Science Review

April 14, 2015
Letter to Oregon Department of Fish and Wildlife
From Scientists on Wolf Recovery

We, the undersigned scientists, are writing to express our concern that now is not the time to delist the gray wolf in Oregon. Continued state Endangered Species Act (ESA) protections are essential for allowing existing populations to stabilize and expand into other suitable habitat. Milestones should be celebrated, but meaningful recovery is not complete in significant portions of suitable habitat in the state. Prematurely weakening gray wolf protections is likely to reverse years of progress, put recovery in jeopardy, and exacerbate conflict.[i] [ii] [iii]

We urge ODFW to:

Maintain ESA status for gray wolves and foster coexistence by getting ahead of – rather than reacting to – conflict. Some suggestions for doing this are to:

- *Focus on positive aspects of wolf recovery, native predators, and healthy landscapes*
- *Conduct and facilitate research regarding wolves and conflict deterrence measures and*
- *Provide landowners with information that will assist in reducing potential conflicts*

Like all native wildlife, wolves are an enormous asset to the biological diversity of our state, ecosystem services, and quality of life. Wolf recovery is overwhelmingly supported by Oregonians. After years of making excellent progress toward recovery, it would be a shame to stop before the final goal is accomplished.

We offer our expertise and support for such an effort and extend our thanks to you for your leadership on wildlife conservation issues.

Signed:

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[i] Tad Larsen and William J. Ripple, "Modeling Gray Wolf (Canis lupus) habitat in the Pacific Northwest, U.S.A," *Journal of Conservation Planning* Vol 2 (2006) 17-33.

[ii] Oregon Department of Fish and Wildlife," Oregon Wolf Population," http://dfw.state.or.us/Wolves/population.asp, (January 27, 2015)

[iii] Carroll, C., R.F. Noss, N.H. Schumaker, and P.C. Paquet. 2001. "Is the return of the wolf, wolverine, and grizzly bear to Oregon and California biologically feasible?" Pages 25-46 in D.S. Maehr, R.F. Noss, and J.L. Larkin, editors. Large Mammal Restoration: Ecological and Sociological Challenges in the 21st Century. Island Press, Washington, DC.

To the Oregon Fish and Wildlife Commission:

I am submitting these comments regarding the ODFW gray wolf biological status review (ODFW 2015). I am a professional quantitative ecologist and principal scientist with the Wild Nature Institute. I have a Bachelor's degree in Anthropology from University of California, Santa Barbara, a Master's degree in Wildlife Natural Resource Management from Humboldt State University, and a PhD in Biological Sciences from Dartmouth College. I am an expert population biologist who has co-authored two population viability analyses (PVA) for the U.S. Fish and Wildlife Service:

1. N. Nur, R.W. Bradley, D.E. Lee, P.M. Warzybok, and J. Jahncke. 2013. Population Viability Analysis of Western Gulls on the Farallon Islands in relation to potential mortality due to proposed house mouse eradication. Report to the National Fish and Wildlife Foundation and the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California.
2. N. Nur, D.E. Lee, R.W. Bradley, P.M. Warzybok, and J. Jahncke. 2011. Population Viability Analysis of Cassin's Auklets on the Farallon Islands in relation to environmental variability and management actions. Report to the National Fish and Wildlife Foundation and the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California.

I co-authored a comprehensive review of demography and population dynamic models (including PVA) that was part of the California Current Seabird Management Plan for U.S. Fish and Wildlife Service:

N. Nur and D. E. Lee. 2003. Demography and Population Dynamic Models as a Cornerstone of Seabird Conservation and Management in the California Current. *in* California Current System Seabird Conservation Plan (eds. W.J. Sydeman, K.

Mills and P. Hodum). Report to the US Fish and Wildlife Service. PRBO Conservation Science, Stinson Beach, California.

Eight, relevant, peer-reviewed scientific articles that I have had published from my research include the following:

1. D.E. Lee, J. Bettaso, M.L. Bond, R.W. Bradley, J. Tietz, and P.M. Warzybok. 2012. Growth, age at maturity, and age-specific survival of the Arboreal Salamander (*Aneides lugubris*) on Southeast Farallon Island, California. Journal of Herpetology 46:64-71.

2. D.E. Lee, R.W. Bradley, and P.M. Warzybok. 2012. Recruitment of Cassin's Auklet (*Ptychoramphus aleuticus*): Individual age and parental age effects. Auk 129:1-9.

3. D.E. Lee. 2011. Effects of environmental variability and breeding experience on Northern Elephant Seal demography. Journal of Mammalogy 92:517-526.

4. A.C. Brown, D.E. Lee, R.W. Bradley, and S. Anderson. 2010. Dynamics of White Shark predation on pinnipeds in California: effects of prey abundance. Copeia 2010 No. 2:232-238.

5. D.E. Lee and W.J. Sydeman. 2009. North Pacific climate mediates offspring sex ratios in Northern Elephant Seals. Journal of Mammalogy 90:1-8.

6. D.E. Lee, C. Abraham, P.M. Warzybok, R.W. Bradley and W. J. Sydeman. 2008. Age-specific survival, breeding success, and recruitment in Common Murres (*Uria aalge*) of the California Current System. Auk 125:316-325.

7. D.E. Lee, N. Nur, and W.J. Sydeman. 2007. Climate and demography of the planktivorous Cassin's Auklet *Ptychoramphus aleuticus* off northern California: implications for population change. Journal of Animal Ecology 76: 337–347.

8. S.F. Railsback, B.C. Harvey, R.R. Lamberson, D.E. Lee, N.J. Claasen, and S. Yoshihara. 2001. Population-level analysis and validation of an individual-based Cutthroat Trout model. Natural Resource Modeling 15:83-110.

I have also acted as an independent consultant offering expert advice on questions of population management and population viability for management authorities and stakeholders involved in the multi-national Action Plan under the Agreement on the Conservation of Albatrosses and Petrels.

As part of my PhD work at Dartmouth College, I conducted a PVA to explore metapopulation dynamics of giraffe in a fragmented ecosystem in Tanzania:

D.E. Lee. 2015. Demography of Giraffe in the Fragmented Tarangire Ecosystem. PhD Dissertation. Dartmouth College.

My expertise has mostly focused on seabirds and other marine predators, in addition to giraffe, but the mathematics and the biological concepts relevant to PVA are universal and well-established. The universality of the concepts is apparent in the variety of taxa population biologists like me are able to apply our expertise to. For example, my work has encompassed taxa as diverse as cutthroat trout, woodrats, mice, seabirds, seals, salamanders, spotted owls, and giraffes.

I have examined the Oregon wolf PVA and found that details of the model's construction are vague or confused about fundamental aspects of the model, and some outputs seem to disagree with conclusions in the text. The model includes many relevant factors important to wolf population dynamics, but excludes or underestimates others such that I believe that the PVA as it was used is too simplistic and lacks sufficient detail of important demographic processes to realistically estimate probabilities of " conservation failure" or "biological extinction" over time.

It is my expert opinion that the existing PVA is fundamentally flawed and does not provide an adequate or realistic assessment of the Oregon wolf population to meet Criterion 1 or 2 or 4, therefore the delisting requirements are not supported by the results of the PVA as it was performed.

