 4.1/1,000 km^2 in moderate-quality, and 6.2 Wolverines/1,000 km^2 in high-quality habitat. These estimates are consistent with 4.8/1,000 km^2 reported by Quick (1953) for moderate quality habitat in northeast BC. The Shuswap Indian Band noted a decrease in Wolverine abundance in the Secwepemc Traditional Territory, which they attributed to overhunting and loss of important migration routes (Shuswap Indian Band 2008).

The Vancouver Island population is believed to be very low, or extirpated. Unverified sightings are reported almost annually to the British Columbia Ministry of Environment (Lofroth pers. comm. 2012). The last confirmed record was in 1992 (BC Government 2013) and it is possible that they have been extirpated.

Alberta

A population estimate for Wolverine in Alberta is unavailable. It is likely that the population was low in the 1950s during rabies control programs when non-selective poisoning killed 5,500 Wolves and an unreported number of Wolverine (Petersen 1997). Wolf control using aerial shooting and poisoning is ongoing in the west-central Alberta range of the Little Smoky Boreal Caribou herd (Campbell 2012), where at least 650 Wolves have been killed since 2005. A quota of one Wolverine harvested per trapline has been in place since 1989.

Opinion surveys of trappers in Alberta suggested a stable population existed north of 56°N latitude but was declining elsewhere in 1987, and in 1994, there was a province-wide declining population (Petersen 1997). An analysis of Wolverine harvest data from 1985-2011 has shown that the number of traplines harvesting Wolverines, and the average Wolverine harvest by trapline have increased since the early 1990s (Webb *et al.* 2013). Harvests increased significantly in the Northwest Boreal and Foothills natural regions, but declined in the Canadian Shield and Rocky Mountains regions. It is not known whether the increased or decreased harvest is due to changes in Wolverine populations, trapper effort, or other factors.

During 2005-2008, Fisher *et al.* (2013) used genetic tagging to conclude Wolverine densities of 6.8/1,000 km^2 in the Willmore Wilderness Park, Rocky Mountains and 3/1,000 km^2 in a foothills study area near Hinton and Grande Cache. Based on camera trap data, Fisher and Heim (2012) believe that the pattern of abundance is similar farther south in the montane Banff National Park, as compared with Alberta's East Slopes. Northern boreal habitats have not been studied.

Saskatchewan

Harvests are low in the southern boreal forest (218,612 km^2) and higher in the north (132,958 km^2) (Siemens Worsley 2011), therefore Wolverine abundance is believed to follow the same pattern. The population is crudely estimated as <1,000, based on range and density assumptions. Trapper questionnaire responses from the South Saskatchewan Trapping Area and the Northern Fur Conservation Area reported that Wolverine were viewed as 'scarce' in both regions (2006/07 to 2011/12) (Gollop 2012).

Manitoba

Wolverines inhabit the northern part of the province, north of 53° latitude (Berezanski 2004). Highest densities appear to be in the northeast, but the northcentral and northwestern regions receive less trapping effort and may represent a population reservoir for surrounding regions. Wolverines were historically rare in southern Manitoba, where human developments forced the range limit north (Berezanski 2004).

Using harvest data, the Wolverine population in Manitoba was estimated at between 500 and 800 animals (Johnson 1990). Berezanski (2004) used a sustainable harvest rate of 6% (from Krebs *et al.* 2004), and the assumption that the harvest was sustainable in Manitoba, to estimate a population of 1100-1600, with 1100 more likely because of presumed lower productivity compared to other areas in western Canada (Berezanski 2004).

An increase in harvest in the 1980s was due to a number of factors, including the cessation of Wolf poisoning, an increase in carrion from Wolf kills, a trapping season closing date that offered some protection to females with kits (which may allow increased production), and an increase in fur prices and associated trapping activity (Johnson 1990). The Wolverine harvest rate since 1980 has been highly variable, but has not significantly changed (Berezanski pers. comm. 2013). The population is thought to be stable overall (Berezanski 2004) and based on harvest records, may be increasing in the Churchill area in the northeast and possibly the south (Berezanski pers. comm. 2013). Wolverine populations in northeastern Manitoba may be benefiting from the increase in the Pen Island (Eastern Migratory) Caribou herd, which is having the same beneficial effect in northwestern Ontario (Dawson 2000; Berezanski 2004). Keeyask Hydro Limited Partnership (2012) reported Wolverine populations to be increasing in the Keeyask region and lower Nelson River region of northern Manitoba, with increases first noted in 2009, albeit this evidence came from a single trapper.

Ontario

Some ATK indicates that Wolverines have always been rare, but have been consistently present with no discernible changes in relative abundance since the 1920s, yet others suggest increases since the late 1970s or early 1980s (Ray 2004). Wolverines reappeared in the Winisk-Peawanuck area in the mid-1990s (Dawson 2000).

Wolverine distribution in Ontario was summarized by the Ontario Wolverine Recovery Team (2013). Wolverines are currently found in northwestern Ontario following a range reduction in the 1800s due to habitat conversion during human settlement, logging and railroad construction, and the overharvest of ungulates (Ontario Wolverine Recovery Team 2013).

There is some evidence from aerial surveys and ATK that Wolverine have recently expanded their range east of the 'peripheral' range (Figure 4) following increases in the Pen Islands Caribou herd in the 1980s and 1990s (Dawson 2000), and changes in Boreal Caribou distribution in the Hudson Bay Lowland (Magoun *et al.* 2004, 2005a; Ray 2004). Ray (2012) recorded incidental Wolverine observations to < 200 km from the Québec border. A Wolverine was harvested in 2012 near the same limit (Dawson pers. comm. 2012). Kelsall (1981) believed that the Wolverines in Ontario were isolated from those in Québec and Labrador, but that may no longer be the case.

