

## Evaluating three categories of interventions in complaints about wolves

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Most wildlife management agencies aim to balance human needs with conservation goals by intervening when people and wildlife clash. We analyzed data, provided by the Michigan Department of Natural Resources (MiDNR) and its agents, describing their interventions in wolf complaints from the Upper Peninsula between 15 April 2003 and 7 July 2013. MiDNR classified complaints as depredation (injury or death of a domestic animal) or perceived threat, and two types of domestic animals were distinguished for each. We pooled data at three spatial scales (1, 36, or 324 mi<sup>2</sup>) and analyzed the delay between the first complaint and a subsequent complaint in its vicinity. Accordingly we analyzed 204 depredations (n=189 livestock or n=15 pet incidents), and 128 perceived threats (n=81 to person or pet and n=47 to livestock) at the smallest scale. Sample sizes refer to the first incident at a given location, rather than all occurrences of a particular complaint or intervention. The MiDNR intervened in several ways after complaints. We categorized interventions as inaction (n=209), non-lethal (n=93), or lethal (n=29). “Inaction” refers to the agency recording no physical intervention although advice and technical support were apparently always provided. “Non-lethal” included one or more of the following: cracker shells, hazing kits, trap-setting, lights, and fencing of flags or other materials. “Lethal” consists of killing one or more live-trapped wolves. If live-trapping was attempted but no wolves were caught, we classified the intervention as “non-lethal”.

Non-lethal interventions were associated with the longest delay to subsequent complaint (1355 ± 1050 days) compared to lethal interventions (881 ± 1077 days) or inaction (846 ± 1111). From univariate analyses we would conclude non-lethal interventions were more effective at the scale of one square mile. At the intermediate scale of townships, inaction was the least effective. At the largest scale of 9 townships, the difference between lethal and non-lethal was not significant.

However confounding variables preclude a firm conclusion. The category of intervention was associated with the class of complaint ( $p < 0.0001$ ) because 79% of lethal interventions followed livestock depredations. Because state permits for lethal control were issued and rescinded several times during the study period (Refsnider 2009), the variable ‘year’ was also significantly associated with the category of intervention ( $p < 0.0001$ ).

The following multivariate, parametric survival analysis should be considered highly preliminary until an adequate treatment of censored data is prepared. Tentative survival analysis – incorporating the class of complaint, year, and the category of intervention – revealed that the class of complaint was a significant predictor of delay to subsequent depredation ( $p < 0.0001$ ) with livestock depredations having the shortest delays (676 ± 1022 days), followed by intermediate delays following livestock threats and pet depredations (1191 ± 1064 days and 1267 ± 1361 days, respectively), and the longest delays for perceived threat to person or pet (1552 ± 1045 days). In the early years (2003–2008), every intervention was associated with a longer delay to subsequent complaint at every scale but less so for lethal interventions. However non-lethal interventions were still associated with almost twice as long an average delay to subsequent complaint as lethal interventions, in later years. The results did not change at larger spatial scales except that lethal control following a livestock threat was associated with a significantly shorter delay to subsequent complaint (82 ± 42 days) at

the largest spatial scale. Finally, an average of 1.7 wolves were euthanized following live-trapping. Removal of more wolves was associated with shorter delays to subsequent complaint (risk=1.13–1.23, p=0.13–0.40).

We recommend the MiDNR use non-lethal interventions if their goal is to prevent future complaints about wolves. We were unable to evaluate the effectiveness of different varieties of non-lethal interventions. Inaction (technical advice and investigation) and lethal intervention (live-trapping then euthanasia) were less effective than non-lethal intervention and comparable to each other. Lethal control may be counter-productive as it was associated with shorter delays to subsequent complaint at the scale of 324 mi<sup>2</sup>, and killing more wolves was associated with shorter delays at all scales. Our findings suggest the miDNR can save taxpayer money, conserve wolves, and prevent complaints about wolves by continuing its non-lethal intervention programs.