My primary concerns with the Oregon wolf PVA are:

1. The base model seems to produce unrealistically stable and high population growth.
2. Density-dependent survival and reproduction are not included.
3. Dispersal and territory establishment are poorly modeled.
4. Environmental and Demographic stochasticity were not explained clearly enough to convince me that the model was properly constructed.
5. Environmental stochasticity was poorly modeled.
6. Impacts of human-caused mortality were downplayed.
7. Sensitivity analyses were insufficient.

1) The **base model seems to produce unrealistically stable and high population growth**. Perhaps due to unrealistically high estimates of vital rates, or due to unrealistic levels of vital rate variability or covariances of vital rate variability (see below), the population growth rate of the base model is unrealistically high and stable. Page 16 of Appendix B says, "Using our baseline model, simulated wolf populations increased an average of 7% ($\lambda = 1.07 \pm 0.17$ SD) per year." This high growth rate (λ = finite rate of population growth) and its variation are comparable to recent estimates from three populations of wolves over 10 years in the northern Rocky Mountains (Gude et al. 2011). However, a recent meta-analysis of three protected and circumscribed populations monitored over 28–56 years showed population growth rates were very close to $\lambda = 1.0$, with much greater variation (SD = 0.33 to 0.51) than the Oregon wolf

PVA described (Mech and Fieberg 2015). A summary in Fuller et al. (2003) of 19 exploited (hunted) wolf populations monitored for 2–9 years described the average finite population growth rate as $\lambda = 0.995 \pm 0.21$ SD. This leads me to believe that the Oregon wolf PVA underestimated the risk of conservation failure and biological extinction due to structural issues in the model, or due to underestimates of variability or covariation in vital rates.

2) Density dependence in survival, reproduction, and dispersal success should have been included in the model structure. What the PVA authors called density dependence was actually a simply calculated carrying capacity, or theoretical maximum wolf population size, given the current elk population, but was not in any way a realistic modeling of density dependent effects on the growing wolf population. Furthermore, wolf carrying capacity was computed in the PVA using summer elk range, when winter range, the period of greatest food limitation and the greatest limitation on elk spatial distribution, is the more realistic and conservative period during which to estimate carrying capacity.

True **density-dependent** effects would have recognized the documented cumulative effects of an increasing or decreasing wolf population on vital rates of survival, reproduction, and dispersal and territory establishment. It has long been known that intraspecific competition related to territoriality seems to regulate wolf density below that predicted by food availability (Stenlund 1955; Pimlott 1967, 1970; Cariappa et al. 2011). Without true density dependence in vital rates, the Oregon wolf PVA assumes wolf vital rates are the same whether wolf habitat is nearly empty of wolves, or when wolves have nearly filled all the habitat. That true density dependence affects wolf populations was well demonstrated in Cubaynes et al. (2014) where adult survival decreased as wolf density increased, independent of prey density in the area (see

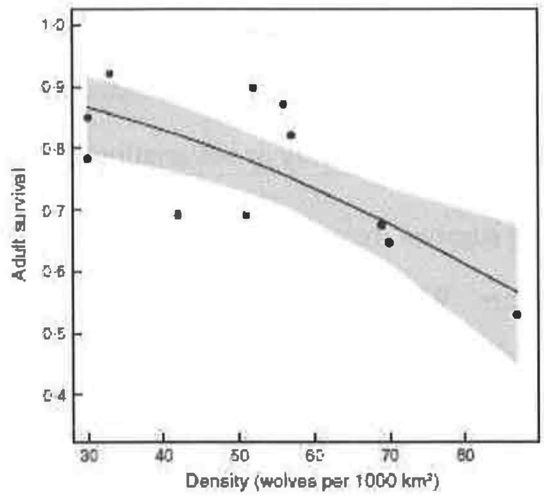

Fig. 3. Annual survival rates of adult wolves in the Northern Range as a function of wolf density in April. The intercept and slope were obtained from a model in which adult survival was modelled as a function of wolf density in April (Model 23), the zone filled with grey represent 95% confidence. Points represent mean survival estimates obtained from a model in which survival was time-dependent (Model 29).

Fig. 3 from Cubaynes et al. 2014, depicted here).

3) Dispersal and territory establishment should have been modeled as a spatially explicit process using a similar spatial simulation as was used for emigration, combined with the habitat model supplied in Appendix A. The PVA uses simple probabilistic rates of dispersal and successful territory establishment. This is unrealistic given that wolves occupy exclusive, defended territories in explicit spatial arrangements, so new territories cannot be established where one already exists (Fuller et al. 2003). This relates also to the unrealistic density dependence mentioned above. Also, wolves dispersing through non-habitat will not have the same survival as wolves dispersing through suitable wolf habitat. A more realistic dispersal process would use the existing wolf habitat map and established wolf territories, keep track of additional territories as the PVA simulation progresses, and when a dispersing individual ends up in an occupied area, it must disperse again until it ends up out of the state, or in unoccupied habitat. Additionally, when wolves are travelling through non-habitat, their survival rates should be lowered to reflect this reality. Human-caused mortality also should be increased when wolves dispersed through non-habitat. Finally, dispersal and territory establishment should have included an environmental stochasticity component.

4) Environmental and demographic stochasticity are two of the most important aspects of population viability analyses, but environmental and demographic stochasticity were poorly described, and even the authors of the Oregon wolf PVA seem confused about this topic.

Appendix B states, "We incorporated environmental stochasticity in our model by randomly drawing vital rate values from a uniform distribution with a predefined mean and standard deviation at each time step of the simulation." What this describes is not environmental stochasticity, this is **demographic stochasticity**, as is stated in the next sentence of Appendix B, "...vital rates were applied at an individual level, which inherently incorporated demographic stochasticity into our model." This confusion over demographic and environmental stochasticity is very disturbing. Nevertheless, we can establish that some level of individual demographic stochasticity is included in the model, but the authors of the PVA are unclear about the details. Drawing from a uniform distribution means all values between the lower and upper boundaries are equally likely to be selected. The authors say the values for vital rates were "from a uniform distribution with a predefined mean and standard deviation", but this is somewhat nonsensical. What I think they mean is that they drew from a uniform distribution where the interval's lower and upper boundaries were defined by the estimate of the vital rate's mean, plus and minus 2 SD, however in Table 1 they say," Values used at each time step of the analysis were randomly drawn from a uniform distribution within the specified standard deviation (SD)." So I am confused about a fundamental aspect of the PVA's construction regarding demographic stochasticity. This is a critical point as defining the uniform distribution as the vital rate's mean ± 1SD would make demographic stochasticity much less than if the uniform distribution's interval was defined as the vital rate's mean ± 2SD.

5) The effects of **environmental stochasticity** are included in the model as two 'catastrophes,' and a prey multiplier effect. The first catastrophe resulted in complete reproductive failure for that year at the pack level to simulate diseases such as canine parovirus, and occurred with an annual probability of 0.05. The second catastrophe was modeled at the population level "to represent extremely rare, range wide events that may affect wolf populations (e.g., disease, abiotic conditions, prey population crashes)," that occurred with a probability of 0.01 and resulted in a population-wide reduction in survival of 25%. These sorts of catastrophe are indeed useful to include because rare phenomena with large demographic effects are real and often have significant effects on populations. Indeed, in the PVA as constructed, these catastrophes were important effects during early years of the simulations, before population size was large enough to be resilient to catastrophes.

