United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

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Memorandum

To: Regional Director, Region 6

FROM: Assistant Regional Director, Ecological Services

CC: Field Supervisor, Montana Ecological Services Office

SUBJECT: Wolverine Final Listing Determination Recommendation

I. Introduction:

This is response to your request of me on April 28, 2014 via teleconference with Matt Hogan to prepare a synopsis of the basis for our recommendation of threatened status for the North American wolverine *Gulo gulo luscus*. This represents our best effort to provide you with that synopsis. We have also attached a white paper related to some specific issues that you had inquired about earlier in support of this memo.

We proposed to list the wolverine as a threatened species under the Act on February 4, 2013. In that proposed rule, we identified the primary threat to the species as the impacts of climate change to wolverine's habitat. Secondary threats identified in that document were considered to be threats only when operating in concert with climate change. These secondary threats included genetic and demographic effects of small population sizes and the effects of harvest, both intentional permitted trapping and incidental trapping as a non-target species. Along with the proposed listing, we also proposed a special 4(d) rule to tailor the take prohibitions of the Act that would apply to the wolverine listing. This 4(d) rule prohibited only intentional take of wolverines with the exception of trapping, where the prohibition on incidental take was applied. We also concurrently proposed to designate a nonessential/experimental population for the southern Rocky Mountains in Colorado, New Mexico, and Wyoming. This designation was intended to facilitate the state of Colorado to release wolverines into habitat there without the consequence of additional regulation under the Act. We maintain this remains the appropriate recommendation for the status of the species.

Wolverines are an iconic species representative of vast cold wilderness and the largest member of the weasel family. The species ranges across northern Europe, northern Asia, and northern

North America. Wolverines occur in a variety of habitats but are dependent on cold conditions and deep persistent spring snow for year-round occupancy and reproduction. In the contiguous United States, these conditions occur only at high elevations in the Mountain West. Currently, wolverines are primarily found in the northern Rocky Mountains of Montana, Idaho, and Wyoming where an estimated 250 to 300 individuals reside. A few wolverines are also found in the North Cascades of Washington, and one each has recently moved to the Sierra Nevada of California and southern Rocky Mountains of Colorado.

II. Distinct Population Segment:

The conservation status of wolverine is secure as a species in its circum-boreal geographic range. The subspecies of wolverine occurring in North America, *Gulo gulo luscus*, is also secure due to strong populations in Canada and Alaska estimated to number more than 20,000 individuals (COSEWIC 2003, pp. 13-23). For the warranted finding in 2010, we conducted a DPS analysis to determine if the wolverines in the contiguous United States comprised a distinct population segment (DPS) and if it did, whether this DPS warranted listing as a threatened or endangered species under the Act. This DPS analysis was carried over into the proposed rule and it is our recommendation that the DPS analysis (summarized below) be carried over to the final rule.

To qualify as a DPS, a population must be both discrete from other like populations and significant to the taxon. A population is discrete if *either* of the following apply:

- It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation, or;
- It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

We conclude that the wolverine in the contiguous United States meets the second DPS discreteness criterion because of differences in conservation status as delimited by the Canadian-United States international boundary, and that those differences are significant in light of section 4(a)(1)(D) of the Act.

The conservation status of the contiguous United States wolverine population and the Canada/Alaska population are different because the contiguous United States population is vulnerable to extinction from identified threats and the Canada/Alaska population is not. This difference is attributable to three characteristics of these populations and their habitat:

1. Population size
    - Canada/Alaska population is likely more than 20,000 individuals
    - Contiguous U.S. population is likely 250-300 individuals
2. Effective population size – that portion of the population that contributes to the next generation

- Effective population size for Canada/Alaska has not been measured but is likely to be more than 2,000 based on the usual proportion of the census population for carnivores
- Effective population for contiguous U.S. is measured at 35, which is lower than the minimum required to maintain short-term genetic diversity
- Low effective population size has already affected the contiguous U.S. population, resulting in reduced genetic diversity by genetic drift. This issue is expected to continue because effective population size is not likely to increase significantly.

