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POLICY BRIEF

WSU Wolves Study: The author's own data disprove his claims and support the state's wolf control policy

Todd Myers, Director, Center for the Environment
and Stefan Sharkansky, Ph.D.

October 2017

Key Findings

1. *Washington State University professor Robert Wielgus' 2014 study claims that killing wolves actually increases the number of sheep and cattle that wolves depredate the following year.*
2. *The WSU study's conclusions are based on erroneous statistical arguments, and are not supported by rigorous analysis of the study's own data.*
3. *Contrary to Wielgus' conclusions, our re-analysis of his study's data finds that the strongest explanation of an increase in loss of cattle and sheep was simply an increase in the wolf population.*
4. *A University of Washington review of his data found a similar error in Wielgus' analysis.*
5. *Wielgus' study also fails to replicate his hypothesis on an independent data set to ensure his finding is not merely an artifact of this data set.*
6. *Wielgus' claim that removing wolves increases the number of breeding pairs is also undermined by the data in his study.*
7. *Data in Wielgus' study actually support the current Washington state strategy of removing wolves where there is conflict with a rancher, consistent with the common-sense conclusion that removing wolves reduces livestock deaths.*

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Introduction

Does killing wolves where they have attacked sheep and cattle actually increase the number of wolf attacks on cattle and sheep in the following year? It doesn't seem to make sense, but that is the counter-intuitive claim made by Washington State University Professor Robert Wielgus in a 2014 study. He implicitly argues against the state's policy of removing wolves in areas where they are killing livestock and are in conflict with ranchers.

In the summer of 2016, after several cows had been killed by a local pack of wolves in central Washington, the Washington State Department of Fish and Wildlife (WDFW) decided to remove the pack, known as the Profanity Peak pack.[1] The decision was consistent with the policy of the Washington state Wolf Advisory Group, a policy group that includes ranchers, environmental activists, farmers and elected officials.[2] The policy of killing members of the pack worked, but not everyone was happy.

Professor Wielgus argued the removal was unnecessary and had been provoked by ranchers looking for a pretext to remove wolves from the area. He told The Seattle Times, "The livestock operator elected to put his livestock directly on top of their den site,"[3] intentionally provoking a conflict that would cause state officials to remove the pack.

That claim caused a reaction from Washington State University's academic department heads, who took the unusual step of responding to their own professor. They released a statement noting, "In fact**,** the rancher identified in the article did not intentionally place livestock at or near the den site of the Profanity Peak wolf pack, and Wielgus subsequently acknowledged that he had no basis in fact for

1 "Profanity Peak wolf pack targeted for extermination after more attacks on cattle," by Rich Landers, *The Spokesman-Review*, August 22, 2016, http://www.spokesman.com/blogs/outdoors/2016/aug/19/profanity-peak-wolf-pack-target-for-more-dead-cattle-found/.

2 Department of Fish and Wildlife, "Wolf Advisory Group (WAG) Members," http://wdfw.wa.gov/about/advisory/wag/WAG_MemberRoster.pdf (accessed August 3, 2017).