Unfortunately, catastrophes are not realistic proxies for true **environmental stochasticity** in abiotic conditions or prey availability that are typically due to stochastic annual variation in weather patterns. True environmental stochasticity would recognize that all wolf vital rates of age-class specific survival and reproduction usually co-vary among years because they are all correlated with certain weather phenomenon (such as extremely cold, wet winters) either directly, or indirectly through the weather's effects on prey species. Environmental stochasticity should have been modeled as a population-wide, or climate zone region-wide effect whereby all demographic parameters rise or fall together according to either a documented relationship between weather and vital rates, or a relationship between weather and prey species that indirectly affects wolf demographic vital rates.

The Oregon wolf PVA did include a prey multiplier effect (page 12) as environmental stochasticity, where, "Each year of the simulation, the prey multiplier had a 1 out of 3 chance of increasing, decreasing, or remaining the same, respectively. In years the prey multiplier increased or decreased, the maximum change was restricted to 0.10." However, this effect seems too small, or perhaps too limited by not affecting reproduction and dispersal, to realistically simulate true environmental variation.

Several studies have documented that the wolf populations are regulated by food, as a function of prey abundance and their vulnerability to predation (Packard and Mech 1980; Keith 1983; Peterson and Page 1988; Fuller et al. 2003). Because prey condition is highly dependent on weather conditions (Mech and Peterson 2003), wolf demography is also dependent on weather (Fuller et al. 2003). "In Denali National Park, Alaska, where humans also have little effect on the wolf population, the trend in wolf numbers from 1986 through 1994 … was driven by snow depth, which influenced caribou vulnerability (Mech et al. 1998)… As snow depth and caribou vulnerability increased, adult female wolf weights also increased, followed by increased pup production and survival and decreased dispersal (Mech et al. 1998)… In the east central Superior National Forest of Minnesota…from about 1966 to 1983, the wolf population trend followed that of the white-tailed deer herd, which was related to winter snow depth. Thus snow was seen as the driving force in the wolf-deer system (Mech 1990)." From Fuller et al. (2003). In Isle Royale National Park, wolf population growth depended mainly on the number and age structure of the prey population, although density dependence, winter severity, and catastrophic events like disease outbreaks also play important roles (Peterson and Page 1988; Peterson et al. 1998; Vucetich and Peterson 2004).

6) Human-caused mortality impacts were significant, but conclusions downplayed the effect of human-caused mortality. The section on lethal control (page 26, Appendix B) addressed the issue of legal and illegal human-caused mortality, and concluded that reasonable levels of human-caused mortality could result in conservation failure and/or biological extinction. Probability of conservation-failure increased to 0.40 and 1.00, for mean human-caused mortality rates of 0.15 and 0.25, respectively. These results highlight the importance of anthropogenic mortality to population viability of wolves. Probability of biological-extinction was relatively low for all simulations with mean human-caused mortality rates ≤ 0.15.

Additionally, human-caused mortality is likely to increase as the wolf population increases, possibly leading to additional density-dependent mortality. Illegal human-caused mortality has been recorded as 30–34% of total mortality (Liberg et al. 2012; Board 2012).

Oregon Legislative Assembly changed the status of wolves to "special status game mammal" under ORS 496.004 (9). Under this classification, and when in Phase III of the Wolf Plan, controlled take of wolves would be permitted as a management response tool to assist ODFW in its wildlife management efforts. This rule would effectively allow the legal killing of all wolves in excess of the conservation objective of 4 breeding pairs. Reducing the population to such a low number would undeniably result in the impairment of wolf viability in the region. A PVA scenario should be run to quantify the probability of conservation failure and extirpation under this legally permitted management action.

7) The **sensitivity analyses** was simplistic and insufficient in my opinion to characterize true sensitivity of demographic parameters under different scenarios of management and environmental conditions. The PVA was supposed to focus on "determining effects of key biological processes, uncertainty in model parameters, and management actions on wolf population dynamics and viability." I recommend a more detailed and systematic sensitivity analysis where specific parameters are individually varied ± 5, 10, and 15% to determine their impact on population growth rate. Additionally, I recommend that after the model structure and parameter values and variation has been corrected as I suggested above, several realistic management and ecological scenarios be explicitly examined to document realistic probabilities of conservation failure and biological extinction.

Sincerely,

Derek E. Lee

Principal Scientist

Wild Nature Institute

PO Box 165, Hanover, NH 03755

October 25, 2015

Oregon Department of Fish and Wildlife Commission
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Chair Finley and Commissioners:

My name is Robert Beschta, I am emeritus professor in the Department of Forest Ecosystems and Society at Oregon State University (professional affiliation provided for informational purposes only). For more than four decades I have participated in research, teaching, and extension activities assessing the effects of land use practices on watersheds and plant communities. Much of that effort was in Oregon but more recently I have done research in Yellowstone National Park and other areas of the American West.

When wolves were extirpated from Yellowstone National Park, increased herbivory by elk soon began to impact plant communities. Over time, and over a wide range of elk densities, the park's aspen, willow, cottonwood, alder, and a wide range of berry-producing shrubs were less able to establish and grow above the browse level of elk; tall forbs and native grasses were also impacted. As a consequence, streams eroded and incised, riparian habitat for birds and other wildlife became limited, and beaver disappeared.

After seven decades of absence, wolves were returned to the park in the mid-1990s thus completing the wild predator guild. With the return of this apex predator, changes to previously browsing-suppressed plant communities began to occur. Initially these effects were small and local but over time the effects have become more widespread. Increasingly aspen and riparian plant communities have become more robust, increasingly plants are growing above the browse level of elk, stream banks are stabilizing, more birds have habitat, and beaver are returning. These effects did not happen overnight, but have become more pronounced over the last several years. It is important to note that Yellowstone is not a unique, stand-alone experiment. Improving plant communities have also been observed in other areas of western North America where formerly extirpated wolves have returned.

Like Yellowstone, wolves were extirpated from Oregon and were absent over many decades. Elk numbers, which had been reduced to only a few thousand in the early 1900s have since increased greatly and in 2011 Oregon's total elk numbers were 3rd highest of 11 western states (based on estimates of the Rocky Mountain Elk Foundation). And, like Yellowstone, wolves have returned.

Oregon's wolf conservation and management plan indicates "Wolves need to be managed in concert with other species and resource plans." Most people would likely assume "other species" simply means elk. I would strongly suggest that we need to look deeper.

Deciduous woody plant communities on public lands in eastern Oregon, plant communities such as those associated with aspen and riparian areas, have experienced major declines over much of the 20th century with adverse consequences to terrestrial wildlife species as well as aquatic species, such as salmon. While outmoded livestock practices have been a major reason for this decline, herbivory by wild ungulates, principally elk, is now a significant factor in many areas and may limit recovery of degraded plant communities even if livestock impacts are minimized.

