NELSON INSTITUTE FOR Environmental Studies
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Dr. Jennifer Price Tack
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Dear Jennifer,
We're writing with a concern about the interpretation of the Adams et al. 2008 [1] model and a recommendation for how it should be used to guide future decisions about wolf hunting seasons and quotas.

Following the 22 June 2021 Wolf Harvest Advisory Committee Meeting in which the issue of the independent variable (x-axis of observed mortality) was discussed, we're hoping to have an open and transparent discussion with you about that variable.

Herein, we present evidence that Adams et al. 2008 only used scientifically measured mortality rates. Moreover, the phrase "observed mortality" should not be interpreted as "reported mortality" or "wolves found dead" because neither Adams et al. 2008 nor the rest of the wolf mortality literature is consistent with that interpretation. Rather the x axis of the Adams et al. 2008 model should be interpreted as "scientifically measured mortality" using rate estimates based on marked wolves.

Our evidence for the above statements comes from reading not just Adams et al. 2008 but also the other peer-reviewed, published studies that attempted the same or similar modeling from Fuller et al. 2003 [2] to Creel and Rotella 2010 [3,4] and Vucetich 2012 [5].

The Adams et al. 2008 model is based on a variety of underlying independent studies done with diverse methods for estimating human-caused mortality, which should each be considered in their own right. Adams et al. 2008 Table 7 presents values from 41 studies, and there is a footnote stating, "[a] Only natural mortality rates based on radio telemetry are provided." This might lead one to presume the other column of mortality rates headed by "Human-caused" represents all records of mortality, but we are dubious that interpretation of human-caused mortality in Adams et al. 2008 Table 7 is correct for several reasons. First, Adams et al. 2008's analysis of their own data from Alaska reported an annual rate of 0.12 human-caused mortality based only on 47 radio-collared wolves, "Twenty of the 50 radiocollared wolves died during our study; an additional 3 wolves were censored ….annual survival rate for wolves ≥1 year old was 0.791 (95% CI 0.714–0.877)." (p.11-12). On p.12 they state, "we estimated a total population-wide harvest rate of 0.116 annually.", after combining the adult and pup harvest rates. Therefore, Adams et al. 2008 did NOT include another 181 additional human-hunted wolves that Adams et al. 2008 acquired and described starting on p.14 of their paper (which one might claim were "observed"). Second, the figure 19 in which Adams et al. 2008 presented their model has an x axis of "Annual human-caused mortality" and the caption reads "Figure 19. Relationship between exponential rate of increase (r) and annual human-caused mortality rates from wolf studies in North America..." not "observed mortality". Finally, several other studies in Table 7 of Adams et al. 2008 were reporting only radio-collared wolves, not all recovered carcasses.

Discussions in other models of sustainable wolf-killing illuminate how Adams et al. 2008 and others use scientifically measured annual mortality rate not "observed mortality". Fuller 1989 [6] and Fuller et al. 2003 discuss the challenges of measuring human-caused mortality accurately and precisely (also see Treves et al. 2017a for a correction to traditional methods [7] and how it applies to Wisconsin in Treves et al. 2017b [8]). Also, Vucetich 2012 discusses the uncertainty and errors in modeling with that variable of annual mortality rate, leading him to recommend a very different regression technique than that used by all other authors. Creel and Rotella 2010 follow Fuller et al. 2003 and Adams et al. 2008 in modeling approach but evaluate the compensatory or super-additive effects of human-caused mortality, a feature of undetected wolf mortality that is not addressed in Adams et al. 2008. Creel and Rotella 2010 also contradict Adams et al. 2008 on the claim that below 29% human-caused mortality, wolf populations do not show slow-downs in population growth. Creel and Rotella 2010 instead find that population growth slows at any level of human-caused mortality. If these authors and the underlying studies they all used had been meaning "observed mortality" to mean those wolves found dead, their modeling efforts and discussions would have addressed search effort and detection probability, which they hardly touched upon. We believe they did not address search effort and detection probability because scientifically measured mortality is usually estimated from marked animals (not all found dead) so that the denominator for rate of mortality is the marked animals not the total population.

If "observed mortality" were in fact all wolves found dead, the search effort and detectability of those carcasses would introduce a massive bias and uncertainty about how closely the found carcass rate matched the real rate. In 2014, several scientists shared this concern with Dr. David Macfarland about how the WDNR was measuring total mortality in http://faculty.nelson.wisc.edu/treves/reports/Letter%20to%20USFWS/2014_Letters-to-USFWS.zip). He seemed to share the same understanding of our concerns, yet the same problem resurfaced in 2021. We mention this only to close the loop on a long-standing scientific issue which we hope you will engage on with us. If the WDNR decides to use "observed mortality" it has to grapple with detection probability, search effort, and other biases discussed in the literature below, before it can justify using its assumed mortality rate to set a quota.

For the reasons above, we recommend either (1) that only marked animals be used to calculate the rate of deaths and disappearances including radios/GPS transmitters that stopped transmitting (as we have done since Treves et al. 2017a) and take into account time on the air (Santiago-Ávila et al. 2020), or (2) both marked and unmarked wolves be considered with a non-detection correction factor used to correct estimates of mortality for unmarked animals as we have also done since Treves et al. 2017b. Our approach is also consistent with past work (Stenglein et al. 2015 [9]) thus meeting the standards of transparency, reproducibility, independent review, and consistency over time. Our recommendation would also follow recent individual-level survival analyses (Santiago-Ávila et al. 2020; Louchouarn et al. 2021 [10,11]) that estimate mortality rate by individual monitoring time and take into account changes in mortality rate with policy, season, monitoring method, etc., thus meeting the standard of using the latest, best available science.

All of the studies mentioned in the above paragraph estimate higher mortality rates than the 14% espoused during the 22 June meeting. Although those studies covered a different span of years, it seems unlikely that the mortality rate has declined at the same time as the annual population growth rate has also declined. Therefore, we also call your attention to the multiple, independent datasets pointing in similar directions that the DNR is under-estimating poaching and total mortality, inaccurately modeling wolf population dynamics, and ignoring social scientific research warning of increased poaching now that wolves are delisted [12-16]. Moreover, suggestions from Nordic countries that liberalized wolf-hunting

reduces poaching do not provide reliable evidence for the discredited notion that "blood buys goodwill" (Chapron & Treves 2016a,b, 2017a,b; Treves et al. 2020; Santiago-Ávila et al. 2020 [17-20] [21,22]). We're happy to discuss that debate with you if the DNR proposes that poaching will decline in 2021 when compared to 2017-2020; the weight of the evidence suggests otherwise.

In any case, we recommend the method for estimating human-caused mortality rate for input into any model should be updated to align with the latest science. Because Fuller et al. 2003, Creel and Rotella 2010, and Vucetich 2012 all predict a lower rate of human-caused mortality would be sustainable and find super-additive mortality or nonlinear depensatory mortality with increasing rates of human-caused mortality, we caution that using the Adams et al. 2008 threshold of 28-29% would increase the risk of unsustainable killing and would jeopardize the DNR's stated goal of stabilizing the wolf population at current levels.

Sincerely,

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