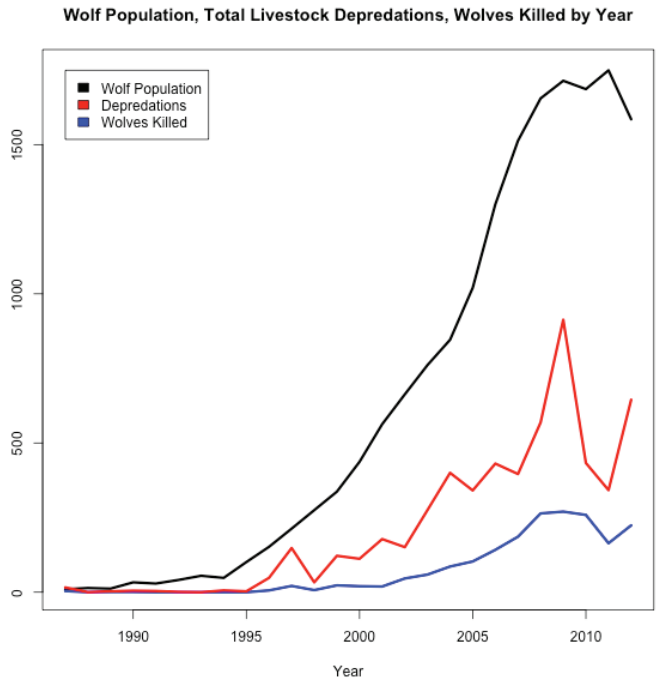
3 "Profanity Peak wolf pack in state's gun sights after rancher turns out cattle on den," by Linda V. Mapes, *The Seattle Times*, August 25, 2016, http://www.seattletimes.com/seattle-news/environment/profanity-peak-wolf-pack-in-states-gun-sights-after-rancher-turns-out-cattle-on-den/ .

making such a statement."[4] They concluded, "WSU apologizes to our friends, our science partners and to the public for this incident."

Wielgus, however, continues to oppose removing wolves where they conflict with the livelihood of ranchers. Based on his 2014 study, he continues to argue that killing wolves makes the problem worse, perhaps because it would lead to an increase in breeding pairs, thus increasing depredations. The study, "Effects of Wolf Mortality on Livestock Depredations," argues against the state's current strategy to reduce conflicts between wolves and cattle.[5]

Careful reviews of this study, however, demonstrate serious methodological flaws and critical omissions in its analytical methods. More thorough analysis of the study's data published with the article finds that Dr. Wielgus' main conclusions are, at best, unsupported by the data, if not refuted outright. His central conclusion that killing wolves increases depredations of cattle and sheep is based on a false statistical argument unsupported by reasoned analysis.

At the same time, the strongest evidence in the data supports the common-sense conclusion that as the wolf population grows, both livestock depredations and lethal wolf control increase correspondingly.



Far from contradicting the state's current policy on wolf management, Dr. Wielgus' own data indicate that the state's policy is probably on the right track.

4 Washington State University, "WSU issues statement clarifying comments on wolf pack," August 31, 2016, https://news.wsu.edu/2016/08/31/wsu-issues-statement-clarifying-comments-profanity-peak-wolf-pack/.

5 Wielgus RB, Peebles KA (2014) Effects of Wolf Mortality on Livestock Depredations, PLoS ONE 9(12): e113505. doi:10.1371/journal.pone.0113505.

The Wielgus study fails to control for wolf population

In the 2014 study, Dr. Wielgus and data analyst Kaylie Peebles examine depredations of cattle and sheep in Idaho, Montana and Wyoming. Their data covers a quarter of a century from 1987 through 2012. They argue, after looking at the data, that killing wolves actually increases the number of cattle and sheep killed the in following year. They claim:

> "…the number of livestock depredated the following year was positively, not negatively, associated with the number of wolves killed the previous year. The odds of livestock depredations increased 4% for sheep and 5-6% for cattle with increased wolf control – up until wolf mortality exceeded the mean intrinsic growth rate at 25%."[6]

Their hypothesis is that killing wolves "could result in increased breeding pairs and livestock depredations following lethal control."[7] If this is the case, controlling depredations by killing wolves would end up being worse for ranchers and livestock.

A closer look at Wielgus' article shows that blanket claims of a four percent increase in sheep depredations and a five-to-six percent increase in cattle depredations are a mischaracterization of his own statistical results. The actual formulas his statistical method produces, and which he reports in the technical tables, estimate the expected change in depredation rate per additional wolf culled specifically *decreases* with an increase in the wolf population.