3. Habitat fragmentation and effects of isolation by distance
   - Habitat in Canada/Alaska exists as a few large and connected habitat patches
   - Habitat in the contiguous U.S. exists as small fragments on mountain tops. Each fragment is isolated from one another by unsuitable habitat making free movement of individuals more difficult (but not impossible). This isolating effect exacerbates the effects of small effective population on genetic diversity.
   - There is a rather abrupt shift in habitat patchiness that roughly corresponds with the international boundary.

The international boundary between Canada and the United States currently leads to differences between the countries in management (control of exploitation) as well as conservation status of the wolverine. The differences in control of exploitation favor the contiguous United States population in that harvest is precluded entirely in all states except Montana where it is tightly controlled. For this reason, we do not use differences in control of exploitation to support a finding of discreteness in the DPS analysis. The difference in conservation status between the two populations is significant because it allows for potential extirpation of the species within the contiguous United States through loss of small populations and lack of demographic and genetic connectivity both between subpopulations within the contiguous United States and between this population in the larger Canada/Alaska population. This difference in conservation status is likely to become more significant in light of threats (discussed below). Therefore, we find that the difference in the conservation statuses in Canada and the United States result in vulnerability to significant threats in the U.S. wolverine population but not for the Canada/Alaska population which is robust to threats due to its large size and expansive habitat.

Existing regulatory mechanisms do not exist to ensure the continued existence of wolverines in the contiguous United States in the face of these threats. Therefore, it is our conclusion that the difference in conservation status between the two populations is significant in light of section 4(a)(1)(D) of the Act, because existing regulatory mechanisms appear sufficient to maintain the robust conservation status of the Canada-Alaska population, while existing regulatory mechanisms in the contiguous United States are insufficient to protect the wolverine from threats due to its depleted conservation status. As a result, the contiguous United States population of the wolverine meets the discreteness criterion in our DPS Policy (61 FR 4725). Consequently, we use the international border between the United States and Canada to define the northern

boundary of the North American wolverine DPS. Other criteria for discreteness (e.g. differing legal status, and differences in control of exploitation) were considered, but rejected for the wolverine DPS.

In making a significance determination in a DPS analysis, we consider available scientific evidence of the population's importance to the taxon to which it belongs (i.e., the North American wolverine (*Gulo gulo luscus*). Our DPS policy states that this consideration may include, but is not limited to: (1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon; (2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. We conclude that that loss of the contiguous U.S. wolverine population would result in a loss of 15 degrees of latitude from the historical range of the species. The historical range comprised approximately 38 degrees latitude. This loss represents a significant proportion of the historical latitudinal range of the species and represents a significant gap in the range of the taxon. This interpretation is consistent with how we have applied the DPS policy for grizzly bears, lynx, and gray wolves.

III. Five Factor Analysis

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence.

We are required by the Act to assess threats information that may occur within the foreseeable future. We define foreseeable future as a timeframe in which impacts can be reasonably expected to occur (see Appendix for further explanation). In the proposed rule, we identified one primary threat to the wolverine DPS: climate change. Other threats were secondary and only rose to the level of threats to the DPS to the extent that they may work in concert with climate changes to affect the conservation status of the species. For this reason we used a foreseeable future identified for climate change (out to the end of this century) for our finding. Our decision to use end of century climate projections was influenced by our conclusion that climate change information was reliable to that point. This conclusion is based on (1) the fact that climate projections out to mid-century are similar to each other regardless of emission scenario used and (2) that the emission scenarios used in the literature we rely upon to project climate changes out to the end of the century are conservative scenarios that recent emissions have already begun to

surpass. The two factors above make the projections reported in McKelvey et al. (2011) likely to be conservative estimates of actual climate change impacts, meaning that effects to wolverines are likely to be as severe as those reported in McKelvey et al. (2011) or worse. Other recent listing actions that have used end of century climate change projections include multiple coral species and the Pacific walrus. For other wolverine threat factors, future projections are not available and it is assumed that current trends will continue unless information exists to the contrary.

Factor A. *The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range*

There are a variety of impacts to wolverine habitat that may be considered risk factors for the species such as (1) Climate change, (2) human use and disturbance, (3) dispersed recreational activities, (4) infrastructure development, (5) transportation corridors, and (6) land management. Only climate change presents a potential threat to wolverines.

