

*Peer Review of the Scientific Findings in USFWS Species Status Assessment
Evaluating the Status of the North American Wolverine (Gulo gulo luscus)*

**Reviewer 2
December 2017**

General Comments

1) *Ambiguity about what is being evaluated* -- A major shortcoming of this Species Status Assessment (SSA) is ambiguity about what exactly is being evaluated. In some instances the evaluation seemed geared towards the entire subspecies, while in many other cases it seemed geared towards the western contiguous USA. For instance, the title implies the whole species, while the description of the wolverine's physical and ecological needs clearly focuses on the western contiguous USA. This pervasive ambiguity led to confusion and misapplication of information. My hunch based on prior listing actions is that the ultimate goal of the assessment was to evaluate status of the wolverine in the western contiguous USA. If that is the case, then it renders many points made in the SSA irrelevant. For instance, lack of a declining trend in density of wolverines in Alaska is largely irrelevant to the status of the species in the western contiguous USA. This confusing and often irrelevant presentation of information significantly clouds the overall analysis. The SSA should carefully define its purpose and then present information that addresses that purpose. This does not mean that information from other regions cannot be included, but the document must make it clear how it is using such information and address any caveats that might exist to applying the information to a different region. For instance, patterns of prey selection in tundra regions may not directly apply to montane regions, although such information might support a premise that carrion can be an important food supply.

2) *Scientific rigor* -- The SSA is fraught with problems and does not meet the bar of acceptable scientific rigor. Although some pertinent facts are presented, the overall presentation lacks scientific rigor and many conclusions are based on conjecture rather than critical analysis of the facts and how they relate to status of threats to the wolverine. These major shortcomings render all conclusions suspect and give the appearance that the SSA was written from a foregone conclusion. Poor logic and writing style in some sections (e.g., Range and Habitat Use) contribute to the overall failure of the document to lead to convincing conclusion. Where facts are inconvenient to the overall conclusions that there are no significant impacts to redundancy, representation, or resiliency, the SSA seems to go to lengths to justify the conclusions by cherry-picking information that is only tangentially related. An example of this is the lengthy discussion about pikas (pp 93-94) that attempts to justify plasticity of wolverine behavior with respect to climate change. The ecological/evolutionary adaptations of pikas have no bearing on wolverines.

3) *Den sites* -- This pervasive tendency for cherry-picking information was also used to distort the relative weight of pieces of information in order to support the conclusions of the SSA. For instance, a review of the literature and the opinions of wolverine biologists nearly universally agree that wolverines are a snow-dependent species and snow cover is particularly important during the denning period. However, the SSA presents a confusing portrait of den site selection and misconstrues and often cherry-picks isolated observations to support a conclusion that snow is not needed for denning (e.g., pg. 35). Numerous studies demonstrate that wolverine dens are nearly always in areas that retain snow into the spring. However, the physical features of dens vary. In some cases, where conditions allow, dens are in tunnels dug into deep snow banks. In other cases dens are located in boulders, tree roots, or other physical structures, but within the snow matrix. These two types of dens are not at odds with each other. Wolverines do not den or occur in regions where snowfall does not occur. Use and description of the non-snow physical features of den sites does not detract from the importance of the snow itself, which provides insulation, preservation of carrion, and may be indicative of other important factors such as prey availability (e.g., survival of small mammal prey is benefitted by snow cover) or occurrence of competitors. The SSA distorted information

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about dens leads to a conclusion that snow is not important for wolverine denning (e.g., pg 30). For instance, the SSA referenced a den reported by Pulliainen 1968, which the SSA described as “at the base of a tree and not covered by snow” (pg. 30). However, Pulliainen 1968:340 actually described this den:

“*Den No 25*. I. 1950. Savukoski, Naltiotunturi. One unsexed blind cub was found at the butt of a spruce in a spruce peat-bog (about 3 km from the nearest fell). There was no snow at the butt of the tree. The cub was covered by spruce brush. The lowest spruce twigs were covered with snow.”

Thus, this den site was covered by snow in the overhanging branches of the tree. The SSA also cited an unpublished dissertation (Makkonen 2015) apparently as evidence that wolverine dens are not associated with snow. However, the SSA seems to have misconstrued information in Makkonen (2015). That study did not measure the amount of snow present at den sites. Rather, habitat characteristics of the dens were measured after the denning event, sometime many years after. Makkonen (2015) simply found that most wolverine dens in central Sweden had physical structure (e.g, such as bounders and trees) that would protect the den from weather if snow was not present. No data were presented on actual presence or absence of snow.