For example, in the case of cattle depredations, the "5-6% increase" per wolf culled is only for the purely hypothetical numerical baseline case in which there are zero pairs of breeding wolves. The formula indicates that as the number of breeding pairs increases, the expected change in depredations actually decreases, to the point where 38 breeding pairs is associated with no expected change in depredations, no matter how many wolves are killed, and where 49 breeding pairs (the maximum number for a case in the study) is associated with an expected 1.5 percent decrease in depredations per wolf culled.

Wielgus' own statistical results, though not his discussion of them, support a policy of lethal wolf control for the purpose of protecting livestock when the wolf population becomes sufficiently large.

Other reviewers found similar problems with the way Wielgus ignores the impact of the increase in wolf population in his analysis.

Last year, University of Washington Environmental Sciences Professor Stanley Asah and his team published a detailed critique of Wielgus' statistical methods and conclusions.[8] They argue that Wielgus' statistical model is incorrectly specified, showing the data violated mathematical assumptions required for his chosen statistical procedure to be valid. They doubt the validity and reliability of

6 Ibid. page 1.

7 Ibid. page 2.

8 Poudyal, Baral, Asah, "Wolf Lethal Control and Livestock Depredations: Counter-Evidence from Respecified Models", PLOS ONE, February 2016, http://journals.plos.org/plosone/article/related?id=10.1371/journal.pone.0148743.

Wielgus' estimates of the relationship between wolf kills and livestock depredations, suggesting his numerical results might be accidental.

Their principal concern is that Wielgus' model fails to account for the steady increase in the wolf population and other variables over time. They re-ran Wielgus' study numbers, applying more rigorous statistical procedures to the same data, and reached a conclusion diametrically opposed to Wielgus' conclusion. They find that culling an additional wolf in a given year is associated with an expected 1.9% *decrease* in cattle depredations the following year, and an expected 3.4% *decrease* in sheep depredations, independent of the size of the wolf population.

Study fails to replicate results in other locations or time periods

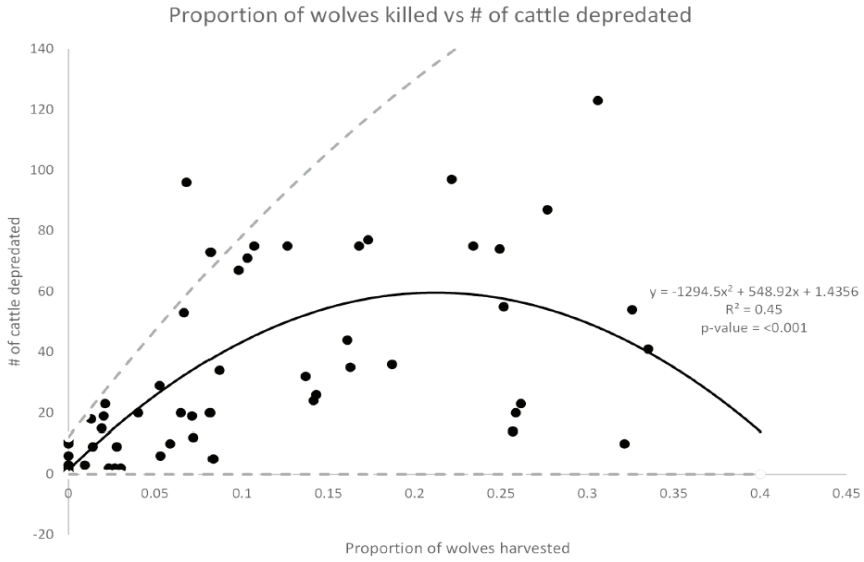


Figure 3. The proportion of wolves killed vs cattle depredated. Proportion of wolves killed the previous year versus the number of cattle depredated the following year. The dashed lines show the upper and lower limits of the 95% confidence interval for the best fit line.

Wielgus' also argues that livestock depredations increase with the proportion of the wolf population killed – up to the 25 percent level -- after which depredations decline. He speculates, without producing evidence from the data, that this may be due to destabilization in pack dynamics and an increase in the number of breeding pairs.