The population estimate for Wolverines in Ontario is 458 to 645 (Bowman pers. comm. 2013), based on an estimated minimum density of 1.4 Wolverines/1,000 km^2 in a 7,626 km^2 study area, where a DNA mark-capture study was undertaken (Dawson *et al.* unpubl. data). If Wolverines persist at similar densities across the province, the Ontario population estimate would be 645. However, results from aerial surveys (Ontario Wolverine Recovery Strategy) suggest that densities are not uniform and this estimate was assumed to be representative of the higher end of the spectrum in the province. Therefore, dividing Wolverine range into high (274,551 km^2) and low density (172,563

km^2) areas, and assuming the density in the latter are to be 0.7/1,000 km^2, yields an estimate of 458 Wolverines. There are no confidence limits on this estimate.

A zero quota was applied to non-aboriginal trappers in 2001/02 and the season was closed in 2009, but occasional accidental kills of 1 - 4 occur annually (Dawson pers. comm. 2002; Bowman et al. 2010). Treaties in northern Ontario allow for Aboriginal peoples to continue harvesting Wolverines for their own use (Heydon pers. comm. 2002).

Québec

The historical harvests of Wolverine in Québec are not well documented. Historical Hudson's Bay Company fur trade data from Fort Chimo (now Kuujjuak) from 1868 to 1923 documents a harvest of ≥1190 Wolverine pelts, with a sharp decline from 23 pelts/year, to 4 pelts/year in the 1914-1923 period (Schmelzer unpubl. data 2012). Harvests ranged between 0 and 24 per winter since Statistics Canada began keeping records in 1919 (Fortin *et al.* 2005). These data have led to the assumption that the species was never particularly abundant in the Eastern Population (Fortin *et al.* 2005). The harvest of Wolverines was banned in Québec in 1981, except in the James Bay and northern Québec Agreement area, which covers much of northern Québec. Current and past generations of Aboriginal knowledge holders from northern Québec report Wolverine as being very rare (COSEWIC 2012b).

Wolverines have not been confirmed to occur in Québec since the last specimen was captured in 1978. An individual captured in the Lanaudière region in 2004 was cited in Fortin *et al.* (2005) as evidence of remnant Wolverines but it has since been established that it had escaped from a zoo in Ontario (Ministère des Ressources naturelles et de la Faune du Québec 2013). There were about 60 unconfirmed reports from Québec and Labrador between 1965 and 2004 (Fortin *et al.* 2005). Over 70 observations were reported between 2000 and 2012 (Thibault unpubl. data 2013; Figure 5); 14 were considered 'probable', 35 'likely', and 22 'questionable', but none were verified. Unverified records based on tracks should be viewed with some skepticism because track size and shape varies with changing snow conditions (McKelvey *et al.* 2008).

Based on recent observations and research (see **Search Effort** section), Wolverines are either very rare, are at a level where they are not detectable using current survey effort, or are extirpated in Québec.

Labrador (mainland Newfoundland and Labrador)

A review of historical Wolverine fur trade data from Hudson's Bay Company posts in Davis Inlet and Moravian Missions of Hebron and Okak in Labrador indicated 873 Wolverine pelts were traded between 1844 and 1923 (Schmelzer unpubl. data 2012). Some pelts traded at Fort Chimo, Québec likely originated from Labrador (Moores pers. comm.). Wolverine pelts continued to be traded until the mid-1900s (Schmelzer 2006).

Over 40 unconfirmed sightings of Wolverines were reported over the last 30 years (Schmelzer 2012). The lack of verified records from numerous surveys (see **Search Effort** section) led to a conclusion that Wolverines may be extirpated from their range in Labrador, and that populations in neighbouring Québec are too low, or absent, to support recolonization (Schmelzer unpubl. data 2012). Innu elders report knowing little about Wolverine at present and suggest they are very rare (Paul F. Wilkinson and Associates Inc. 2009), although they were relatively abundant around 1935-1940 in the Schefferville area of Québec and Labrador (Clement 2009).

Canadian Population Estimate

The population is unknown, but likely > 10,000 adults. If harvest data are accurate, and if population size can be adequately extrapolated from density estimates, the Wolverine population estimates (mature individuals) would be as follows: Yukon (3,500 to 4,000), NWT (3,430-7,325), BC (2,700 to 4,760), Saskatchewan (<1,000) and Manitoba (1,100 to 1,600). The available information on distribution and known densities in similar ecological areas suggests that populations in the remaining jurisdictions are approximately as follows: Alberta, 1,500 to 2,000 (Wolverine range is relatively extensive, with some high quality habitats); and Nunavut, 2,000 to 2,500. The estimate for Ontario is 458 to 645 Wolverines. The result is a total Western sub-population estimate of 15,688 to 23,830 adults. However, these estimates assume trapping effort is constant and that Wolverine densities are relatively uniform across the range.

There is no estimate for the Eastern Wolverine sub-population and the last verified record was in 1978. The lack of verified records among the many reported observations (Figure 4) implies that the population is very small (<100 individuals), and possibly extirpated.

Fluctuations and Trends

Wolverine population fluctuations and trends were discussed by jurisdiction in the **Abundance** section. To summarize, population estimates are uncertain but there are likely >10,000 Wolverine in the population. Trend is unknown but information from harvest and trapper survey indices suggests sub-populations are increasing in parts of the NWT, Nunavut, northern Alberta, Manitoba, and Ontario, but decreasing in the southern range. Extirpations (or near extirpations) have occurred in a substantial portion of the historical range, including eastern Canada, the Prairies, and Vancouver Island. It is unknown if past declines in the Southern Mountains National Ecological Area of BC and Alberta have continued since the last assessment (COSEWIC 2003).

