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Re: Extension of the Comment Period on the Proposed Wolverine Listing Determination

I was asked to be one of the 7 people to peer review the science in the wolverine listing determination. By the phrasing used in the Federal Register to provide background information and request additional information on the proposed rule for listing wolverines, it is apparent that the USFWS remains unclear on why some reviewers question the science upon which the listing decision was based. As one of those reviewers, I wish to further clarify my position:

I AGREE that wolverines are dependent on cold, snowy conditions and that the snow cover map in Copeland et al. (2010) is largely concordant with ("closely approximates") the landscapes where wolverines occur (although, as I pointed out in my review, wolverines do breed, feed, and shelter outside the boundaries of that map, sometimes up to 100 km or more, so the USFWS should specifically define the term "closely approximates" in the revised determination document, also pointing out that there are places within the spring snow cover map where wolverines DO NOT occur).

I AGREE that wolverines are dependent on persistent late spring snow (but as discussed in Magoun and Copeland 1998). In fact, it would be difficult to DISAGREE with the USFWS "determination that wolverines are dependent on persistent late spring snow" because the determination document does not specifically define "persistent late spring snow" or the biological reasons why wolverines are dependent upon it. This term as used in Magoun and Copeland (1998) refers to snow depth ≥1m (not "snow cover" regardless of depth), includes snow patches, and gives no definitive date for the end of the "persistent late spring snow." The determination document cites Copeland et al. (2010) for the scientific basis for obligate spring snow, which hypothesized that the occurrence of wolverines is constrained by an obligate association with "persistent spring snow cover." Copeland et al. (2010) also does not specifically define the term but simply offers a map of MODIS-measured snow cover on May 15. However, Copeland in his response to my review stated "<u>nowhere in Copeland et al. (2010) does it state that wolverines require snow until May 15"</u> (underlining for emphasis is Copeland's).

I AGREE that wolverines den under snow and require snow for denning. Wolverine births and denning occur over a relatively broad time period (Inman et al. 2012) so it would be difficult to put an ending date on the denning period.

I AGREE that "the spring snow coverage should be viewed as an approximation of underlying bioclimatic requirements" (Copeland et al. 2010), if what this statement means is that some undefined bioclimatic factor or factors determine the range of the wolverine, not snow cover on May 15. One or

more of these undefined obligate bioclimatic requirements may provide a more accurate range map of where wolverines feed, breed, and shelter.

I DISAGREE with using May 15 as a date for examining the relationship between wolverines, snow, and the effects of climate warming, especially without explaining why May 15 snow cover "closely approximates" wolverine distribution. It is not enough to simply state that wolverines are adapted to cold snowy conditions, den under snow, and require persistent late spring snow [these conditions need not be reliant on snow cover to May 15 as described by MODIS satellite data in Copeland et al. (2010) nor have they been shown to be so]. May 15 snow cover in Copeland et al. (2010) may simply be an artifact of where snow in many years is deep enough and/or temperatures cold enough to make snow cover, as measured by MODIS satellites, linger into May over a large portion (but not all) of the wolverine's distribution. This snow cover map in no way explains obligate bioclimatic conditions for wolverines. The ecological significance for wolverine habitat from a potential 2-week earlier melting of snow cover (as measured by MODIS satellites) has yet to be demonstrated. The disappearance of snow cover by May 15, as presented in the McKelvey et al. (2011) climate model, has not been shown to be accompanied by loss of snow earlier in the denning season. In fact, just the opposite might occur (e.g., in February and March; Kapnick and Hall 2012*) with more snowfall earlier in the winter under climate change (see my review comments). I presented considerable support (Appendices A-Z attached to my review) for my position on the "best available science" used in the listing determination (posted on the USFWS peer review website [http://www.fws.gov/mountain-rairie/science/peer_review.cfm] for anyone who wishes to understand the scientific arguments for this position). In order for the science used by the USFWS in the listing determination to be considered the "best available science," the science MUST

1) EITHER, offer ecological/biological reasons why wolverines must have snow cover until May 15 ("snow cover" as measured and described by Copeland et al. 2010 and used in McKelvey et al. 2011) and show that without this snow cover, wolverines cannot occupy (i.e., "feeding, breeding, and sheltering") the landscapes currently underlain by the Copeland et al.(2010) snow cover map [note: this option of obligate May 15 snow cover is not subscribed to by Copeland as noted above in the underlined passage]
2) OR, demonstrate that snow cover in McKelvey et al. (2011) that is proposed to disappear from the landscape by May 15 in 50 to 100 years is causally related to and a measure of snow conditions earlier in the winter (or some other underlying bioclimatic requirement) that will also deteriorate in 50 to 100 years to a degree that the landscape will no longer be suitable wolverine habitat (i.e., wolverine will no longer occupy those landscapes for "feeding, breeding, and sheltering").

There is no evidence presented in any of the documents cited in the listing determination or elsewhere that indicates that either 1 or 2 is true. A scientific hypothesis must be stated in a way that will allow other scientists to test the hypothesis. If scientists and the USFWS are not saying that wolverines require snow until May 15, then what is the specific hypothesis being put forward? How do we test that hypothesis? If the snow cover map is a "proxy" for some other underlying bioclimatic requirements, what are those requirements? For example, if we propose that wolverines require snow for dens and/or for food caching, then what kind of snow, how much snow, how is it distributed, and how long does it need to last? Will OBLIGATE snow conditions (as yet to be defined) deteriorate or disappear if snow melts 2 weeks earlier in the spring? Are scientists, the public, and the USFWS to simply accept that the future loss of snow cover 2 weeks earlier in spring (i.e., McKelvey et al. 2011) predicts that wolverines will no longer feed, breed, or shelter in those areas, even if snow is still plentiful over the rest of the winter and remnant snow drifts last well into summer? Loss of this May 15 snow cover has not been linked to loss of critical snow conditions during the preceding winter months when wolverines are denning, and so far, the limited science that does exist indicates that there actually could be more snowfall in the future in the mountains of the western states during most if not all of the wolverine denning season (see my review), which if true should also provide for the wolverine's requirement for habitats with cold, snow conditions.

I ask that the USFWS pay particular attention to the points of agreement and disagreement that are discussed above and be diligent when interpreting and quoting comments made by the peer reviewers in any subsequent documents. To be clear, I request that the peer reviewers be given the opportunity to review the next draft of the determination document before it is released to the public so that the reviewers can proof statements that are attributed to them.

Respectfully submitted,

Audrey J. Magoun

*Kapnick, S. and A. Hall. 2012. Causes of recent changes in western North American snowpack. Climate Dynamics 38:1885-1899.