Figure 3 of Wielgus' study (shown above) is the source of his claim that as the proportion of wolves killed increases to 25 percent, the number of cattle depredated increases the following year.[9] He shows a reasonable correlation between the two variables (R2=0.45). He found a similar, although much weaker, correlation for the number of sheep depredated the year after wolves were killed.

Correlation, however, is not causation. For any given data set, it is relatively easy to devise a function that shows a superficial correlation in the data. One can often find apparent statistical patterns even in sets of randomly generated numbers after tinkering with enough formulas. This alone is not good science.

9 Ibid. page 7.

To validate a scientific hypothesis using statistical methods, one must, among other things, begin with a mathematical model which reasonably describes real-world processes and which considers the variables which are reasonably anticipated as having the most influence on the studied outcome.

If a scientific finding is to be used to guide decisions in, say, medicine or public policy, it is not enough only to infer relationships and derive a numerical formula from past data. One must also test the derived formula "out of sample," that is, against new data to see how accurately it predicts outcomes in cases that were not used to derive the original formula.

If the formula is shown to predict out-of-sample outcomes with acceptable accuracy, then it might be used as a decision-making tool. If its out-of-sample predictions are no better than other methods or random guesses, then it is a poor tool for shaping important decisions.

For example, if Wielgus' estimated relationships between wolf killing and livestock depredations based on the data from Montana, Idaho and Wyoming through 2012 were shown to predict depredations in those states in later years with reasonable accuracy, or to reasonably match the pattern of wolf killings and depredations in other states, then his formulas could be a plausible tool to help formulate wolf control policy.

If the estimated relationships do not generalize to other states or times, they may be specific to a particular place and time for unexplained reasons or are merely spurious. In either case, they are unhelpful in guiding sound public policy.

Wielgus' study does not report any attempt to validate his results out-of-sample, so even without other concerns about the study, that alone marks this research as a work in progress, insufficient to guide policymakers. Moreover, we can demonstrate that his claim is based on false statistical reasoning and is not grounds for expecting this spurious relationship to be observed in other settings.