The SSA misconstrues the findings of Copeland et al (2010) and seems to use this in part as a basis for concluding that wolverines use and den in areas without snow cover. The goal of Copeland et al (2010) was to test the hypothesis that the geographic range (i.e., Johnson’s first order selection) is limited by areas with persistent spring snow and the wolverine’s upper thermoneutral zone. They did this by creating maps of the distribution of spring snow cover and average maximum August temperatures, which were compared with a map of the current distribution of wolverines and den/telemetry locations. Results strongly supported the broad scale range-wide association of wolverines with areas with spring snow. This is appropriately interpreted that at the range scale, wolverines select for areas with spring snow. That does not mean that every den ever used by wolverines is in a region with persistent snow. On the other hand, any unusual exceptions also do not mean that wolverines are not a habitat specialist of cold climates with spring snow. The association of dens with snow within home range scale has also been well documented in the literature. Thus, the validation of the relationship between wolverine dens and snow at both local and range-wide scales is compelling evidence that spring snow is a key habitat requirement for wolverines. Thus, it is inexplicable that this variable was not included in the wolverine’s key physical and ecological needs.

4) *Historical and current distribution* -- The SSA posits that wolverine populations are currently stable in the contiguous USA (or overall in North America) and that is used as basis for concluding that there is adequate resiliency (e.g., pg 93). This conclusion overlooks several important facts, namely, that the current distribution and abundance of wolverines in the contiguous USA is a fragment of its historical distribution and abundance. For instance, it is estimated that in the contiguous USA there are currently about 318 individual wolverines with an effective population size of < 60. Similarly, the SSA largely ignores and under represents the historical distribution of wolverines in the contiguous USA. There is no evaluation or assessment of the historical distribution in the central Great Plains, Great Lakes, Upper Midwest, or Northeast regions, even given recent observations of wolverines in some of those areas. Given that the SSA is ostensibly an assessment of the North American range of the wolverine, the explanation for why an assessment of these populations is not included is not satisfactory (e.g., pg 15). The current range of wolverine in the contiguous USA is much less than historically. A map of the historical range of the wolverine in the contiguous USA should be included. The conservation biology literature is replete with information about the risk of small population size to the viability of populations, and yet the SSA barely mentions current population size and makes no mention of vast literature on the profound impacts small population size can have on a species.

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The map, “Current Range of North American Wolverine” (Figure 3), is a fantasy. This map grossly misrepresents the current range of the wolverine in North America and should not be used for any analyses. For instance, this map shows the Southern Rockies and Sierra Nevada as within the currently occupied range of the wolverine. Range maps depict the usual area occupied by a species. Recent isolated occurrences of wolverines in the Southern Rockies and Sierra Nevada have involved single male individuals. Further, the male that wandered to Colorado eventually wandered to another state where it was killed. There are no known wolverines occurring in Colorado or elsewhere in the Southern Rockies. Using the occurrence of these single animals within a state to shade in large swaths of country as “occupied” is dishonest. These records should more appropriately be considered extralimital occurrence points (mapped as dots) as they occur outside the known breeding range of the species (only specific areas confirmed as breeding range should be shaded). At the same time, the map ignores records of individual wolverines from other locations such as Michigan. This map is a clear example of how the SSA cherry-picks information and makes inappropriate conclusions based on fragmentary information.

Figure 2 is an appropriate representation of the *historical* range of the wolverine in the western contiguous USA, with the caveat that records were apparently not collated based on reliability of the reports and hence may include erroneous records (see Aubry et al. 2017 PLoS ONE 12(6): e0179152 for an example of how using unverified records can change interpretation of species distribution).

5) *Roads* -- The “assessment” of impacts of roads (pp 52-54) is an example of a section that provides facts, but where conclusions are then drawn based on cherry-picking or misinterpreting facts or without scientific evaluation of facts as they relate to status or stressors on wolverine populations. The SSA cited a large number of studies that clearly demonstrate that wolverines avoid roads (including for den site selection) and that roads can result in direct mortality. Habitat selection studies evaluate the use of habitats relative to their availability. If a habitat is used more frequently than expected based on availability, then that habitat is considered selected by the species. In contrast, if the habitat is used less than availability, then that habitat is considered avoided. May et al (2012) unambiguously demonstrated that wolverines avoid roads and other infrastructure for den site selection:

“At both the home-range and landscape scales, dens were located far from public roads, and especially at the home-range scale they were also located away from private roads. This supports the hypothesis that wolverines at larger spatial scales may be affected by human activities (e.g. recreation, resource extraction) associated with private roads, which reach farther into wolverine habitat (May *et al.*, 2006). Overall, dens were generally located far from infrastructures [7.5 km (0.5 SE) from public roads and 1.4 km (0.1 SE) from private roads and/or recreational cabins], which is difficult considering the almost complete lack of true wilderness areas in modern Norway (see Fig. 1).”