Climate Change

- Worldwide, wolverines are dependent on habitats that maintain persistent, deep snow cover late into spring for both year-round use, and for denning. No known dens are located in areas without deep snow.
    - Wolverines need deep snow that persists into late spring for den structure (Pulliainen 1968; Copeland 1996; Magoun and Copeland 1998; Banci 1994; Inman *et al.* 2007c; Copeland *et al.* 2010)
        - Deep snow likely provides security from predators
        - May also provide a thermal buffer for kits while they are in the den
    - Persistent snow across the home range may provide a deterrent to other carnivore species that are not snow-adapted, providing a competitive advantage (Copeland et al. 2010).
    - There may be a thermal constraint on wolverine physiology that requires them to live in cold and snowy conditions (Copeland et al. 2010)
    - Deep snow and cold temperatures throughout a home range may provide for "refrigeration" of cached food (Inman et al. 2013).
    - There may be other reasons that snow and cold are important that we don't know. The precise mechanism(s) behind the relationship between wolverines and deep snow is less important than the fact that deep snow appears to be an obligate habitat feature for this species.
- In 2010, a group of scientists representing the most prominent wolverine biologists from around the world published a bioclimatic envelop model for wolverines that examined the role of late spring snow persistence in wolverine habitat use. This paper (Copeland et al. 2010) showed a remarkable concordance between wolverine habitat use and persistent spring snow.

- In 2011, McKelvey et al. published a climate change analysis using the Copeland et al. snow model as the basis. This analysis was used as the best available science in the proposed rule. From it we concluded that:
    - Within the foreseeable future, wolverine habitat in the DPS is likely to decline significantly
    - Projected habitat loss of 31% by mid-century (interval midpoint 2045)
    - Projected habitat loss of 63% by late-century (interval midpoint 2085)
    - Increased landscape "resistance" to wolverine movement due to increased distance between suitable habitat patches would make wolverine connectivity more difficult
    - Genetic diversity of wolverine population in the DPS was likely to continue to decline due to reduced connectivity
    - Wolverine metapopulation may be in danger if connectivity continues to decline due to the inability for subpopulations to rescue one another
- There are several other peer-reviewed and published climate change analyses of wolverine habitat that generally support the conclusions we have drawn from McKelvey et al. (2011): Peacock 2011, Johnston et al. 2012, Gonzalez et al. 2008.

We conclude that climate change impacts to wolverine habitat constitute a threat because habitat losses of the magnitude above, when considered in light the already small and genetically depauperate wolverine population in the DPS, would likely lead the population to the point of endangerment in the foreseeable future. Although the wolverine population is likely to still be expanding in the southern portion of the Greater Yellowstone Area, the impacts to habitat from climate change are likely already being felt in northern portion of the DPS where populations have been established since the 1950s. For the overall population, there may be a lag period before loss of habitat due to climate change affects the population to the extent that population numbers as a whole begin to decline. We expect this "turning point" for the population to occur well before mid-century, when conservative projections estimate a 31% decline in habitat. See Appendix for further explanation.

Factor B: *Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

Harvest

- Harvest in the contiguous U.S. occurs only in Montana and is low and controlled geographically to prevent concentrated mortality in any one area.
- Montana has suspended harvest for the past two seasons in response to litigation over our listing process.
- The level of harvest permitted by Montana prior to the suspension (5 wolverines) is not currently a threat to the DPS.

- Incidental harvest by those in pursuit of other species occurs rarely. We have worked with AFWA to develop mitigation measures that would minimize incidental capture of wolverines.
- In our proposed rule, we concluded that wolverine harvest (intentional and incidental) at this level is a threat in concert with climate change. As wolverine habitat declines and becomes more fragmented and isolated, even small numbers of mortalities will become more significant due to the need for individuals to successfully move between habitat patches. We have analyzed this potential threat in light of the new information we received during the comment period and have determined that trapping for other species, when conducted in accordance with AFWA guidelines, does not constitute a threat. Therefore, we recommend that in the final 4(d) rule, the prohibition on incidental trapping be removed for those trappers that employ the AFWA guidelines.
- Comments from peer reviewers and states questioned the basis for concluding that such low levels of harvest represent a threat to the species.
- We continue to support the conclusion that permitted trapping or incidental trapping conducted in a manner not consistent with the AFWA guidelines is a secondary threat to wolverines due especially to impacts to individuals attempting to disperse between habitats. We believe that even small numbers of mortalities are likely to be problematic when habitat and populations are contracting due to climate change.