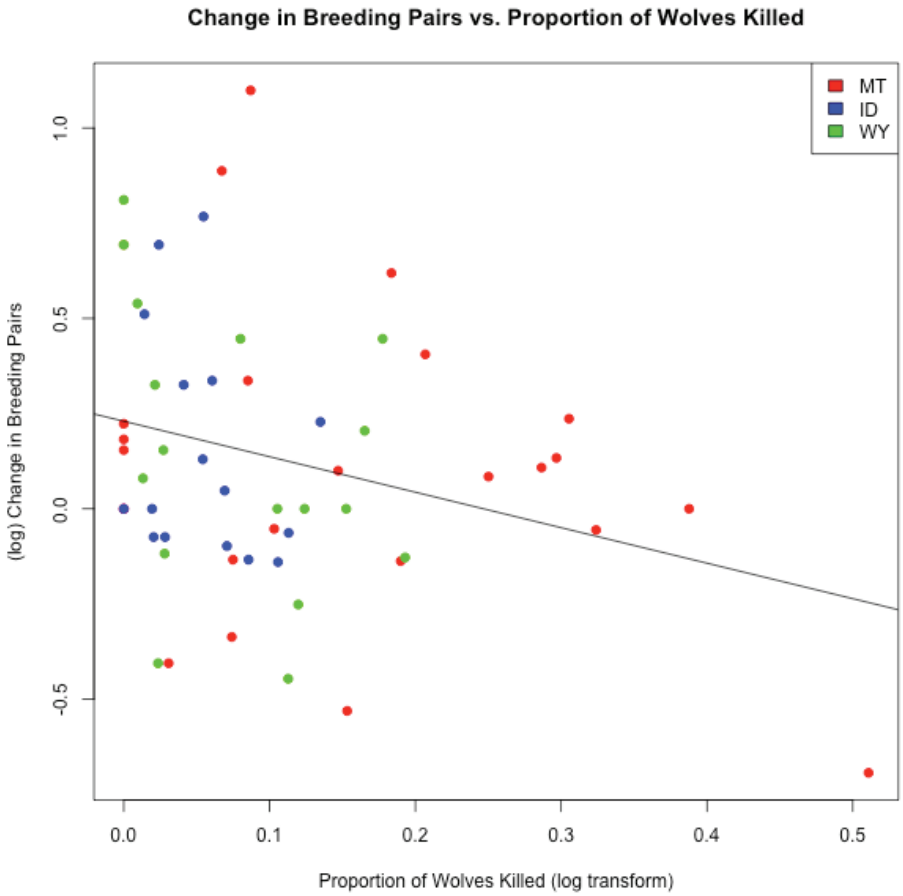
Wielgus' own data undermine his claims

Wielgus speculates that killing wolves destabilizes pack dynamics and results in an increase in breeding pairs, which in turn prey on more livestock. He cites another study which "predicted that increased wolf mortality could result in fracture of pack structure and increased breeding pairs."

He offers no evidence to support the suggestion that increased wolf mortality is associated with increased breeding pairs in the years and states that he studied, let alone a contributing factor to an increase in depredations. His own data, however, offers a simple and straightforward way to test his claim that the number of breeding pairs increased with increased wolf control.

The data include the annual number of breeding pairs, so we can easily examine whether the proportion of wolves killed in a given year is correlated with the percentage change in breeding pairs in the following year. If killing a larger proportion of wolves leads to a larger number of breeding pairs, we would expect the data to show greater changes in breeding pairs after a greater proportion of

wolves is killed. The figure below plots that relationship.[10] Contrary to Wielgus' speculation, the scatterplot and trendline fail to show a positive relationship between wolf control and breeding pairs.



To the contrary, it suggests a slightly significant, and more intuitive, result that the number of breeding pairs decline subsequent to wolf control. However, this relationship disappears when we look at the three states individually, indicating no discernible significant relationship between wolf control and the subsequent change in breeding pairs.

In the absence of additional data, or a suggested alternative way to view the given data, the data do not support, and may contradict, Wielgus' hypothesis that an increase in wolf control results in an increase in the number of breeding pairs.

Since Wielgus' only suggested explanation for the claim that increased wolf control results in increased livestock loss is shown to be uncorroborated, the statistical argument he uses to support this conclusion merits additional scrutiny. This statistical argument is unreliable for various technical reasons, such as omitted-variables bias and violation of the assumption of independent and identically distributed error terms. The simple lack of applicability to the real world is even more fundamental and clear.

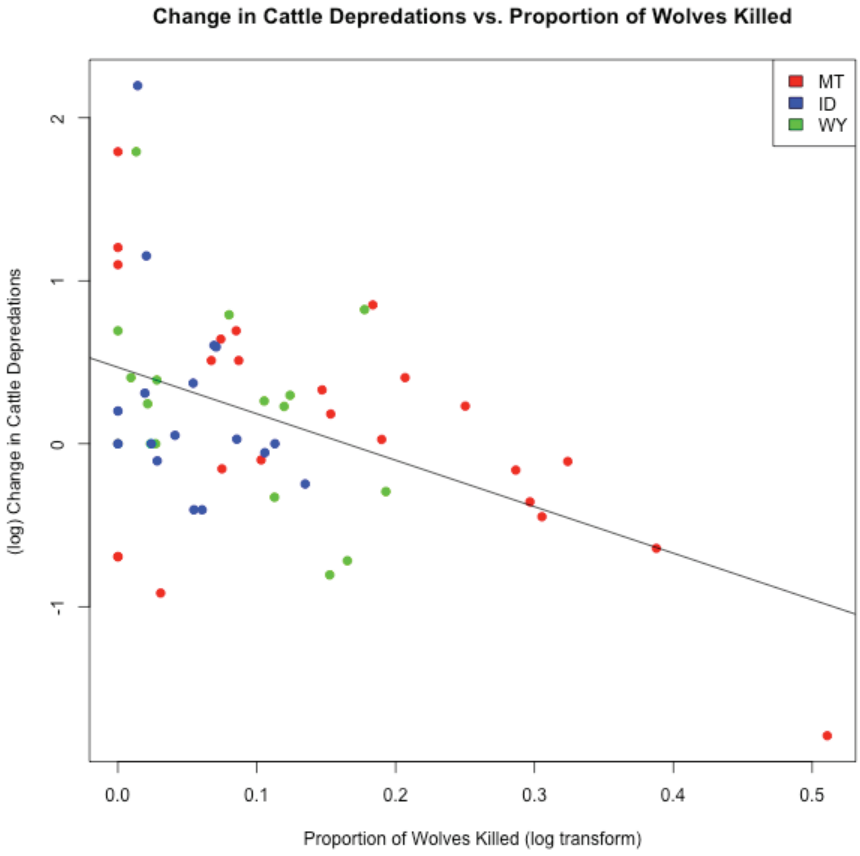
10 Specifically, we follow a standard practice and take logarithms of these quantities before plotting and analyzing. The results are quantitatively similar though less precise if the original quantities, not the logarithms, were used.

