Supplemental Comments on the Magoun review – Jeff Copeland May 9, 2013

Shawn,

At your request, I reviewed Dr. Magoun's review of the Proposed Rule, specifically her argument that Aubry et al. (2007), Schwartz et al. (2009), Copeland et al. (2010) and McKelvey et al. (2011) do not represent the best available science. While I attempted to go through the review and provide detailed comments in response to particular statements, I realized after reading her Summary and Conclusions section that the majority of her comments stem from a fundamental misunderstanding of the results provided by the aforementioned publications, which I attempt to clarify below.

Dr. Magoun's concerns, regarding all these publications, revolve around her belief that the dates used to develop the bioclimatic envelope model and therefore the related least-cost path and climate modeling are incorrect, therefore invalidating the conclusion that wolverines will be adversely impacted by a warming climate. I attempt below to explain our conclusions relating to the spring snow cover mapping effort and the wolverine's actual association with snow. I would suggest that Dr. Magoun re-read the methods section of Copeland et al. (2010), for which she is a coauthor, in hopes that it will clarify her understanding of how the May 15 date contributed to the model development.

Throughout her review, including that contained within her attachment A, Dr. Magoun continually states that Copeland et al suggest that wolverines are obligated to snow that persists until May 15. This is a complete fabrication on Dr. Magoun's part. Nowhere in Copeland et al. (2010) does it state that wolverines require snow until May 15. May 15 was simply a component of our modeling effort that enabled us to produce a coverage that represented persistent snow. That coverage was then compared to known wolverine den sites and year-around habitat use to judge how precise it was in depicting where wolverine occur. It contained documented denning habitat at nearly 99% accuracy and year-around habitat use by nearly 90%. Based on this overwhelming congruence of our spatial model with known wolverine dens, coupled with the fact that nowhere has a verified wolverine den been found that was not associated with snow, we suggested that snow was an obligate feature – a necessity for wolverine reproductive denning. The model represents the cessation of reproductive denning and produces a relatively conservative estimate of the distribution of deep, persistent snow cover.

The snow model represents a hypothetical representation of the wolverine's world-wide distribution. We tested that hypothesis by overlaying nearly 700 known wolverine dens, along with year-around relocation data, to judge how well the model fit the known distribution of dens and year-around habitat use. It simply says that our snow model is congruent with year-around wolverine presence. Our belief, presented in Copeland et al. (2010), that adequate spring snow cover is obligatory represents a conclusion based on the weight of all the data presented in this paper. Suggesting that the model is invalidated because a few dens occurred outside the model boundary is akin to suggesting that a 95% probability, commonly accepted throughout science as an adequate level of confidence, is inadequate to conclude hypothesis acceptance simply because 5% fell within the tail of the distribution. The model represents a relatively coarse (although one would have to agree that a 500 meter resolution is not bad at a world-wide scale) representation of spring snow cover. The fact that the model includes 98% rather than 100% of all known dens indicates that the time period we selected was just about right – it did not overestimate or

underestimate. Late spring snow coverage tends to become very patchy in the spring with high elevation snow or drifted snow persisting into early summer. The female wolverine must select a snow denning site in February that will persist, in many instances, into May. In mountainous areas this is provided by high elevation while in boreal and tundra regions may be provided by drifted snow. Our challenge was to use data that did not provide snow depth to create a model that reflected snow depth and captured areas that were becoming very patchy in their snow distribution. Our 98% coverage of dens suggests to me that we managed such very well. The model represents a hypothetical-deductive process rather than a simple model fitting exercise, which seems to have escaped Dr. Magoun. The dates we used were simply a component of the model development process. Had snow depth data been available on a world-wide scale and temporally matched with each den we would have used it rather than the MODIS data. Whether or not a particular den falls inside the snow layer had much less bearing on our conclusion that snow is obligatory than the fact that <u>every</u> den that has ever been verified has been associated with snow. While Dr. Magoun is quick to point out in her Attachment A that a number of lactating females in Canada and Scandinavia have been found present outside the snow model, <u>she never once suggests that these females actually denned in the absence of snow</u>.

The snow model bounds wolverine denning habitat at an accuracy of 98% and year-around habitat at an accuracy of nearly 90%, on a world-wide scale; and it does so as a single variable model! In our current state of science, which highly values parsimony, this is a phenomenal result. It is probably providing exactly what Dr. Magoun would want; she just does not understand the process. Additionally, the scientific process is about developing fundamentals and then building on those. Certainly, there are other important factors influencing wolverine distribution. The fact that Dr. Magoun can find a very few instances where she believes the model does not fit does not invalidate the model by any means. The true test of the validity of the question regarding whether or not snow is obligatory for wolverine denning is to simply ask whether or not a wolverine den occurred in the snow, rather than in the model. The 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.

The point here is that wolverines do not den in the absence of snow. The model is an attempt to diagram where snow of a depth adequate to cover a den might occur. Certainly, it misses in a few areas – her Ontario den and several dens in Scandinavia were noted in the paper. We asked the coauthors in all those cases if the dens were structured in the absence of snow or was it likely that the dens occurred in places that were patchy snow which was simply classified as non-snow by the model. In all cases the coauthors confirmed that indeed, the dens were snow-structured.

Science is all about measuring variability, and attempting to capture that variability such that we can begin to generalize about some characteristic of an organism. In regards to the wolverines tendency for den site choice in its relationship to snow, to date we have seen no variability – none whatsoever. Should a wolverine view a non-snow denning site as an acceptable alternative to a snow den we should have detected such after analyzing a sample of over 600 den sites. As such, I would argue that our conclusion as to the obligate nature of snow (not the snow model) to the wolverine is valid.

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