Factor C. *Disease and Predation*

- There is no indication that disease or predation is a threat to wolverines

Factor D. *Inadequacy of Existing Regulatory Mechanisms*

- As discussed under Factor A, habitat loss and modification resulting from environmental changes due to climate change constitute the primary threat to the wolverine.
- In the proposed rule we concluded that regulatory mechanisms are necessary to mitigate the impact to wolverines from climate change, but that these mechanisms do not exist, and so inadequacy of regulatory mechanisms was not a threat to the DPS. This is a policy determination that, in our opinion, is non-sensical in light of a plain reading of the Act.
- The United States is only beginning to address global climate change through the regulatory process (e.g., Clean Air Act (42 U.S.C. 7401)). There is no information at this time on what regulations may eventually be adopted, and when implemented, if they would address the changes in wolverine habitat likely to occur in the foreseeable future. Existing regulatory mechanisms do not address climate change in a way that would ameliorate impacts to wolverine habitat.

- We recommend changing the Final Rule to conclude that the existing regulatory mechanisms are not adequate to address the threat of habitat loss and modification resulting from the environmental changes due to climate change.

Factor E. *Other Natural or Manmade Factors Affecting Its Continued Existence*

- Small population size
    - Effective population size is very small: 35 for the northern Rocky Mountain population which is the largest population in the DPS and represents most of the occupied habitat (Schwartz et al. 2009). Other populations in the DPS are much smaller and can be expected to have smaller effective population sizes.
    - Small population size combined with low connectivity has already resulted in low genetic diversity (Schwartz et al. 2009; Cegelski et al. 2003; Cegelski et al. 2006; Kyle and Strobeck 2001)
    - As habitat patches become smaller and effective population size also shrinks, connectivity is likely to become more difficult, resulting in further genetic impoverishment and possible demographic effects
    - Metapopulation dynamics that rely on subpopulations rescue of each other may break down.
    - We conclude that the effects of small population size alone are not a threat to wolverine, but when considered cumulatively with climate change, small population effects (both demographic and genetic) make the species more vulnerable to other stressors.

IV. Peer Review, Public Comments, and Science Panel

Peer Review

We initiated a peer review of the proposed rule in February 2013. Seven peer reviewers were selected for their expertise in wolverine science as demonstrated by their research and publication record. Peer reviews were generally supportive of the way the proposed rule presented and interpreted science. One area was identified in which there was sharp disagreement among peer reviewers. Two peer reviewers took issue with our use of Copeland et al. (2010) as a proxy estimate of wolverine habitat because in their opinions:

- The model is not validated as an estimate of wolverine habitat
- The mechanism posited by Copeland et al. was unlikely to be the reason for the correlation between wolverine habitat use and persistent spring snow
- The dates used to delimit persistent spring snow in Copeland et al. are not well founded in wolverine biology

- The Model developed by Copeland et al. (2010) does not encompass all known wolverine dens worldwide

Because these two peer reviewers question the scientific basis for Copeland et al. (2010), they also question the validity of McKelvey et al. (2011) as a valid estimate of potential effects of climate change on wolverine habitat, because McKelvey et al. (2011) used the model in Copeland et al. (2010) as the starting point for their analysis and made the assumption that it was a valid estimate of wolverine suitable habitat.

States within the wolverine range also raised similar questions about basing a listing decision on these two papers when there were significant scientific questions about the validity of their conclusions regarding future wolverine habitat under climate change scenarios. States also questioned the use of a foreseeable future (end century) that was so distant. They argued that wolverine populations in the DPS are currently growing and that it is speculative that habitat changes will occur in the distant future that would turn that growth into decline.

In November of 2013, we met with state wildlife directors and other state wildlife officials from around the DPS range in Salt Lake City to discuss the science behind the listing rule. Those state directors asked us to take another look at the criticisms levied by the two peer reviewers and several states regarding the science behind the threat of climate change in the proposed rule. The directors supported the idea of extending the deadline for the listing by six months and engaging with the scientific community to re-evaluate the available scientific information on wolverine habitat use and potential climate change impacts to wolverines.