Wielgus study claims depredations are unrelated to wolf population

The procedure Wielgus uses, ordinary least squares linear regression, estimates a formula, which, in this case, gives the average value of the number of livestock depredated for the proportion of the wolf population killed. His claim depends only on that proportion, ignoring any other environmental factors.

Notably, the formula does not take into account the actual wolf population, which varies widely among the different states covered in the study and across time, ranging from ten wolves in Montana in 1987, to 870 wolves in Idaho in 2009. Using Wielgus' conclusions means accepting a formula for predicting the average number of annual cattle depredations which does not depend on the number of wolves or the number of breeding pairs in the population, or the geographical size of the area considered.

As a result, the formula offers the absurd prediction that whether there are ten wolves in an area or 1,000, when no wolves are culled, an average of one cow would be depredated. Further, he claims that when 21 percent of wolves are culled – whether that is two taken from a population of ten, or 200 taken from a population of 1,000 – an average of 60 cattle would be depredated. Wielgus' conclusion that depredations increase with the proportion of wolves killed up to 25 percent depends entirely on this implausible formula, and therefore cannot be accepted as scientifically sound without further evidence.



The salient problem with Wielgus' analysis, as Asah et al. point out, is that he does not take into account the increasing trend in the wolf population. His data, however, offers a straightforward way to test his hypothesis that an increase in the proportion of wolves killed is associated with an increase in depredations while accounting for other contemporaneous factors of the environment.

Similar to the way we examined the change in breeding pairs in relation to the proportion of wolves killed, we examined whether the proportion of wolves killed in a given year is correlated with the percentage change in cattle depredated in each state from the given year to the following year. The figure above plots that relationship (also on the log scale).

Not only does the scatterplot and trendline fail to show a positive relationship between wolf control and increase in depredations, it suggests a slightly significant trend of depredations declining subsequent to increasing wolf control. In the absence of additional data, or more convincing way to view the given data, it is not reasonable to accept Wielgus' conclusion that an increase in the proportion of wolves killed (up to 25 percent) results in an increase in cattle depredations.

Although Wielgus' conclusions about the relationship between lethal wolf control and cattle depredations do not hold up under scrutiny, we can learn other lessons from the data he has provided. As noted earlier, the study by Asah et al. finds that wolf control is in fact associated with a decrease in depredations, a conclusion that has the virtue of reflecting the expected policy outcome.

The strongest relationship we found in the data is very simple and consistent with common sense – as the wolf population grows larger, more cattle get eaten by wolves, and as wolves are removed, depredations decline. The figure above illustrates the close correspondence between the wolf population and cattle depredations.