Whether the positive ecosystem effects found in Yellowstone and other areas following the return of wolves will occur in Oregon is not yet known. However, if wolves are going to be a factor in the recovery of degraded aspen stands and riparian plant communities on public lands in eastern Oregon, I would strongly indicate that delisting this keystone species is a move in the wrong direction.

Sincerely,

Robert L. Beschta

Robert L. Beschta, PhD

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October 27, 2015

Dear Commissioners,

Soon the Commission will decide whether to remove wolves from the Oregon state list of endangered species. For reasons outlined below, we urge the Commission to refrain from removing wolves from Oregon's endangered species list at this time.

Because Oregon state law requires delisting decisions be based on the best-available science, the Oregon Department of Fish and Wildlife has made a concerted effort to perform scientific analyses to evaluate the appropriateness of removing wolves from Oregon's endangered species list. That analysis is reported in a document entitled, *Updated biological status review for the Gray Wolf (Canis lupus) in Oregon and evaluation of criteria to remove the Gray Wolf from the List of Endangered Species under the Oregon Endangered Species Act*. Hereafter we refer to that document as ODFW (2015).

While the analyses described in ODFW (2015) are important, those analyses are also, by themselves, an insufficient application of best-available science. A sufficient application of best-available science also requires analyses, like those reported in ODFW (2015), to be adequately vetted by the scientific community through an independent review process. To our knowledge, that vetting has not to have taken place. In particular, we are especially concerned that the extinction risk analysis and its interpretation has not been adequately vetted.

This scientific vetting is especially critical because discourse arguing for state delisting is enabled only because the U.S. Congress removed wolves from the federal list of protected species in 2011. But delisting action was based entirely and overtly on political circumstances, not best-available science. That circumstance heightens the need for Oregon to offer due diligence with respect to best-available science, where the federal government has failed.

ODFW (2015) includes analyses which strongly suggests that wolves should remain listed at this time. In particular, ODFW (2015) indicates

1) that Oregon has 106,853 km^2 of currently suitable range for wolves. That is, range with sufficient prey and habitat where wolf-human conflicts are relatively minimal (as indicated by road density and land uses such as agriculture and developed areas).
2) wolves currently occupy about 12,582 km^2.

ODFW (2015) also implies that former range of wolves (i.e., range occupied before humans drove wolves to an endangered status) would have been greater than the current suitable range.

To summarize, ODFW (2015) indicates that wolves in Oregon currently occupy *less than* 12% of their former range and only about 12% of current suitable range. Comparing that circumstance conditions with Oregon's Endangered Species Act provides important context for informing Oregon's listing judgment. In particular, the Act states that an endangered species is one that is "...in danger of extinction throughout any significant portion of its range within this state." By that standard wolves are endangered because the species remains extirpated from nearly 90% of its currently suitable range (and extirpated from an even greater proportion of the range that wolves occupied before human persecution).

Oregon state law does not require wolves to occupy all of their former range. Oregon state law does not even require wolves to occupy all of the currently suitable range. However, it is untenable to think that being extirpated from nearly 90% of current suitable range (a subset of former range) would qualify the species for delisting.

This comparison between the language of Oregon's law and wolves' circumstance in Oregon is robustly supported by considerable scholarship and judicial opinion. Some of that peer-reviewed scholarship and judicial opinion is presented in Vucetich et al. (2006); Tadano (2007); Enzler & Bruskotter (2009); Geenwald (2009); Kamel (2010); Carroll et al. (2010), Bruskotter et al. (2013). If the Commission would be interested in a more detailed account of this scholarship for itself or its constituents, we would happily provide such an account upon request.

We fully understand that wolves can be a challenging species to manage. And we appreciate that delisting may seem a solution to that challenge. However, two very important considerations suggest otherwise. *First*, Oregon already has many tools for managing wolf-human conflicts. Vigilant and judicious use of those tools is the key to effectively managing wolf-human conflicts. That much is clearly demonstrated by the good work of the Commission and ODFW. However, it is difficult to envision how wolf-human conflicts would be more effectively managed as a result of premature delisting.

Second, the consequences of acting in haste or inconsistently with principles outlined here increase the risk that other decisions pertaining to delisting and natural resource management in general would be made out of political convenience rather than principle of law and science.

For these reasons, we urge you to refrain from removing wolves from Oregon's list endangered species at this time.

Sincerely,
John A. Vucetich, Professor of Wildlife, Michigan Technological University

Jeremy T. Bruskotter, Associate Professor, School of Environment and Natural Resources, The Ohio State University

Michael Paul Nelson, Ruth H. Spaniol Chair of Renewable Resources and Professor of Environmental Ethics and Philosophy, Oregon State University

References

Bruskotter, J. T., Vucetich, J. A., Enzler, S., Treves, A., & Nelson, M. P. (2014). Removing protections for wolves and the future of the US Endangered Species Act (1973). *Conservation Letters*, *7*(4), 401-407.

Carroll, C., Vucetich, J.A., Nelson, M.P., Rohlf, D.J. & Phillips, M.K. (2010) Geography and recovery under the US Endangered Species Act. Conserv. Biol. 24, 395-403.

Enzler, S.A. & Bruskotter, J.T. (2009) Contested definitions of endangered species: the controversy regarding how to interpret the phrase "A Significant Portion a Species' Range". Virginia Environ. Law J. 27, 1-65.

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28 October 2015

To the Oregon Fish and Wildlife Commission:

The following comments relate to the proposal to delist gray wolves in Oregon, entitled "Updated biological status review for the Gray Wolf (Canis lupus) in Oregon and evaluation of criteria to remove the Gray Wolf from the List of Endangered Species under the Oregon Endangered Species Act (Oregon Department of Fish and Wildlife (ODFW), October 9, 2015)" hereafter "ODFW Review 2015".

I have been studying wolf-human interactions for 16 years and ecology generally for >25 years. I've published >50 scientific articles on ecology, conservation and human dimensions. **My lab group is the only one in the world to have measured changes in individual humans' tolerance for wolves over time and attitudes under changing policies on lethal management and delisting.** We have also studied poaching (illegal take) iin several peer-reviewed scientific publications. More information about my lab and our work on wolves can be found on our webpage: http://faculty.nelson.wisc.edu/treves/.

My comments address human tolerance for wolves, illegal take, and the public trust. I restrict my comment to two points:

(1) Oregon's delisting criteria have not been met,
and
(2) The main threat to wolf population viability is not adequately understood by any state or federal agency yet, therefore the expected benefits of delisting are unlikely to manifest and the likely costs are not well addressed by current regulatory mechanisms.

By Oregon law ORS 496.17, state delisting can occur if all of five conditions are met. I address the first and fifth here.

1. The species is not now (and is not likely in the foreseeable future to be) in danger of extinction in any significant portion of its range in Oregon or in danger of becoming endangered; and

5. Existing state or federal programs or regulations are adequate to protect the species and its habitat.

Comment 1. **The criteria for state delisting have not been met.**

The phrase "**The species is not now... in danger of extinction in any significant portion of its range in Oregon**" has two implications. The first relates to historic range and the second to not being endangered.