We worked with staff from state wildlife agencies in Montana, Idaho, and Wyoming to organize a scientific panel whose individual expertise would include one or more of the following areas: wildlife management, habitat modelling/remote sensing, and climate change science. On April 2nd and 3rd 2014, we held a two day facilitated workshop in which the nine panel members were led through discussions and scoring exercises with the intended purpose of gauging their individual opinions on strength of the scientific information on the potential for climate change to affect wolverine habitat. We have posted a final report of the results of the panel on the Region 6 wolverine website, a summary of our interpretation of the results follows here:

- Panelists agreed strongly that wolverines were obligate snow denners (i.e., 95% of values were placed in this category).
- Panelist's views had more variation regarding whether deep snow was needed by wolverines at the home range or species range scales. Overall, panelist scores indicated their beliefs that wolverines tended toward having an obligate relationship with contiguous snow at the home range and species' range scales; however, there was wide disparity between individuals' scores.
- There was a tendency toward considering cold temperatures as an obligate requirement for wolverines at the home range and species' range scales, but the results indicated high uncertainties within individual panelist's scores.

- Panelists indicated strong support for McKelvey et al. (2011) as an analysis of the impact of climate change to snow cover indicting relatively high certainty that climate changes would reduce snow cover similarly or more severely than depicted in that paper.
- When asked whether McKelvey et al. (2011) accurately represented likely changes to wolverine habitat, panelists registered scores indicating uncertainty as to whether McKelvey et al. (2011) was an overestimate, underestimate, or right on estimate. This indicates that in the panelists' individual views McKelvey et al. was not systematically biased, but panelists tended to allocate equal points to all three possible bins. Discussions after the scoring exercise indicated that for some of the panelists, their scores were meant to convey that there was uncertainty associated with longer-term (i.e. end of century) predictions of wolverine habitat. We interpret this uncertainty to be related to panelists' general lack of comfort with the assumption that the model in Copeland et al. (2010) (the starting point for McKelvey et al.) was a useful estimate of wolverine habitat. Each of the panelists agreed with our interpretation that wolverines would continue to expand in the short term, but that by the end of the century, wolverine populations would likely be significantly affected by habitat loss due to climate changes.

V. Recommendation

Based on the information summarized above, and the general validation of our approach to interpreting climate science by the wolverine science panel, we conclude that relying on Copeland et al. (2010) and McKelvey et al. (2011) as the best available scientific information regarding the effects of climate changes on wolverine habitat remains scientifically justified. The Montana Field Office recommends that; 1) the wolverine listing be finalized as threatened under that Act, 2) that the 4(d) rule be finalized as well and, 3) that the experimental/nonessential (10j) rule in the southern Rocky Mountains be finalized, facilitating a reintroduction effort there to proceed should the State of Colorado decide to pursue it. We also recommend that the 4(d) rule be changed to recognize the state led efforts to devise mitigation measures for trapping that would reduce or eliminate wolverine incidental captures by removing the prohibition on incidental take from trapping for those who choose to follow the mitigation procedures while trapping. I support these recommendations.

In our review we have been unable to obtain or evaluate any other peer reviewed literature or other bodies of evidence that would lead us to a different conclusion. While we recognize there is uncertainty associated with when population effects may manifest themselves, any conclusion that there will not be population effects appears to be based on opinion and speculation. In our opinion that would not represent the best available scientific or commercial data available.

Appendix

Foreseeable future:

There were several points of significance to wolverine taken from the January 16, 2009 M Opinion on the meaning of "Foreseeable Future". Foreseeable future determinations must be based on the best available data that allow predictions in the future and can only extend so far as those predictions are reliable (meaning sufficient to provide a reasonable degree of confidence in the prediction). Degree of foreseeability depends on the species and the type of data available for different threats. If the information and data used are reliable for the purpose of making predictions and lend themselves to a particular timeframe, it may be helpful to identify that time scale but no specific period is necessary.