More wolves means more depredation

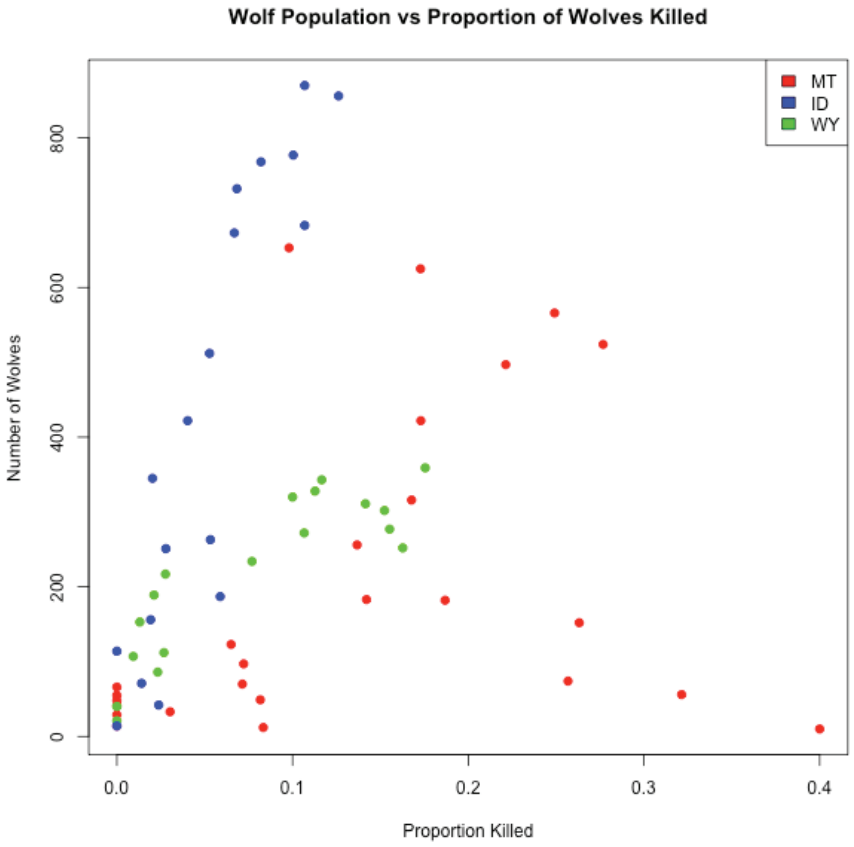
Adjusting for the differences between the three states, this relationship between increased wolf population and cattle depredation has a very high R^2=0.79. While this simple illustration is not dispositive statistical proof, it is a confirmation of the reality that depredations increase with the wolf population. Wielgus included similar plots in his own paper showing the joint increase in wolves and depredations, but did not explain why he dismissed this explanation.

Surely additional human and environmental factors influence the number of depredations. The increasing wolf population, however, whether as a count of individual wolves or as a count of breeding pairs, is so strongly linked to the increasing depredations in the data that it cannot be ignored in any realistic statistical analysis of depredations.

A complete study would be bound either to include wolf population as a variable in any model to predict the number of depredations, or to explain why wolf population was omitted. Wielgus chose not to incorporate the wolf population in his analysis purporting to show a relationship between proportion of wolves killed and depredations, and he offers no explanation for the omission.

Nevertheless, as noted above, Wielgus' Figure 3 from his study does seem to show a statistically significant relationship between the proportion of wolves killed and the number of cattle depredated. Even though the explanation above cast

doubt on its scientific usefulness, perhaps it has some relevance to understanding depredations that we are overlooking? The following plot suggests an explanation for the apparent relationship, which is additional evidence that it is simply a result of happenstance and unrelated to any underlying biological mechanism.



The shape of this scatterplot we created is similar to the shape of Wielgus' Figure 3. The explanation for the pattern he observed is fairly straightforward. In the earlier years of the study, when the wolf population was small, there was wider variability in the proportion of wolves killed, as small differences in the actual numbers of wolves killed corresponded to a large range of proportions. The table below shows the key numbers for the first six years of the study from Montana.