May et al (2012) went on to explain that selection for suitable elevation and topography were the most strongly selected features because wolverines require deep snow for denning. In other words, just because an area is far from a road does not necessarily mean it will have suitable denning habitat; the suitable den site characteristics must come first and within that wolverines select areas relatively far from roads. May concluded that once wolverines find areas that offer suitable den sites (e.g. near treeline), they tend to use the same areas for denning over multiple generations indicating that they are consistently preferred. Thus, the suitable den site characteristics are the overriding factor determining where wolverines den. But, infrastructure also influenced selection, including thresholds a distance below which wolverines did not use sites, although there was a wide range of distances observed. In contrast, the SSA essentially dismissed the findings of May et al (2012) by focusing on the “wide tolerance range” for distance to

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infrastructure. In contrast, the fact remains that the May study demonstrated an avoidance of roads by wolverines (as have other studies).

The SSA also presented information on studies that reported observations of wolverines crossing roads. They conclude that these observations indicate that roads do not act as absolute barriers. This conclusion is odd as one would not expect roads to serve as absolute barriers to most species. That is only one of many possible impacts that roads could have on a species. The more important issues are disturbance, altered habitat, increased human access (e.g., Dawson et al (2010) reported hunter killed wolverines were in areas with high road density), increased access by other carnivores, and direct mortality. Those factors were not evaluated in the SSA

Finally, the SSA conducted a flawed evaluation of the impact of major roads on wolverines. This “evaluation” consisted of summing the kilometers of different types of road within modeled primary and female dispersal habitat in the western contiguous USA and within the flawed Current Range map. These “analyses” simply resulted in the reporting of the road density within various regions and by elevation. They conclude that of all roads, there is a low proportion of major highways. This fact is meaningless given that major highways are almost always more rare than smaller roads. Further, some studies have shown that while wolverines are more likely to be killed on larger roads, smaller roads are more numerous and are avoided by wolverines. Similarly, they concluded that there are fewer roads at higher elevations than at lower elevations. Again, this is an almost meaningless statistic. The SSA provides no meaningful scientific evaluation of how these roads might impact wolverine populations. For instance, what proportion of simulated home ranges would be impacted by roads? How does road density influence extent of modeled habitat? etc.

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Available Data:

1. *Please identify any oversights or omissions of data or information, and their relevance to the assessment. Are there others sources of information or studies that were not included that are relevant to assessing the viability of this species and not repetitive of other information or studies already included? What are they and how are they relevant?*

The SSA did not utilize all pertinent information and tended to heavily rely on select references to support conclusions. This was pervasive throughout. See general comments for examples.

2. *Provide advice on the overall strengths and limitations of the scientific data used in the document. Is the information presented in the SSA report explicit about assumptions and limitations of, and concerns regarding, the data, and are these appropriately qualified or explained? Are there concerns that the Service did not identify, and if so, how relevant are these concerns to the assessment of the North American wolverine? Are there any inconsistencies in how the data are presented or assessed?*

The SSA referenced most relevant papers. However, it misrepresented or cherry-picked information in those papers. See general comments above.

Analysis of Available Data:

3. *Have the assumptions and methods used in the SSA report been clearly and logically stated in light of the best available information? If not, please identify the specific assumptions and methods that are unclear or illogical.*

The assumptions and methods used in the SSA have not been clearly and logically stated. Conclusions are often made based on little or no scientific evaluation of the information. See general comments above.

4. *Are there demonstrable errors of fact or interpretation? Have the authors of the SSA report provided reasonable and scientifically sound interpretations and syntheses from the scientific information presented in the report? Are there instances in the SSA report where a different but equally reasonable and sound interpretation might be reached that differs from that provided by the Service? If any instances are found where this is the case, please provide the specifics regarding those particular concerns.*

The SSA suffers from pervasive bias in its use and interpretation of information. There is an overall failure to scientifically evaluate information used to formulate conclusions. See general comments above for more detail.

As another example, the SSA evaluated climate change and future snow cover. Data presented conclusively showed that climate change will reduce snow cover. However, in interpreting this information, the SSA simply concludes “Their results indicate significant areas (several hundred square kilometers (miles) for each site) of future snow (greater than 0.5 m (20 in) in depth) will persist on May 1st at elevations currently used by wolverines for denning”. However, this conclusion discounts the LOSS of snow cover and no analysis is presented on how the loss of habitat will impact wolverines.