We did not explicitly define foreseeable future in the Proposed Rule, but used threats information that was available and that we deemed reliable. For climate change, we decided that end-of-century projections (i.e. 2085) based on IPCC global climate models were reliable, and that analyses of effects to wolverine habitat based on those models would also be reliable. This approach is similar to how we and NMFS have viewed foreseeable future for other species in recent actions such as Pacific walrus and multiple species of corals, but different from how we treated foreseeable future for polar bear and pika. For polar bear and pika, we restricted foreseeable future to mid-century climate projections due to divergence of models after that point related to different emissions scenarios. In drafting the wolverine Proposed Rule, we considered alternative interpretations of foreseeable future, including limiting foreseeable to the mid-century (i.e. 2045) projections in McKelvey et al. (2011). This approach had the benefit of more certainty as far as persistence of wolverine populations are concerned, but IPCC projections based on moderate emissions scenarios as used by McKelvey et al. have tended to underestimate climate change impacts in the past, so long-range projections are actually more likely to reflect the magnitude of impacts or be an *underestimate* of impacts (this also came out clearly from the climatologists on the Panel). For this reason we determined that the 2085 projections were reliable for use in this listing process.

We note that although we have confidence in the foreseeability of snow projections and their reliability into the future, some question does remain as to the mechanism linking wolverines to snow. Our determination in the Proposed Rule that impacts to future snow coverage equate to impacts to wolverine populations are based on the correlation between wolverine habitat use and snow cover. For purposes of the proposed rule, we listed several potential mechanisms for this correlation, while acknowledging that correlation is not proof of any single mechanism.

When wolverines would likely exhibit a biological response:

Exactly when wolverines would begin to decline due to habitat loss by climate change is a matter of educated inference based upon the current scientific information. Here is how our thinking on the subject informed what is in the Proposed Rule.

There are many unknowns in this analysis, among them are: current population size, population trend, habitat capacity, and amount of available habitat in the past. Based on climate change

over the past 150 years or so, it is likely (though not measured) that wolverine suitable habitat has already declined. The world came out of a major cooling event, the "little ice age", around 1850, and worldwide temperatures have increased since that time, at first as a natural rebound from the little ice age, more recently as a result of anthropogenic warming. Based on what we know about wolverine habitat's sensitivity to temperature, it is likely that wolverine habitat availability has been slowly shrinking since 1850 and continues to do so today.

The wolverine historical record of occurrences is complicated by the fact that wolverines were extirpated from the contiguous United States by the early 20th Century by human-caused mortality. The historical record shows that wolverines have expanded from zero (by 1930) to their current numbers and distribution, while at the same time habitat availability has likely decreased. An educated estimate is that there are currently about 300 wolverines in the DPS, mostly in Montana and Idaho. There is also reason to believe (though with high uncertainty) that populations may still be expanding in the southern portion of the currently occupied area in Wyoming. Conversely, we have also seen several long-distance dispersal events of wolverine leaving the Greater Yellowstone area (including the wolverine that went to Colorado). These emigration events may indicate that habitat in this area is becoming filled, and wolverines are seeking new areas with open territories. The hypothesis that wolverines are still expanding and may continue to expand is as much speculation as is the current population level, whereas future impacts to wolverine habitat due to climate change are demonstrated by actual scientific analysis. For this reason it makes little sense to reject the scientific information as "uncertain" while accepting the idea that wolverine populations are expanding and will continue to do so.

In the Proposed Rule, we concluded that the most likely future scenario for wolverine populations was that they would continue to expand for a period of time, but as populations filled the available habitat, and habitat continued to shrink, density-dependent factors related to limited resources would eventually force the population into decline. When that will occur is further complicated by the north to south progression of wolverine re-colonization. Wolverines recolonized northern Idaho and Montana first and progressively moved south as habitat patches were filled by resident females. It is likely that the northern portions of the DPS have been filled for 60 years or so based on occurrence records, and that filling of the southernmost portion of the GYA is not yet complete. It may be that the population in the DPS is already feeling the effects of reduced habitat in the north, even while populations are continuing to expand in the south. Populations in current wolverine strongholds like Glacier National Park and central Idaho may already be adjusting to habitat changes, while other populations may continue to expand for years to come due to differences in time of colonization and population growth rates. The 2045 projections from McKelvey et al. suggest a conservative estimate of 31% decline in habitat by that time. It is reasonable to conclude that wolverine populations would be suffering significant effects from this level of habitat loss regardless of their location.