The historic range of the wolf in Oregon was the entire state (*1*) as the ODFW Report 2015 correctly noted and visible in Appendix A for map of historic range in the U.S. Habitat suitability analyses for wolves confirm that prey availability and human-caused mortality are the major factors limiting wolves from recolonizing a region, e.g., (*2*). If one limits the geographic extent considered to be wolf range to those areas where people want wolves to live, one opens the door to illegal and otherwise unacceptable human-caused mortality determining where wolves can live. The legal and biological flaws in this line of thinking have been described and rejected for federal delisting of the gray wolf (*3*). In simple terms, the ODFW **should not define wolf range based on interest group anger or some unquantified social acceptance, because that opens the door to a form of extortion by intolerant communities**, "We'll kill wolves that move here." Threats posed by people are something to combat.

Instead available range should be defined by the biological capacity of wolves to find what they need to reproduce in an area and the acceptable recolonization might be determined by legal standards (see below).

With this biological logic in mind, the gray wolf is currently present in less than 6% of the state's land area now (ODFW Review 2015), approximately equivalent to Douglas County, OR. Now imagine if the 3% of Oregon's human population in Douglas County were the only ones to benefit from the presence of an endangered species (e.g., Washington Ground Squirrel or Lower Columbia River Coho Salmon). Wouldn't other counties' residents demand access without extreme efforts? Currently, too few citizens have access to the benefits generated by wolves in Oregon, which include aesthetic, ecological, and uses that deplete the asset (if that depletion leaves the asset unimpaired). Furthermore, future generations of Oregonians have a right to those benefits also. That point is emphasized by the case law upholding the public trust doctrine in Oregon. Wildlife belongs to all state citizens by Oregon law as a trust asset [1]. That trust obligation limits the allocation of assets such as wildlife to private interests, e.g., livestock producers demanding lethal control of wolves (*1*). That trust obligation also curbs the eagerness of administrative agencies to allocate assets,

> "In *Morse v. Department of State Lands,*[2] the 1979 Oregon Supreme Court remanded the director's decision to issue a permit authorizing a fill for an airport runway extension because he failed to determine whether the public need for the project outweighed damage to public use of trust resources..." (p. 686, section 6.2) in (*4*)

Therefore I recommend the Commission consider all current citizens and the rights of future generations for whom the trust is held.

I recommend that 'a significant portion of range' be interpreted so as to defend against litigation. **I recommend 'a significant portion of range' be defined as one of the following geographic extents: at least one breeding pair in every county or breeding pairs in a majority of counties.**

Furthermore, the current population size of wolves in Oregon "As of July 2015, there were 16 known groups or packs of wolves containing a male-female pair (Table 2), and the mid-year minimum population (non-pup) was 85 wolves." (ODFW Review 2015). A recent illegal shooting has probably lowered that number while emphasizing the role of negligent hunters in illegal take (http://www.statesmanjournal.com/story/news/2015/10/19/man-shot-and-killed-wolf-could-face-charges/74223524/). At a population size <85, the addition of a few extra wolf deaths in a year can stop

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[1] State v. McGuire, 33 P. 666 (Or. 1883)

[2] *Morse*, 590 P.2d at 715; After *Morse*, the Oregon legislature amended the Submerged and Submersible Lands Act to require the director to find that the "public need" for the project outweighs harm to public rights of navigation, fishery, and recreation. OR. REV. STAT § 196.825(3) ("The director may issue a permit for a project that results in a substantial fill in an estuary for a nonwater dependent use only if the project is for a public use and would satisfy a public need that outweighs harm to navigation, fishery and recreation and if the proposed fill meets all other criteria ... [in the Act].").

or reverse population growth. As the ODFW Review 2015 noted, wolves are highly susceptible to human causes of mortality and many of these mortalities go undetected and unreported (cryptic poaching). The ODFW Review 2015 reported illegal take was the leading cause of death among wolves in a small sample of recovered mortalities. For a quantitative example from another state, we estimated an average of 44% (SD 4%) of Wisconsin wolves aged >7.5 months died each year after delisting procedures began and the state regained intermittent authority for lethal control (*6*). **The majority of those wolf deaths went undetected and nearly half of all deaths were poached wolves. If that pattern applies after delisting in Oregon, one should expect 34–41 yearlings and adult wolves to die in the year that follows. Most will go undetected.** Overcoming such high mortality rates would require higher than average population growth seen in the Oregon population (Table 2, ODFW Review 2015). Chronic, undetected, human-caused mortality challenges the success of Oregon's wolf recovery.

Moreover hopes that delisting or state authority for lethal control will reduce poaching have been fostered by a flawed analysis (*7*), see (*1*) and (*6*) for why it is flawed. The actual conclusion should be just the opposite, namely delisting and legal culling authority increased poaching in Wisconsin[3].

In sum, the Oregon wolf population has not met the first criterion for delisting, whether measured by geographic distribution or population size.

The next comment speaks directly to the fifth requirement that, "**Existing state or federal programs or regulations are adequate to protect the species**"

Comment 2. **The main threat to wolf population viability is not adequately understood by any state or federal agency yet, therefore the expected benefits of delisting are unlikely to manifest and the likely costs are not well addressed by current regulatory mechanisms.**

The ODFW correctly identifies the major threat to wolf population viability is human tolerance manifested through illegal take (poaching) mainly, "Since human tolerance has been and remains the primary limiting factor for wolf survival, building tolerance for this species will require acceptance of the Plan's approach to addressing wolf conservation and human conflicts." (p. 3, ODFW Wolf Conservation and Management Plan, December 2005 and Updated 2010)" hereafter "ODFW Plan 2010") and same sentence on p. 34 of the ODFW Review 2015. One should expect the major threat to a listed species to be well understood and abated if delisting will succeed. Unfortunately the threat is neither **well understood nor abated currently**. Our evidence that **illegal take has not been abated** comes from the section above and data on illegal take in the past as well as the likely prospect that **illegal take is likely to increase** as we explain below. The evidence that **human tolerance is not well understood by the ODFW** comes from the ODFW Review 2015 and the ODF Plan 2010.

The ODFW Plan 2010 and ODFW Review 2015 are not up-to-date on research relating to human tolerance for wolves despite 36 instances in which those documents mentioned "tolerance" or "attitude". There are over 100 scientific, peer-reviewed articles on human attitudes to wolves (*3*), and >10 recent studies from the USA address what to expect in human tolerance for wolves after intervention or after policies change (*3, 8-16*). The ODFW Review 2015 does not cite a single one of those studies or anything by the leaders in the field, which suggests that **the ODFW has not considered the scientific evidence for the major threat to Oregon wolves**.

[3] Please contact the author for evidence to support this assertion in a report under review.

Instead, the ODFW Review 2015 cites wolf biologists who have never collected human dimensions data when making a claim about human tolerance, "There are many references which relate human tolerance to successful wolf management (Mech 1995, Bangs et al. 2004, Smith 2013)." Had the ODFW reviewed the expert scientific literature rather than biologists' opinions, they would have learned the following:

Public acceptance for lethal control has declined significantly since the 1970s and the public prefers non-lethal methods for managing wildlife. Tolerance for carnivores and inclinations to poach them are not well predicted by wealth or economic losses but rather by peer networks and social norms that foster resistance to authority and anti-establishment actions. Those inclined to poach tend to justify their actions by over-estimating how many of their neighbors and associates do so. Tolerance for bears declined when messaging was purely negative or concerns hazards posed by wildlife. Tolerance for wolves declined after delisting and legalization of lethal management, probably because people perceived the government was sending a signal that wolves have less value or illegal take will not be enforced. The implementation of lethal control did not raise tolerance for wolves after 8 years and the inauguration of public wolf-hunting did not raise tolerance for wolves after one year. Messaging that includes a sizeable component of information on benefits is more likely to raise tolerance for carnivores than messaging that focuses on costs and risks.