Year	Wolf count	Wolves killed	Proportion killed	Cattle depredated the following year
1987	10	4	40%	0
1988	14	0	0%	3
1989	12	1	8%	5
1990	33	1	3%	2
1991	39	0	0%	1
1992	41	0	0%	0

Both the smallest and largest proportions in the study are from the earliest years, when the population of wolves was smallest. When the wolf population was smallest, so was the number of depredations. As the wolf population increased, the

average proportion of wolves killed tended to increase and stabilize in the ten to twenty percent range. Since the cases where the proportion is in that range are also when the wolf population was greatest, the depredations in the following years were unsurprisingly the highest.

Although we cannot rule out the possibility that there is some relationship between proportion of population killed and an increase in depredations, the simple explanation and data strongly suggest that there is no evidence to support such a connection.

In summary, Wielgus' statistical analysis is problematic and his main conclusions are either unsupported or actually refuted by more careful analysis of his own data.

His study was prompted by the fair observation that the effects of lethal wolf control on livestock depredation merits empirical scrutiny. Surely some wolf control measures are likely to be more beneficial than others, and it is possible that under certain conditions some measures may have unintended consequences that are harmful to livestock.

Any such findings could be helpful in guiding the actions of ranchers and state wildlife officials. Although Wielgus' 2014 study does not provide helpful conclusions, he concludes his article with well-considered suggestions for follow-up research that may yield promising results:

> "Further research is also needed to account for the limitations of our data set. The scale of our analysis was large (wolf occupied areas in each state in each year) and the scale of some other studies were small (wolf packs). Simultaneous, multi-scale analysis (individual wolf packs, wolf management zones, and wolf occupied areas) may yield further insights."

The policy implications of the study

The Wielgus study has been injected into the highly politicized debate regarding the management of wolves in Washington state. Wielgus has actively inserted himself into that debate, accusing ranchers of creating conflict and attacking supporters of the current management agreement.

Indeed, he includes a claim that is beyond the scope of his study, arguing that although killing more than 25 percent of wolves in an area will reduce livestock depredation, "that mortality rate is unsustainable and cannot be carried out indefinitely if federal relisting of wolves is to be avoided."[11] That conclusion is speculative and need not be true if the wolf population is managed only in areas where there are conflicts.

The State Department of Fish and Wildlife (WDFW) agrees that local control is consistent with statewide recovery. In a presentation last fall, officials argued that "increased levels of human caused mortality in the NE region of Washington state (that include current levels) will not affect the ability of wolves to achieve statewide

11 Wielgus RB, Peebles KA (2014) Effects of Wolf Mortality on Livestock Depredations, PLoS ONE 9(12): e113505. doi:10.1371/journal.pone.0113505.

recovery goals."[12] WDFW officials believe they can manage wolves in such a way that allows statewide populations to continue to increase while mitigating those circumstances where conflicts exist.

Conclusion

In such a politicized environment, it is important to ensure that science is sound and free of real or perceived political motives. The failure of the Wielgus study to consider, and rule out, the most obvious alternative explanation, is a serious weakness in the credibility of the study.

The ironic result is that the data demonstrate a stronger case for the common-sense conclusion that more wolves leads to more livestock depredation than the case Wielgus wants to make.

It is understandable that wolf biologists would be most concerned about protecting the wild species they have spent their careers studying. In the same way, ranchers are concerned about protecting their valuable livestock from unnecessary predation. Given those emotional aspects of the issue, statistical analysis needs to be independent, rigorous and complete, to ensure policy decisions are sound and based on science. Given the Wielgus study's shortcomings in those areas, policymakers should be wary of relying on its questionable results.

12 Washington State Department of Fish and Wildlife, "Handouts September 14, 2016," http://wdfw.wa.gov/about/advisory/wag/handouts_091416_WAG.pdf (accessed August 7, 2017).

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