First, as described above, the more northerly populations are likely to feel any effects of climate change immediately due to their populations likely already being at capacity. Second, whether or not there is still expansion potential in the southern portion of the currently occupied range (i.e. GYA and southern Idaho), there is not likely to be enough room to accommodate a loss of 31%, much less the 64% losses projected for 2085. Third, wolverine habitat in the contiguous U.S. is naturally fragmented and requires movement between patches of habitat (i.e. mountain

ranges) to maintain demographic and genetic health of the overall population. There is genetic evidence that current connectivity between the lower 48 population and northern populations is impaired to the extent that genetic variability is very low in the U.S. populations due to inbreeding.. With these habitats getting smaller in the future, we expect that connectivity will become more difficult and genetic diversity further impaired . In addition, we concluded that some of the more isolated habitat patches are likely to become vacant due to lack of re-colonization after local extinction or if they become too small to support home ranges. It is also likely to make connectivity even more difficult. For these reasons, in the Proposed Rule we predicted that wolverine population declines would be greater than the aerial extent of habitat declines.

In the Proposed Rule, we concluded that there likely is some room for expansion in the southern GYA. We did not discuss whether there is enough room to accommodate a 31% or 64% reduction in habitat without causing the population to decline. There is reason to believe that there is not that much room for expansion, and this conclusion too requires a bit of informed speculation. If there is still room for expansion, it is likely limited to the southern fringe of the current range in the GYA and southern Idaho (the North Cascades may also have some expansion room, but the available habitat is very limited). We believe these areas may have room for expansion because the few efforts to find wolverines in this area have found few wolverines. So while the 31% habitat decline would be occurring throughout the range of the species, the potential for population growth would be in one or two small parts (this assumes that female wolverines would not reach habitat in the southern Rockies and Sierra Nevada in sufficient numbers to found a population in either of those areas). It is highly unlikely that there is sufficient room for expansion to accommodate a habitat loss of 31% without affecting the overall population numbers. In the proposed rule, we concluded that wolverine populations would be affected by the 2045 habitat loss projected in McKelvey et al, and that population level effects would be significant by that time.

Use of Models

All listing decisions are based on models that allow us to project threats information into the future to determine whether a species is threatened or endangered. These models may be explicit as are the climate change models used in the wolverine decision, or implicit. For example, when we review the history of species decline and attribute it to causes that look like they are becoming more severe and will continue to do so, we are building a mental model of how the world works for the species under consideration. We generally prefer to use explicit models for listing because they are more scientifically defensible and transparent. Sometimes those models are already part of the scientific literature and in other cases we may ask for outside assistance in developing them; examples of the use of climate models in listing include pika, polar bear and Pacific walrus where modeling was used to evaluate how climate change might affect these species habitats. In these cases, the result was a not warranted finding for pika because we found that the predicted degree of temperature increase was within the thermal tolerance for the species and warranted findings and eventual listing for polar bear and walrus because we inferred significant future losses in habitats based on warming predictions. We have also used population viability analysis models extensively in listing actions.

One of the key issues identified by the wolverine science panel and by state comments and peer-review is the lack of certainty behind the mechanism linking wolverines to climate-affected habitat. It is reasonable to believe that food resource availability drives reproductive success and that females locate dens in the middle of large expanses of deep snow to avoid both predation at the den site and competition from other carnivores that are not snow-adapted, but this link is difficult to prove conclusively. In this way, the wolverine Proposed Rule is different from that of the polar bear and walrus rules. We simply have not solidly documented actual impacts to wolverines from climate change like we have for polar bears for instance. In the case of polar bears, we have documented drowning of individuals when ice retreated far from shore and the bears didn't have the endurance to make the swim. We have documented female bears with cubs that were stranded on land and unable to hunt because ice had retreated far out to sea. However, for wolverine we are unlikely to ever get this kind of "smoking gun" because they are seldom observed even when radio collared, and the effects of climate change are likely to be much more subtle, such as slightly decreased reproductive output, fewer prime home ranges that are productive enough to support a female with kits, or decreased connectivity resulting in fewer successful movements between major habitat areas. Thus, detecting a species' response either now or in the future is unlikely due to the near impossibility of obtaining such information on this hard-to-study species.