There is no evidence of population changes in the range of the eastern sub-population (Québec-Labrador).

A minimum of 559 Canadian Wolverine were killed in 2009-2010, and over the last 17 years (1992-1993 to 2009-2010, there have been similar harvest levels (range 385-637) across Canada (Table 1).

Rescue Effect

Nuclear DNA evidence of genetic similarities suggests connectivity currently exists between Alaska and western Canada (Gardner *et al.* 1986; Kyle and Strobeck 2001, 2002). Wolverine populations in Alaska are continuous with those in the Yukon and BC, making rescue along the international boundary with Alaska likely. Wolverine density estimates in Alaska are presented in Table 2.

The likelihood of rescue of Canadian Wolverine populations from the conterminous United States is negligible. Increasingly fragmented populations currently inhabit montane regions in Washington, Idaho, western Montana and Wyoming (Aubry *et al.* 2007; Figure 3). The total number of Wolverines inhabiting this area may be 35 (credible limits 28-52) (Schwartz *et al.* 2009). Genetic sub-structuring has been documented in Wolverine populations in Idaho (Kyle and Strobeck 2002) and Montana (Cegelski *et al.* 2003, 2006), suggesting relatively low migration rates between adjacent mountain ranges.

THREATS AND LIMITING FACTORS

An IUCN Threats Calculator was conducted among jurisdictions and COSEWIC members in order to document the scope and extent of major threats (Appendix 1). The overall Threat score was 'medium', due mainly to concerns with declining Caribou populations, response to disturbances such as road and infrastructure development, and access leading to potential unsustainable harvest levels.

Threats have been identified in several recent documents, including the 2003 COSEWIC Status Report (COSEWIC 2003), the Ontario Wolverine Recovery Plan (OWRT 2013), and the Eastern Population Recovery Plan (Fortin *et al.* 2005). Habitat loss, habitat fragmentation, and climate change continue to threaten Wolverine populations at the southern and eastern peripheries of their range. Habitat loss results from conversion of natural habitats for human land uses including agriculture, ranching, urban and suburban developments, mining, oil and gas development, hydroelectric reservoirs, and associated road networks that facilitate access for harvest and disturbance.

Threats to the eastern sub-population relate mainly to loss of carrion associated with declining Caribou herds, hydroelectric developments, and road density in areas with increased resource development. Threats in the southwestern range relate mainly to declining Caribou, roads, increased access and potential overharvest, and climate change. Threats in the northern range relate mainly to resource development sites, harvest, and declining Caribou in some areas. Details are discussed below.

Harvest

Harvest is presently the human activity with the greatest potential to directly reduce Wolverine populations to levels which could have a detrimental effect on metapopulation dynamics and cause extirpation (Lofroth and Ott 2007). In BC, the harvest of Wolverine was stable at the provincial level, but was unsustainable in 15 of 71 population units (Lofroth and Ott 2007). Low densities, large home range size, and long-distance movements by dispersing individuals contribute to the Wolverines' vulnerability to trapping and hunting. An increased vulnerability of Wolverines to trapping after Snowshoe Hare population crashes leads to the false perception that they are more abundant (Hatler 1989; Jung *et al.* 2005; Slough 2009). Banci (1987) noted an increase in the harvest of adult males in March 1983 following a Snowshoe Hare population crash.

Harvest levels have remained stable in western jurisdictions (Table 1). Harvest management, including trapping closures, limited seasons, quotas, limited entry, and registered trapping concessions have reduced these threats in most jurisdictions (Slough *et al.* 1987; Johnson 1990). Beneficiaries of the Nunavut Land Claims Agreement are not restricted to these harvest rules (although members may have local restrictions; Crystal pers comm. 2014) and harvest rates by beneficiaries are not as well documented. Exported Wolverine furs require permits but a high proportion of Wolverines from the Arctic are used locally and not exported to fur auctions, so there is a potential for overharvest going unnoticed. The estimated annual harvest of Wolverines (including unrecorded harvests from Yukon, NWT and Nunavut) is likely <1,000.

Survival was <0.75 among all age/sex classes in trapped areas, and >0.84 in areas where trapping does not occur (Krebs *et al.* 2004). Intrinsic rates of increase (λ) were estimated at 0.88 in trapped populations and 1.06 in untrapped populations. Survival was highest among adult females (0.88 in untrapped areas, 0.73 in trapped areas) and lowest among subadult males (0.45 in trapped areas) (Krebs *et al.* 2004). This evidence suggests that most trapped populations would decline without immigration from refugia. Local overharvest of Wolverines may occur in some areas (Krebs et al. 2004), but this harvest is largely replenished by immigrants from untrapped refugia. Cardinal (2004) identified several refugia from trapping across northern Canada. The consideration of use of untrapped areas as functional refugia in trapline management is a strategy practised by many trappers and promoted in trapline education (*e.g.,* Yukon Department of Renewable Resources, no date). Many refugia are de facto, where trapping areas are simply large and inaccessible. Krebs *et al.* (2004) pooled data from 12 North American studies, and estimated that at an average harvest rate of 12.2%, and an intrinsic rate of increase of 6.4%, refugia from trapping would need to cover twice as much area as harvested areas. Self-management by trappers and inaccessibility are the primary sources of refugia. The percentage of land not subject to harvest is unknown but expert opinion during the Threats Calculator exercise estimated that 70-100% of the range (in jurisdictions where trapping is allowed) would be exposed to potential harvest. It is noted that refugia are not regulated and the

reliance on refugia to maintain a sustainable harvest is at risk of failure if incentives for harvest increase and refugia become trapped.