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5. *Provide feedback on the inclusion and portrayal of uncertainty in the SSA report. Have the scientific uncertainties presented and the analyses conducted been clearly identified and has the degree of uncertainty been appropriately characterized? If not, please identify any specific concerns.*

Most climate models show major changes to species distributions after about 2050 (e.g. see Johnston et al 2012 for data relevant to wolverine). I am concerned that the SSA limited its analysis to 40-50 years. Proper planning now to identify locations most likely to retain suitable wolverine habitat over the next century will be important in assuring the species does not go extinct. Models indicate significant reductions in suitable habitat after 2050.

Johnston, K.M., K.A. Freund, O.J. Schmitz. 2012. Projecting range shifting by montane mammals under climate change: implications for Cascadia's national Parks. *Ecosphere*, 3(11):97

6. *Does the SSA report adequately consider what the species needs to maintain viability in terms of resiliency, redundancy, and representation?*

The three physical and ecological needs described for the wolverine in the western contiguous USA are not adequate:

- (1) large territories in remote landscapes; at high elevation (1,800 to 3,500 meters (5,906 to 11,483 feet));
 - Need to define what is meant by "remote"
- (2) access to a variety of food resources that varies with seasons; and
 - This conveys the wrong idea about food requirements; rather, wolverines need access to specific food resources depending on season.
- (3) physical/structural features (e.g., talus slopes, rugged terrain) linked to reproductive behavioral patterns.
 - The absence of snow from this description seems like a glaring oversight.

The SSA does not adequately consider what the species needs to maintain viability in terms of resiliency, redundancy, and representation:

Resiliency—The definition of resiliency is "having sufficiently large populations for the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, birth versus death rates and population size" (Page 5). Based on this definition, it seems clear the wolverine in the contiguous USA lacks resiliency due to its small overall population size and exceptionally small effective population size. Wolverines have low reproductive rates and human-mediated mortality can be additive. Climate models demonstrate significant loss of future habitat. In contrast, the SSA concludes that wolverines are behaviourally plastic and may adapt or adjust to changing conditions. I find no compelling science-based argument in the SSA to support this view.

Redundancy--The definition of redundancy is "having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. The greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events." The Current Range map presented in the SSA grossly over-represents the breeding range of the wolverine in the contiguous USA and no map or analysis is provided of the wolverine's historical distribution. It is currently estimated that there are about 318 individual wolverines in the western contiguous USA with an effective population size of < 60. A wealth of information from conservation biology indicates that populations this small have high extinction risk. The wolverine is functionally extinct from many areas where it historically occurred. In contrast, the SSA concludes that "The wolverine occurs across the contiguous United States within a metapopulation structure. The best available information indicates that

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the species continues to expand into historical, previously occupied areas in the contiguous United States following decades of hunting and trapping.” The fact that the wolverine occurs as a metapopulation is somewhat irrelevant. The fact is that the entire population in the contiguous USA is very small. First, the dramatic examples of this “expansion” are observations of males that have dispersed from core reproducing populations. No new populations will form unless females also disperse, but which have more limited dispersal potential. Second, it is very likely that these dispersal events (e.g., Colorado, Sierra Nevada) are only now observed due to advances in technology such as pervasive use of remote cameras and satellite GPS. Dispersal of single animals is not necessarily indicative of recolonization. Thus, I find no compelling science-based argument to indicate that wolverines in the contiguous USA have adequate redundancy.

Representation—The definition of representation is “having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species’ range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics within the geographical range.” The SSA concludes that “The wolverine is currently found across the west-northwestern United States, as well as much of Canada, and Alaska. The best available information indicates that the species is found across a wide range of habitats. Modeled primary habitat for the wolverine in the contiguous United States has been estimated at 164,125 square kilometers (km²) (63,369 square miles (mi²)). “ This conclusion is fraught with problems. 1) The wolverine is not “currently found across the west-northwestern United States”. Rather, reproductive populations are found in some patches of habitat and it is absent from a large portion of this region. 2) Occurrences in Canada and Alaska are largely irrelevant to its representation in the contiguous USA. 3) The wolverine is largely limited to arctic, boreal, and subalpine biomes. That fact that it can use different microsites within this area is largely irrelevant and does not convey that it is a habitat generalist. 4) The extent of modeled primary habitat is irrelevant because the wolverine does not occur throughout all of the modeled primary habitat. In contrast, reproductive populations only occur in a fraction of the available primary habitat. In contrast to the conclusions of the SSA, genetic studies in conjunction with information on current distribution and abundance of wolverines in the contiguous USA demonstrate that they do not have adequate representation.