The available evidence suggests delisting and legalizing or liberalizing lethal control is more likely to **increase poaching which is the major threat to wolves in the USA** than decrease it.

Despite the latest results described above, the scientific community still does not know enough to abate poaching, which we believe is generated by intolerance. Perpetrators of poaching are poorly studied. That creates uncertainty about who would poach a wolf, under what conditions, and where. It is widely believed that the average human's tolerance in areas inhabited by wolves will predict behaviors that harm or help wolf conservation. If that hypothesis is false, concerns with social tolerance are misplaced and attention should focus on a few perpetrators and their social networks that promote law-breaking, rather than on the general public

I conclude that state delisting might have costs that the ODFW has not anticipated and is currently ill-equipped to understand let alone abate.

Furthermore the ODP Plan 2010 is liable to lead to an increase in poorly understood take in the wake of delisting. "A delisting decision by the Commission is not expected to significantly affect the management of wolves. This is because the Wolf Plan and associated OAR's guide the management of wolves regardless of OESA listing status, and a delisting decision would not inherently alter the management aspects of the Wolf Plan." (ODFW Review 2015). That is unfortunate because **delisting should lead to a change in management to reduce legal AND illegal killing and increase messages about the benefits of wolves to Oregon ecosystems and citizens.**

Of particular concern is whether the ODFW has correctly described the future costs and benefits of its management efforts that affect wolf survival and reproduction. Lethal management raises such concerns because there has never been a rigorous scientific experiment to test if killing wolves actually prevents future wolf predation on livestock (*17-19*).

Also Oregon's state delisting would presumably activate the hunting and trapping of wolves as a "special status game mammal" under ORS 496.004 (9). (While the state wolf Plan indicates that controlled take of wolves could not occur until wolves enter into Phase III, ODFW has publically indicated that the population goals established in the Plan for moving into Phase III could be met as early as 2017. The Plan also advises that it is expected that wolves will have been delisted by the time Phase III management regimes and the availability of controlled take of wolves begins. With these guidelines and the timeline ODFW has indicated, controlled take of wolves will follow delisting in short order but without scientific basis.) The expectation that "controlled take of wolves would be permitted as a management response tool to assist ODFW in its wildlife management efforts" presumes public hunting is a useful management response. **Setting aside private hunters desires to hunt or revenue generation from hunting, what conservation purpose does hunting play in a population recovering from extirpation?**

Reviews of this question find little or no benefit of public hunting and trapping for conserving large carnivores (*20-24*). Furthermore, studies of cougars suggest public hunting can exacerbate problems with domestic animal owners (*25*). It may seem obvious that killing a wolf in the act of chasing, biting or otherwise attacking livestock will save that animal but the vast majority of lethal management is done far from the livestock and long after an attack has occurred. Under such indirect circumstances, lethal management is not clearly effective. Consider the unsettled dispute about lethal management of Northern Rocky Mountain wolves despite twenty years of lethal management (*26, 27*). Another concern is that the ODFW over-states the problem of livestock depredation in the following quote, "The challenges of wolves in areas with livestock are well documented, and wolves prey on domestic animals in all parts of the world where the two coexist". This over-states the challenge posed by livestock predation because it ignores years of evidence that a minority of wolf packs are involved in domestic animal depredations and the geographic locations of such attacks are predictable (*14, 28, 29*). Moreover it ignores the many non-lethal methods that are more effective than lethal control and have not had detectable side-effects and counter-productive results such as higher livestock predation.

I recommend the ODFW pay close attention to research by independent scientists with academic freedom (not USDA-WS which has a financial conflict of interest and not hunter interest groups for the same reason) who have reviewed the evidence on whether killing wolves – either through public hunting or by USDA-WS contract – will prevent livestock predation. Otherwise, and until the scientific community finds consensus on this evaluation, any such killing authorized and condoned by ODFW is not based on best science. Indeed it is being conducted in the absence of scientific justification and may be in violation of the public trust duties of the state, as mentioned previously.

In conclusion, I find **(1) Oregon's delisting criteria have not been met**, and **(2) The main threat to wolf population viability is not adequately understood by any state or federal agency yet, therefore the expected benefits of delisting are unlikely to manifest and the likely costs are not well addressed by current regulatory mechanisms.**

Thank you for reading my comments.

Adrian Treves, PhD

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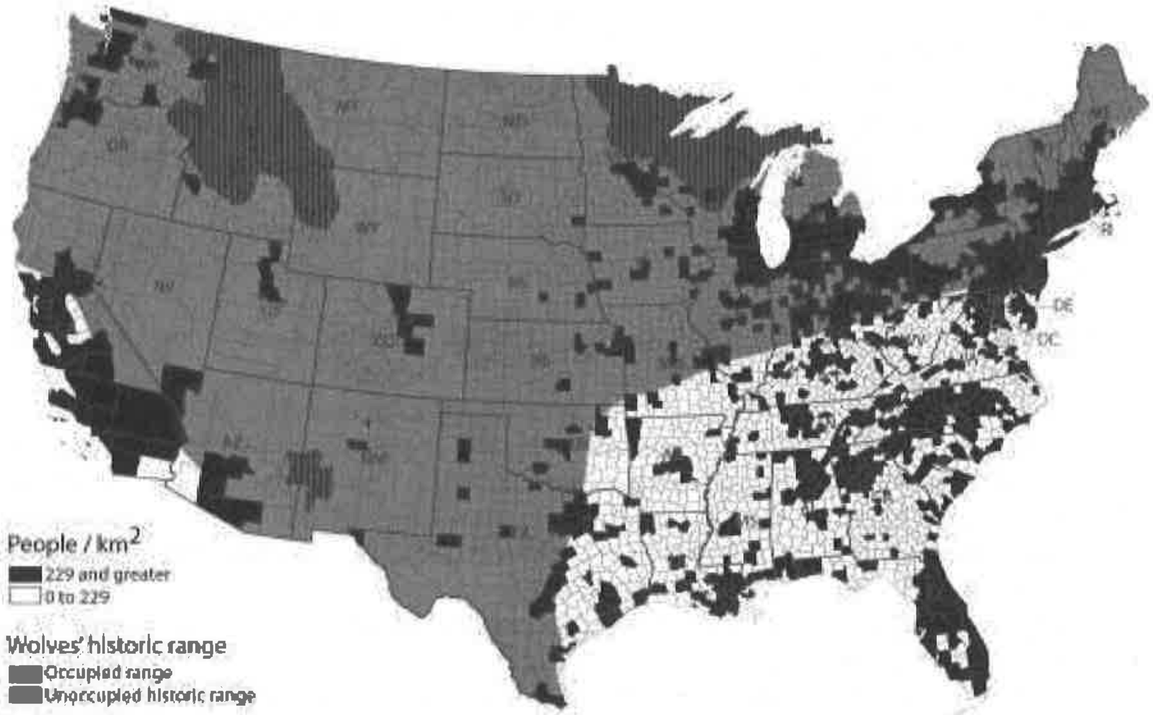
Appendix A.