Refugia can quickly become accessible; in northeastern BC, 279,595 km of forest was cleared for seismic lines between 1996-2008, which is approximately an extra 2.54 km/km^2 of access for trappers (Weir pers. comm. 2014). The use of snowmobiles to run down Wolverine, or to get close and shoot one, is common in some jurisdictions (*e.g.*, Yukon; Jung pers. comm.) and there is concern that harvest by snowmobile, rather than traditional set traps increases the range of harvest and minimizes actual trap refugia.

Roads and Transportation Corridors

The increased density of roads in logged areas and elsewhere may have a direct effect on Wolverine and their prey (*e.g.*, Caribou), through disturbance (Krebs *et al.* 2007; Bowman *et al.* 2010). Roads also place Wolverines vulnerable to trapping and road mortality. Gwich'in in the Mackenzie River region suspect the Mackenzie Valley Highway will increase access to harvest, and roadkill of Wolverine (GRRB 2014). May *et al.* (2006) found that Wolverines in Scandinavia selected home ranges based on degree of human development and, to a lesser extent, habitat quality, and in Ontario, road densities had an apparent influence on home range selection (Dawson *et al.* 2010). Areas with roads or human structures were avoided or selected less than large roadless areas. A similar relationship was found in the northwestern conterminous US where road density or human population density were more important than quantity or quality of vegetation in determining Wolverine counts (Rowland *et al.* 2003). Their watershed-scale models predicted lower Wolverine counts at higher road densities (road densities of 0.44 to 1.06 km/km^2). In the Rocky Mountain region, Carroll *et al.* (2001) predicted a decline in the occurrence of Wolverines when road densities exceeded approximately 1.7 km/km^2. The mean road density in Wolverine home ranges was 0.43 km/km^2 in Ontario, and individuals whose home ranges had a higher road density than the mean had a higher risk of mortality due to anthropogenic factors (Bowman *et al.* 2010). Wolverines were less abundant in areas with human activities including roads (mean road density of 0.37 km/km^2) and logging (*i.e.*, temporary and functional habitat losses) (Bowman *et al.* 2010). Resource development is often accompanied by road access, so road density serves as a proxy for the extent of the human footprint (Bowman *et al.* 2010). Road density is not only associated with avoidance behaviour by Wolverine, but there is an increased mortality risk due to trapping, hunting, and collisions with vehicles.

Large highways and other transportation corridors such as those in southern Alberta and BC may act as barriers to movements and dispersal, and may be a source of mortality (Gibeau and Heuer 1996). Disturbance by noise (Golder Associates 2003) and traffic may lead to avoidance of transportation corridors. Gibeau and Heuer (1996) documented two highway mortalities of Wolverine in Banff National Park, where they also noted patterns of approach and retreat behaviour before successfully crossing roads during busy periods. Austin (1998) found that Wolverines selected narrow crossings (*i.e.* <100 m wide), avoided areas within 100 m of the Trans-Canada

Highway, and preferred areas more than 1,100 m away. Alexander *et al.* (2005) studied the effect of traffic volume on the carnivore guild, which included Wolverines, in the same area. They suggest that a carnivore movement threshold exists between 300 and 500 vehicles per day, or an average annual daily traffic volume (AADT) of 3000-5000, assuming a 10:1 annual to winter traffic ratio. No wolverine crossings (n=39) were detected at that traffic volume (Alexander pers. comm. 2013). The AADT in Banff National Park is 14,000, and similar volumes are likely for the Trans-Canada highway westward through Wolverine range.

Wolverine gene flow and movements across highway crossing structures (underpasses/overpasses along fenced sections of highway) are being assessed on an additional 30 km of the Trans-Canada Highway (TCH) twinned in Banff National Park (Clevenger *et al.* 2011a). A larger study is monitoring the occurrence and rate of all wildlife-vehicle collisions and use of crossing structures (Clevenger *et al.* 2011b). In the 17 years (1996-2014) of monitoring of the TCH, there have been 10 recorded crossings (9 using underpasses, 1 using overpass) by at least two different Wolverines (Clevenger, 2013; Clevenger pers. comm. 2014). Genetic typing from hair samples indicates five males and two females crossed the TCH over a three-year period, though they were most likely crossing at unfenced sections. There have been four mortalities since 1980 at unfenced parts of the TCH. Sample size is low but early results suggest that the TCH is not a barrier to males, and may be for females (Clevenger pers. comm. 2014).

Biological Factors

Biological factors that limit Wolverine populations include the species' low intrinsic rate of increase, low natural densities and large home ranges (Banci and Proulx 1999). Conversely, long-distance dispersal abilities give Wolverines the capacity to recolonize vacant habitats (Vangen *et al.* 2001; Flagstad *et al.* 2004). Re-population may take several decades but is possible where factors favour Wolverine survival (Johnson 1990; Vangen *et al.* 2001).

Indirect effects on the prey base and large carnivores, which impact scavenging opportunities, will also impact Wolverine populations. Such effects include overhunting of ungulates and carnivores, and population declines of prey and carrion due to loss and fragmentation of their habitats (Cardinal 2004). A recent recolonization of southern Scandinavia by Wolves led to an increase in scavenged Moose in the diet of Wolverine, and a decrease in the occurrence of Wolverine-killed Caribou and rodents (van Dijk *et al.* 2008).

The availability of prey and carrion is another biological limiting factor (see **Habitat Requirements** section). Wolverines rarely prey on livestock in North America (as they do in Europe; Landa *et al.* 1997) and so are not directly targeted for predator control. Wolf poisoning programs in western Canada that killed Wolverines as by-catch ended in the 1970s, but were reinstated in west-central Alberta by 2005. Wolverines may be impacted by Wolf reduction programs designed to reduce predation on declining Boreal Caribou herds.

Climate Change

Spring snow cover during the denning period is an important habitat requirement of Wolverines (Aubry *et al.* 2007; see **Habitat** section). Climate models predict increases in temperature and precipitation in Canada (IPCC 2007), with the largest warming projected for northern Canada. Precipitation is likely to increase in winter and spring, but decrease in summer. Snow season length is predicted to decrease, but a net increase in snowfall should make up for the shorter snow season, resulting in a net increase in snow accumulation. Spring snow cover in the Arctic has melted about 4-7 days earlier since the late 1980s (Foster *et al.* 2008), and earlier snowmelt is also occurring in the western mountains (Stewart 2009).

The impact of reduction of snow on Wolverine is uncertain (Wolverine Science Panel 2014). In northern range, earlier snowmelt may not be an issue because snow persists during the natal denning period (Magoun and Copeland 1998). However, in mountainous regions, particularly in BC and Alberta, decreasing spring snow is considered a serious threat. Productivity could decrease, range could shift and habitats and populations could become more fragmented (Copeland *et al.* 2010; McKelvey *et al.* 2011; Weir pers. comm. 2013).

Public Attitude

Societal views on Wolverine vary from dislike due to the damage they cause to traps, animals, cabins, and food caches, to respect for their abilities (see **Special Significance** section). Attitudes could be an impediment to recovery of Wolverine population in Québec and Labrador where even low mortality levels would significantly impact the population (Fortin *et al.* 2005).

Recreational Activities

Wolverines prefer large roadless areas, but home ranges frequently overlap active traplines, cross-country ski trails, busy roads such as logging roads, seismic lines (Krebs *et al.* 2007), and the edges of communities. Winter recreation in the form of helicopter skiing and backcountry skiing, snowmobiling (*e.g.,* high-marking) and the presence of roads reduced habitat values (*i.e.*, functional losses) for Wolverines in the Columbia Mountains, BC (Krebs *et al.* 2007).

Habitat avoidance results from human activities such as backcountry recreation, which may impact Wolverine behaviour patterns such as denning, kit rearing, travel and foraging. Disturbance of Wolverine maternal den sites may lead to den relocation or litter abandonment (Myrberget 1968; Pulliainen 1968). Evidence for direct impacts of winter recreation on denning Wolverines is conflicting (Copeland 2009; Heinemeyer and Squires 2012), but helicopter skiing and backcountry skiing in western Canada have been shown to reduce functional habitat values for Wolverines, especially adult females (Copeland *et al.* 2007; Krebs *et al.* 2007; May *et al.* 2012), whose reproductive success may be affected (Carroll *et al.* 2001; Rowland *et al.* 2003; Copeland *et al.* 2007; Krebs *et al.* 2007; Copeland 2009). Aboriginal knowledge holders feel that the use of snow machines has changed harvesting practices and patterns, allowing people to travel further and faster, which has resulted in increased Wolverine harvest (WMAC and Aklavik HTC 2003; Cardinal 2004; Banci *et al.* 2005). Wolverines opportunistically use inactive snowmobile trails for travel and scavenging trapped animals and hunter kills.

Conflicts at Resource Development Sites

Wolverine-human conflicts at mining camps have recently been identified as an potential threat to Wolverine populations in the NWT and Nunavut, where diamond mines in particular are becoming more common in the Southern Arctic ecozone. Wolverines generally avoid areas of human activity but are curious, and will investigate campsites, food caches, garbage dumps, cabins, traplines, and hunter kills, usually when humans are not present, and scavenge for food. Occupied mining camps are approached in the NWT and Nunavut for food and shelter.

Wolverines usually maintain a separation distance of at least 500 m from human activity (AXYS 1998), but attraction to food sources at camps and other areas of human activity (see **Physiology and Adaptability** section) may result in the habituation of animals, and increased vulnerability to problem wildlife control, hunting and trapping, and collisions with vehicles (NSMA 1999; Golder Associates 2003). Adaptive mitigative measures are used to reduce Wolverine occurrences at diamond mines (Golder Associates 2012a, b; Rescan 2012). There were one nuisance-control mortality and four relocations at the Ekati diamond mine between 2003-2011 (Rescan 2012) and one accidental human-related Wolverine mortality at Snap Lake in 2011 (Golder Associates 2012a). There were two incidents of Wolverines being deterred from the camp prior to 2008, and 8 cases in 2008 (Golder Associates 2010). There were 47 incidents involving Wolverine deterrence from 2000 to 2011 at Diavik mine. There were also two relocations and two mortalities (DDMI 2012). There were 30 incidents involving Wolverine deterrence and two reported mortalities at Meadowbank gold mine in the Kivalliq region, Nunavut, in 2011 and 2012 (Lecomte pers. comm. 2013). ConocoPhillips (2006) waste management plan recognizes that certain petroleum-based products such as lubricants may attract Wolverine. Wolverine mortalities and relocations as a result of diamond mining activities appear minor, but in conjunction with trapping and hunting, may be contributing to local population declines (Boulanger and Mulders 2013a).

Responses of Wolverines to flying aircraft are variable, ranging from no response to running away and hiding (AXYS 1998). Generally, Wolverines are reluctant to abandon carrion, even when disturbed. A lack of response was most common (38 of 40 encounters) in fly-overs in the Yukon (Jung pers. comm. 2013).

Number of Locations

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all Wolverines present. As such, there are 'many' locations in Canada.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, Wolverines are harvested in all northern and western jurisdictions (Manitoba, Saskatchewan, Alberta, BC, Yukon, NWT, and Nunavut). There is no non-aboriginal harvest permitted in Québec, Labrador or Ontario (since 2001/02). Aboriginal harvest is permitted in the northern part of the range in Québec, as per the James Bay and Northern Québec Agreement: Fortin *et al.* 2005). The incidental harvest of Wolverine still occurs in Ontario (Ontario Wolverine Recovery Team 2013). In the United States, Wolverine harvest is permitted in Alaska and Montana, although it has been temporarily closed since November 2012 in Montana.