Blue area is the historic range of the gray wolf in the conterminous United States. Hatched gray areas are the current range of breeding pairs of wolves as of 2013. The dark polygons show relative human population density (*1*).



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Comments re: ODFW's gray wolf delisting recommendation and status review

October 29th 2015

To the Oregon Fish and Wildlife Commission:

This comment concerns the document "Updated biological status review for the Gray Wolf (*Canis lupus*) in Oregon and evaluation of criteria to remove the Gray Wolf from the List of Endangered Species under the Oregon Endangered Species Act (Oregon Department of Fish and Wildlife (ODFW), October 9, 2015)" in particular to the Appendix B "Assessment of Population Viability of Wolves in Oregon" hereafter termed "the PVA".

My name is Guillaume Chapron, I am Associate Professor in quantitative ecology at the Swedish University of Agricultural Sciences and my research focuses on large carnivore conservation and management, with a particular emphasis on modeling and viability analysis. I have more than a decade of experience in this field and my research has been published in the top U.S. and international peer-reviewed scientific journals (see e.g. Chapron et al. 2014. *Science* 346 (6216): 1517-1519, Bauer, Chapron et al. 2015. *PNAS.* 10.1073/pnas.1500664112).

I submit this comment to help the commission in meeting the requirement outlined in OR ESA that listing decisions be based on "documented and verifiable science".

My first comment is to congratulate ODFW for providing details on the PVA and sharing the R source code of the PVA. Such openness and transparency are not so common among agencies and deserve to be praised, as they open up for the possibility of constructive criticism. My comments are the following:

1) The PVA is not statistically correct.

A PVA typically functions by running multiple stochastic (i.e. random) trajectories of a simulated population and counting the resulting number of extinct trajectories. For example, if one would simulate 1000 trajectories and obtain 137 extinct trajectories among these 1000, the extinction probability would be 13.7%. A critical part of a viability model is therefore how stochastic processes are modeled. I have reviewed the source code of the PVA written in the R language and the way stochasticity is modeled is not correct. Taking the example of survival events, stochasticity is modeled by generating a random number from a uniform distribution between 0 and 1 (as I understand it, this amounts to demographic stochasticity), and then comparing that number with another number. This latter number is randomly generated from a uniform distribution with parameters (mean-SD, mean+SD) and, as I understand it, this amounts to environmental stochasticity. This approach is fundamentally wrong for two reasons. First, the breadth of the latter distribution is restrained and values lower than mean-SD and larger than mean+SD are by default impossible (which roughly means 32% of all possible values, see the "68–95–99.7 rule", noting that excluding the lowest values will have the most severe impact on extinction risk). Second, all values are equally likely, which is typically not the case when estimating parameters from field data as one gets a normal (or bell-shaped) parameter distribution. The PVA therefore restricts possibilities of extinction and adds noise in parameters that could be more informative. The proper way to model environmental and demographic stochasticity for survival is by using a beta-binomial mixture where beta distributed values (with shape parameters obtained through the method of moments with mean and SD) are randomly generated to serve as parameters of the binomial distribution.

The same problem is also present for litter size, where the PVA uses a uniform distribution between 2 and 8. This means that litter sizes of 1 are impossible and that litter sizes of e.g. 2, 3, 4, etc till 8 are all equally likely. This approach is simply inconsistent with wolf biology. One could use a Gamma-Poisson mixture to generate stochastic integer numbers with some environmental stochasticity.

Environmental stochasticity in the PVA is in practice implemented by sampling a vector with stride of 0.01 or 0.001. However I noticed the stride was different between environmental (0.001) and demographic (0.01) stochasticity for poaching and this is also not correct.

Finally, because the model has a quite a few parameters, I believe that running 100 trajectories is not enough to get informative and converging estimates of extinction risk and 1000 trajectories would have been a minimum. I consider the points raised in this section justify the rejection of the PVA without further consideration.

2) The PVA is not properly validated.

Calibrating and validating a complex Individual Based Model is important but can also be challenging. For the OR wolf PVA this seems to have been done by comparing simulations with a time series of 5 years. I do not believe this is statistically rigorous. Modern algorithms such as Approximate Bayesian Computation with prior-posterior inference or Pattern Oriented Modeling would be more suitable here. Note that the PVA has probably quite a few weakly identifiable parameters (pairs of different parameter values giving the same model fit). Importantly, it is not because the model was published in a peer-reviewed journal that this implies the model is validated or correct (see previous point showing it is not) and I recommend the OR wolf PVA and its R source code be peer-reviewed in an open and transparent process. Finally, I would like to point to the fact that the initial population is randomly assigned across age and social classes, which suggests the population did not start at an asymptotic stage, and early oscillations of the population structure may have affected simulations and the results of the sensitivity analysis.

3) The PVA does not use realistic parameter values or scenarios.

The PVA is parameterized with a very low poaching rate. This is not in line with what has been found in other wolf or large carnivore populations. Using a hierarchical Bayesian state-space model I have found that half the mortality of wolves in Sweden was due to poaching and that two third of poaching was not observed (Liberg, Chapron, et al. 2015. Proceedings of the Royal Society B 279 (1730): 910-915). There has been several documented cases of illegal take in OR and the total number is likely higher as illegal activities are typically under-reported. The PVA also assumes that survival rates were not influenced by social status of the animal but I question whether this is realistic as some social classes are exposed to higher mortality risks by being more active in hunting large prey.

A critical assumption of the PVA is that the past is a proper representation of the future, in particular regarding human induced mortality rates. However, the PVA in this case is actually being used to make a decision making the future different from the past (delisting). Therefore, justifying delisting based on a PVA assuming that parameters will remain constant for the next 50 years is inadequate as parameters are likely to change as soon as and if delisting happens—especially if the state moves to initiate legal hunting and/or trapping of wolves. Indeed, the PVA actually documents the effect of such changes and finds that the probability of conservation failure dramatically increases with legal mortality. A proper interpretation of the actual PVA results would actually support not delisting the wolves in OR.

Another critical assumption in the PVA is the annual immigration of 3 wolves in OR. This raises two questions. First, a population is generally considered as viable when considered as a stand-alone population and not through the regular addition of individuals. Second, the persistence of this flow of immigrants is doubtful as, for example, adjacent states are attempting to dramatically reduce their wolf populations.

4) A PVA is not the appropriate tool.

The PVA completely ignores long-term viability and the ability of OR wolves to adapt to future environmental change. However, there is a substantial amount of literature of the need for populations to have a genetically effective population size of at least *Ne*=500 to be considered as genetically viable and a large number of viability analyses in the conservation literature have used a package called VORTEX to include genetics aspects in viability estimates. It is unfortunate the PVA ignores such aspects and this precludes using the PVA to reach conclusions on the long-term viability of OR wolves and hence meet the requirement of OR ESA.