Harvests are managed with spatial and temporal restrictions including variations in season length, quotas, limited entry (*e.g.*, the use of registered trapping concessions, group and community trapping areas), and trapline management by the trapper (Slough *et al.* 1987). Harvests are monitored either through mandatory pelt sealing, year-end harvest reporting, or by monitoring fur exports. Local use of Wolverine pelts is common, particularly in Inuvialuit and Inuit communities in the NWT and Nunavut, where harvests are monitored using carcass collection programs (see **Sampling Effort and Methods** section).

Wolverines are not listed by the Convention on International Trade in Endangered Species; international trade in Wolverines is not monitored or restricted.

Non-Legal Status and Ranks

Wolverines were ranked Least Concern by IUCN in 2009 (IUCN 2012) due to their wide distribution and remaining large populations. Although there is an overall continued decline due to human persecution and land-use change, it is not at a rate sufficient to qualify for listing at this time. Previous listings by IUCN were Near Threatened (2008) and Vulnerable (1996).

The provincial/territorial status rankings for Wolverines are given in Table 3. Most rankings are similar to the COSEWIC (COSEWIC 2003) rankings for the Eastern and Western populations (Endangered and Special Concern, respectively). Provincial/territorial rankings are Endangered or Threatened for the Eastern Population, and Sensitive or Special Concern for the Western Population, although Wolverines are ranked Threatened in Ontario.

Table 3. Wolverine Status Ranks, Canada and U.S.A. Compiled July 2013.

Jurisdiction	COSEWIC / SARA	General Status[1]	Provincial/ Territorial	NatureServe[2]
Global IUCN: Least Concern				G4
U.S.A				N4
WA				S1
CA				S1
CO				S1
Idaho				S2
WY				S2
OR				S2
MT				S3
AK				S4
Canada		3		N3N4
NL	Endangered; Schedule 1	1	Endangered	S1
QC	Endangered; Schedule 1	1	Threatened	S1
ON	Special Concern; No Status	1	Threatened	S2S3
MB	Special Concern; No Status	3	Special Concern	S3S4
SK	Special Concern; No Status	1	No Provincial Ranking	S3S4
AB	Special Concern; No Status	2	Data Deficient	S3
BC (*luscus* ssp.)	Special Concern; No Status	3	Blue (Special Concern)	S3
BC (*vancouverensis* ssp.)	Special Concern; No Status	No Status	Red (Extirpated, Endangered, or Threatened)	G4T1QSH
YT	Special Concern; No Status	3	No Territorial Ranking	S3
NT	Special Concern; No Status	3	No Territorial Ranking	S3
NU	Special Concern; No Status	4	Sensitive	SNR

1. General Status Ranks: 0.1 Extirpated, 1 At Risk, 2 May Be at Risk, 3 Sensitive, 4 Secure (CESCC 2011).
2. NatureServe Status Ranks: G=Global, N=national, S=Subnational, T=Infraspecific taxon; H=Presumed Extirpated, 1=Critically Imperilled, 2=Imperilled, 3=Vulnerable, 4=Apparently Secure, 5=Secure, NR=Not Ranked, Q=Questionable Taxonomy (NatureServe 2013).

General status ranks (Canadian Endangered Species Conservation Council (CESSC) 2011) (Table 3) are Secure (NU), Sensitive (Canada, YT, NT, BC, MB), May Be at Risk (AB) and At Risk (SK, ON, QC, NL).

State listings for Wolverines are: Washington (Protected Wildlife; candidate), Idaho (Protected Nongame Species), Wyoming (Vulnerable), and Montana (Candidate). There is no state listing for Alaska. NatureServe ranks are provided in Table 3.

The U.S. Fish and Wildlife Service (2013) has proposed listing Wolverines in the conterminous United States as Threatened under the *Endangered Species Act*. The effect of climate warming on the snow pack is listed as the major threat, while backcountry recreation, timber harvesting and infrastructure development are not considered significant threats and therefore will be allowed to continue.

Habitat Protection or Ownership

Most of the Wolverine's range is on federal land administered by Aboriginal Affairs and Northern Development Canada. Modern land claim and self-government programs have resulted in the ownership of settlement lands by Aboriginal governments and authorities in Yukon, NWT, Nunavut, and BC. Land use activities on both Aboriginal and non-aboriginal lands, not defined as settlement lands, are administered by the applicable land manager in consultation with First Nations, Inuvialuit, and Inuit.

Six communities in the Inuvialuit Settlement Region (Aklavik, Ulukhaktok, Inuvik, Paulatuk, Sachs Harbour, Tuktoyaktuk) have adopted community conservation plans, updated in 2008 (Joint Secretariat). Recommended Wolverine conservation measures include the identification and protection of important habitats from disruptive land uses, avoidance of den disturbance, discouraging hunting in summer, and forbidding the use of poison. Some conservation plans specify winter Wolverine harvesting areas.

Department of National Defence establishments in some parts of the country are used by Wolverine, including NWS radar sites in the Arctic (Shingle Point, Yukon; Horton River, NWT; Hall Beach, Nunavut), and properties in the Chilcotin (west of Williams Lake, BC) and Pierce Creek (south of Chilliwack, BC) (Nernberg pers. comm. 2012). Wolverines are suspected to be present at CFB Cold Lake, Alberta.

Kelsall (1981) and Dauphiné (1989) considered parks to be refugia from trapping and resource developments but some caution seems necessary in parts of the range because Wolverine trapping is permitted in most northern National and Provincial Parks of the western range. Also, Wolverines have large spatial requirements (see **Habitat** section) and sub-populations within the parks are not buffered from trapping activities around their peripheries. Wolverines that reside partly in refugia are susceptible to harvest mortality. Recreational activities, like snowmobiling and skiing, during the late winter denning period may result in disturbance to females and their litters, leading to relocation or abandonment (Heinemeyer and Squires 2012). The size requirement for an effective refugium from development has not been determined, but refugia larger than 20,000 km^2 may be required for an isolated habitat to maintain a viable population (Magoun *et al.* 2005b).

Trapping is permitted in many of the BC provincial parks, and by First Nations, Inuvialuit and Inuit Beneficiaries in national parks in Yukon, NWT, and Nunavut Territory, and in Wood Buffalo (NWT and Alberta) and Wapusk (Manitoba) National Parks. Most types of resource extraction or activities contributing to habitat losses and fragmentation are not permitted in protected areas. However, recreational activities, such as snowmobiling and skiing, which may disturb denning Wolverines, are generally not restricted and transportation corridors bisect and penetrate parks.

In Ontario, the habitat of Wolverine is protected from damage and destruction under the *Endangered Species Act*, 2007, and forest management operations are modified to maintain buffers around known Wolverine dens (OMNR 2010).

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Brian G. Slough obtained an M.Sc. from Simon Fraser University in 1976. His thesis on Beaver ecology led him to a 15-year career as furbearer management biologist with the Yukon Fish and Wildlife Branch. He has published work on furbearer species including Beaver, Arctic Fox, American Marten, and Canada Lynx, and has also written about trapline and furbearer management in northern and western Canada. He prepared COSEWIC status reports on Wolverine (2003), American Marten, Newfoundland population (2007), and Western Toad (2012). Mr. Slough has recently prepared NWT Species at Risk Committee status reports on the Northern Leopard Frog, Western Toad, and Wolverine.

Since leaving the Yukon government in 1996, Mr. Slough has conducted environmental assessments, protected areas research, and research on rare amphibians and mammals, including rodents, shrews and bats. He served two terms as a member of the Terrestrial Mammals Specialist Subcommittee of COSEWIC (2006 to 2013).

COLLECTIONS EXAMINED

No collections were examined during the preparation of this report.

Appendix 1. Threats calculator summary for Wolverine.

Species or Ecosystem Scientific Name	Wolverine (*Gulo gulo*)
Date	16/01/2014
Assessor(s):	Brian Slough (report writer), Graham Forbes (TM SSC Co-chair), Dave Fraser (BC), Gord Court (AB), Suzanne Carrière (NT), Shelly Moores (NL), Vivian Brownell (ON), Isabelle Gauthier (QC), Thomas Jung (YK), Ruben Boles (CWS), Patrick Nantel (Parks), Donna Hurlburt (ATK Co-chair) Jeff Bowman (TM SSC member); Nicolas Lecomte (TM SSC member), Neil Dawson (ON), Dean Berezanski (MB), Robert Mulders (NT), Janet Winbourne (TK Researcher), Emily Herdman (NL), Malik Awan (NU), Isabelle Thibault (QC), Vincent Carignan (CWS-QC), Victoria Snable (CWS-Prairie), Paul MacDonald (CWS-NL), Donna Begelow (CWS-NT), Rich Weir (BC)
References:	2014 Draft COSEWIC status report

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	4	4
Calculated Overall Threat Impact:		Medium	Medium

Overall Threat Comments	Generation time at least 5 years; hence severity assessed for 15 years.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential and commercial development		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
1.1	Housing and urban areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
1.2	Commercial and industrial areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
1.3	Tourism and recreation areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2	Agriculture and aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2.1	Annual and perennial non-timber crops		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2.2	Wood and pulp plantations		Negligible	Negligible (<1%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs)	
2.3	Livestock farming and ranching		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3	Energy production and mining		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
3.1	Oil and gas drilling		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Increased access may lead to disturbance and mortality from road kill, trapping and nuisance control mortality at camps. BC: increase in access will increase harvest/trapping (see 5.1) Note: road networks are excluded in this calculation (see 4.1)