Worth noting is that under no possibility could a population of ~85 individuals be considered as not warranting listing under the IUCN Red List, which is a globally recognized authority in assessing species extinction risks. Similarly, the Mexican wolf population is today larger than the OR wolf one but is not at all considered as recovered by Federal authorities. There appears to be little substance for ODFW to consider a population of ~85 wolves as being recovered.

ODFW finds that the wolf is not now (and is not likely in the foreseeable future to be) in danger of extinction throughout any significant portion of its range in Oregon. However, ODFW makes this statement by implicitly removing "any significant portion of its range", as only the outcome of a non-spatial PVA is considered sufficient. The reality is that the wolf is past being in danger of extinction throughout many significant portions of its range in OR because it occupies only 12% of its suitable habitat (so is extinct in 88% of its suitable habitat). The interpretation of this section of OR ESA by ODFW is an illegitimate interpretation that implies the suitable habitat where the species has become extinct is no longer considered as part of the species range and included in recovery targets. This interpretation also runs contrary to recent scientific literature on significant portion of range.

Finally, there has been an impressive amount of research on the ecological role wolves can play in shaping ecosystems and the report by ODFW does not consider fulfilling this role as a criteria for delisting.

Based on the points raised above, I conclude that the PVA does not provide support for delisting wolves in OR.

Yours sincerely

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October 28, 2015

Scientific peer review comments on Oregon Department of Fish and Wildlife Review of the Biological Status of the Gray Wolf

Thank you for your invitation to submit comments on the updated biological status review document of October 9, 2015. My research as a wildlife ecologist with the Klamath Center for Conservation Research in Orleans, California, has focused on habitat, viability, and connectivity modeling for a diverse group of threatened and endangered species ranging from large carnivores to rare and endemic plant species. I have also served on the Science and Planning Subgroup of the Mexican Wolf Recovery Team. I welcome the opportunity to use this expertise to evaluate the document.

Firstly, I wanted to commend the Oregon Department of Fish and Wildlife (ODFW) for its work over the past decade to advance wolf recovery in Oregon, and specifically on the work that went in to preparation of the biological status review document. On the whole, the document is well-written, factual, and informative. However, there are several areas where the document could be improved to better reflect current science. Although the document states that a change in status (delisting) of Oregon wolf populations will have little practical short-term effect on management of the species in the state, it is nonetheless important that any status determination reflect best available science.

The population viability analysis (PVA) completed by ODFW to support the status report provides relevant information concerning some factors effecting population status. The PVA results support the intuitive conclusion that the relatively high reproductive rate shown in many colonizing wolf populations make them fairly resilient to extirpation in the short term in the absence of high human-associated mortality rate (such as from hunting or lethal control programs). This conclusion can be drawn from simple deterministic PVA models. The PVA associated with this status review expands on this conclusion by using a stochastic individual-based model to evaluate factors (such as disease outbreaks or other chance events) that may threaten small populations, even if these populations on the whole show positive population growth. However, I have two areas of concern with the PVA, and with the resulting conclusion as to the resilience of the current Oregon wolf population:

1) the manner in which stochastic factors are parameterized in the PVA is overly optimistic;

2) the PVA does not incorporate the effects of small population size and isolation on genetic threats to population viability. Instead the status review relies on a brief qualitative discussion which does not accurately represent what is currently known about genetic threats to small wolf populations.

Treatment of stochastic factors

The ODFW PVA incorporates stochastic factors such as disease outbreaks or prey decline in two ways (PVA p 14):

1) An effect on reproduction via a 5% chance per pack of reproductive failure in any year. Importantly, these reproductive failures were not correlated between packs, so population-level reproductive output did not experience "bad years".
2) An effect on population-level survival where survival was reduced by 25% on average once in 100 years.

The PVA does not document the source of these parameter estimates, but they appear highly optimistic when compared to data from well-studied wolf populations such as in the Yellowstone region. In terms of stochastic factors affecting reproduction, effects of disease outbreaks on fecundity (considered broadly to include pup survival) are often correlated between packs in a population, which increase the effect of this factor on viability. Additionally, the ODFW PVA's mean interval of 100 years between catastrophes likely underestimates the frequency of events impacting population-level survival rates. If only rare "catastrophic" events are considered, then a 25% decrement likely underestimates the effect of such an event on survival. In contrast to the parameters used in the ODFW PVA, Almberg et al. 2010 concluded based on data for the Yellowstone region that "wolf managers in the region should expect periodic but unpredictable CDV-related population declines as often as every 2–5 years".

Treatment of genetic issues associated with population size and isolation

Recent wolf PVAs (e.g., Carroll et al. 2013) have explicitly incorporated the effects of genetic factors on population viability. In contrast, the ODFW PVA omits quantitative consideration of genetic factors, which may cause its results to be overly optimistic. The status review relies on statements such as "In context of a larger meta-population, Oregon's wolf population is neither small, nor isolated" (p 20). This statement is so general as to be uninformative. Wolves were historically present throughout their range in the lower 48 states as a largely continuous population with some degree of genetic isolation by distance (Vonholdt et al. 2011). The current Oregon wolf population is small and relatively isolated when compared to historic conditions, and thus genetic factors are of potential concern. This is true even when Oregon's wolves are considered in a metapopulation context. The fact that wolves are good dispersers even in the current landscape may reduce genetic effects associated with small population size but will not eliminate these effects.

The review implicitly assumes that wolf populations in other states within the metapopulation will remain at their current size and continue to be a robust source of dispersing individuals. For example, on page 18, the document states "We contend that high levels of genetic diversity in Oregon wolves will be maintained through connectivity to the larger NRM wolf population." However, one cannot assume that populations in adjacent states will remain at current levels. The Idaho wolf population could potentially be reduced fivefold from its recent peak level, to a minimum of 150 wolves, under current state management regulations. Any such reduction would reduce dispersal into Oregon below that evident in the last decade. Additionally, if, in the longer term, hunting is permitted after delisting of Oregon wolves, this increased human-caused mortality, even if sustainable from a demographic perspective, would be expected to reduce immigration from the NRM population.

More generally, the document's statement (p 17) that "Small populations of wolves are unlikely to be threatened by low genetic diversity" is not consistent with the latest research on small wolf populations. For example, the wolf population in Isle Royale National Park has long been used as an example of the ability of a small, isolated wolf population to persist. However, recent developments have demonstrated the high risks associated with genetic inbreeding in this population (Raikkonen et al. 2009), which as of early 2015 had dwindled to 3 individuals (Vucetich and Peterson 2015). Similarly, the Finnish wolf population has decreased in size in recent years to the point where it has become genetically depauperate (Jansson et al. 2012).

Given these potential risks, a precautionary management approach is appropriate in order to avoid undermining the progress to date in recovering Oregon's wolf populations. Management of wolves in the Eastern Wolf Management Zone (WMZ) should ensure that the rate of dispersal to western Oregon during the period in which the western population is still being established is not reduced, so that wolf populations in the Western WMZ can be founded with the broadest sample of genetic representation from the larger metapopulation, in order to avoid future genetic problems. Continued frequent dispersal into the Western WMZ will also facilitate the establishment of wolf populations is all "significant portions of range" in western Oregon where habitat remains suitable for wolves.

Sincerely,
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