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.2	Mining and quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Increased access may lead to disturbance and mortality from road kill, trapping and nuisance control mortality at camps. BC: increase in access will increase harvest (see 5.1) NT: There are 4 mines in NT that increase the disturbance and increase a number of related issues (see 5.1) Note: road networks are excluded in this calculation (see 4.1)
3.3	Renewable energy		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4	Transportation and service corridors	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	(This would include habitat that are rendered ineffective from (ex.) mines and would include road kills as well)
4.1	Roads and railroads	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Transportation corridors may act as barriers to movements and dispersal, and may be a source of mortality (based on road mortality and the effects of access roads. This does not deal with active trapping but creating movement and avoidance) Scope BC: half the population would encounter roads YK: 30-70% of the population would encounter roads NT: the avoidance of roads is low but increase in access will increase hunting; believes that 11-30% of the Canadian population would experience roads Severity YK: there has only been 1 road kill in the past 10 years ON: 6-7 road kills documented BC: there have been a number of documented cases along TransCanada highway; mortality from road evident. There are also about 6-7 deaths associated with logging roads and highways in the southern portion of the range.
4.2	Utility and service lines		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Transportation corridors may act as barriers to movements and dispersal, and may be a source of mortality
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting and collecting terrestrial animals	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Wolverine harvest is restricted and monitoring is mandatory in most jurisdictions. Monitoring in NT and NU is by fur exports and voluntary carcass collection programs. The efficacy of harvest monitoring using carcass collections, in Inuit communities where most pelts are used locally, is uncertain. Harvest of ungulates and large carnivores may impact Wolverine prey and scavenging opportunities. Discussion: what % of Canadian pop. are exposed to trapping/hunting/bycatch? The only area that is excluded is where animals aren't accessible. Is untrappable area more than 30% in Canada? YK: most animals are exposed to hunting and trapping in YK. Even most parks north of 60° allow trapping (there are no legal barriers) ON: high but not large NL: none in NL NU: NU has more than 90% of the population and gov't has no jurisdictions BC: increase in road access (due to oil/gas/mining) will increase harvest Severity of the impact QC: Eastern situation is very different than elsewhere. Any mortality will have a high impact on the population to the east. MB: Wolverines are only hunted/trapped for a certain part of the year. Wolverine numbers are increasing in the province AB: has no information ON: 4-5 trapping this year. Similar to MB, Wolverine numbers are expanding in the province (eastward) YK: does not believe there is a decline in Wolverine numbers NU: same, range is also expanding eastward and towards the southern portion NT: agrees that severity is 1-10%: they are taking upwards of 200 and there is a slight range expansion up north BC: harvest is stable and range does not look like it is contracting The situation is more dire in the east but probably negligible for the whole country.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.3	Logging and wood harvesting	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Road density in logged areas leads to disturbance and mortality from trapping and road kill. Ecological changes due to logging are not permanent, and not necessarily negative Scope BC: all of BC has logging; about 80% of the range QC: we need to look at the connectivity b/w QC and ON ON: most of the logging is in the southern end and the Wolverine population is located north of that. The effect is relatively small; about 1-10% in ON YK: fuel wood harvesting is higher here NT: logging is small but more than people might think. A plan in NT is a move towards oil harvesting. Comfortable with 1% for Canada's range Severity - question "if there is more logging, then wouldn't that mean better habitat for moose = better for Wolverine?" ON: around Red Lake it really depends on the forest. If forest is deciduous, then there is an avoidance by Wolverine, even though there are more moose Concern is that we cannot include cumulative effects of logging, which will change the hunting and trapping of Wolverines. That must be taken into account in 5.1
6	Human intrusions and disturbance	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Disturbance of denning females may lead to litter abandonment and kit mortality Discussion that 6.1 and 6.3 should be similar - difficult to separate recreational activity and other activities.
6.2	War, civil unrest and military exercises		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
6.3	Work and other activities	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Discussion that 6.1 and 6.3 should be similar - difficult to separate recreational activity and other activities.
7	Natural system modifications	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
7.1	Fire and fire suppression		Not a Threat	Restricted - Small (1-30%)	Neutral or Potential Benefit	High (Continuing)	Fires are a natural occurrence in boreal forests and ecosystem effects are positive for Wolverine. Forest fires definitely play a factor in the Western Boreal; scope is larger than 10%.
7.2	Dams and water management/use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
7.3	Other ecosystem modifications	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	Discussion on the declining caribou population * BC: there is a decline in the Southern Mountain pop. but the effec. is not a large factor; Wolverines have other ungulates to choose from (ex. moose) * YK: similar situation as BC; there is more diversity and Wolverines rely on more than just caribou * MB: unsure, but one staff certainly thought that moose could play a factor. It has been over 25 years since the big forest fire and there is an increase in moose habitat now; particularly in the northern part of MB. NT: Bathurst has a decline of 90% in herd size and about 70% decline in the central herd
8	Invasive and other problematic species and genes		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	
8.1	Invasive non-native/alien species						MB: getting an increase in White-tailed Deer; another potential prey that could affect the Wolverine population Noted that forest pests are dealt with under ecosystem change (7.3)
9	Pollution		Negligible	Negligible (<1%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs)	
9.2	Industrial and military effluents		Not Calculated (outside assessment timeframe)	Unknown	Unknown	Insignificant/Negligible (Past or no direct effect)	This could be an issue, but not enough information exists YK: there was a paper done but cannot recall the findings

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural and forestry effluents		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	
9.4	Garbage and solid waste						May result in habituation of Wolverine and resultant nuisance control mortality. Of the lone Wolverine found, garbage did not contribute to the death, it was a capture attempt and therefore would fall under hunting and trapping (5.1)
9.5	Air-borne pollutants		Unknown	Unknown	Unknown	High (Continuing)	
9.6	Excess energy		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	BC: there could be threats around oil/gas exploration or maintenance
10	Geological events		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs)	
10.3	Avalanches/landslides		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs)	Minor source of mortality Mortality of Wolverine might be insignificant, but the carrion and debris from avalanches might provide scavenging opportunities and den sites.
11	Climate change and severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting and alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Reductions in the extent of Wolverine habitat due to reductions in spring cover is disputable. It is likely that a decrease in snow season length would not impact natal denning requirements, because a net increase in snowfall should make up for the shorter snow season, resulting in increased snow accumulation. Any impact on Canadian Wolverine populations should be first detected in the Southern Mountain ecological area of BC and Alberta. A shorter snow season may increase primary productivity to the benefit of Wolverine. Discussion on snow conditions (US study) and if it'll happen in 10 yrs BC: the model forecast is within 25 yrs; more of a longer term issue. However, in the last 10 yrs, southern portion of BC had noticeable snow shrinkage NT: impact of snow is minimal in northern latitude. What would be the bigger issue is how climate change affects larger ungulates, thus having an effect on the scavenger species. Both a direct and indirect effect. YK: Unknown, but reduced snow length season would benefit Wolverines. The whole issue of the US study is controversial but most like the model that US has proposed. Expecting that the suitable snow conditions will shrink substantially over the long term; this will have an effect, but not sure by how much.
11.3	Temperature extremes		Unknown	Unknown	Unknown	Unknown	