Research questions:

1. Did lethal control delay subsequent depredation (latency) at a site?  
Preliminary answer: no at three spatial scales (see preliminary report for full details)
2. Did lethal control of a greater number of wolves delay subsequent depredation (latency) at a site? Preliminary answer: no at three spatial scales (see preliminary report for full details)
3. Did the interventions of inaction, non-lethal, or lethal differ from each other in delay to subsequent depredation (latency)? Preliminary answer: (see this report)
4. Taking into account the nature of the complaint (livestock depredation, livestock threat, pet depredation, perceived threat to person or pet), the year and the type of intervention (inaction, non-lethal, or lethal) could we predict time to subsequent depredation (latency)? Preliminary answer: (see this report)

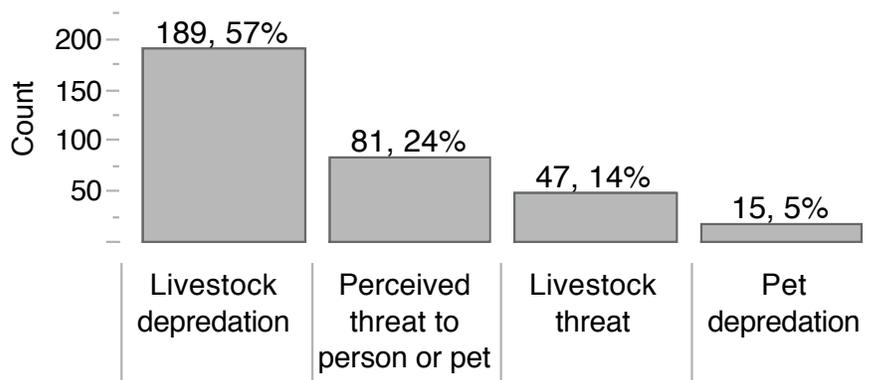


Figure 1. Agency categories of complaints about Upper Peninsula wolves 15 April 2003–7 July 2013. The graphs present the counts and percentages (n, %) of the first incident at a site, excluding subsequent incidents in the vicinity.

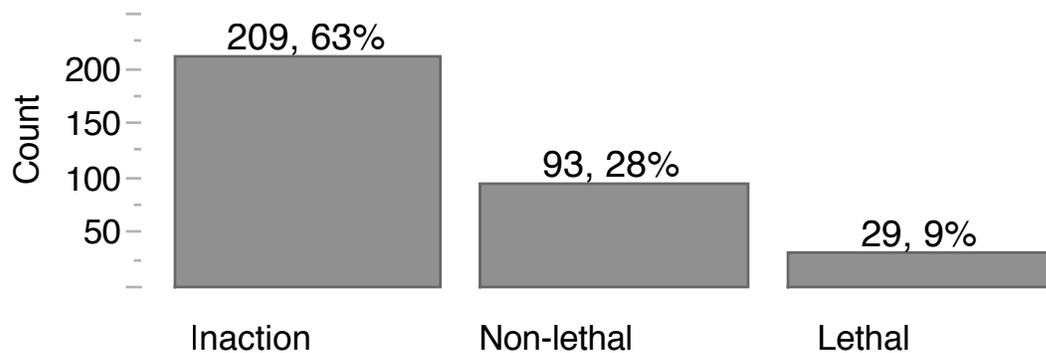


Figure 2. Agency interventions in response to Upper Peninsula resident complaints about wolves 2003–2013. Counts and percentages (n, %) present the dominant response at a property (e.g., if non-lethal interventions were followed by lethal intervention, the property was classified as “lethal” only). “Inaction”= no physical intervention (advice and technical support were apparently always provided). “Non-lethal” = cracker shells, hazing kits, trap-setting, lights, or fencing of various materials. “Lethal” ≥1 live-trapped wolves.

## Results

Research question 3: Did the interventions of inaction, non-lethal, or lethal differ from each other in delay to subsequent depredation (latency)? Preliminary answer: yes non-lethal was more effective at delaying a subsequent depredation.

Non-lethal had the longest latencies (1355 ± 1050 days) compared to lethal (881 ± 1077 days) compared to inaction (846 ± 1111).

However the category of intervention was associated with the type of complaint (Pearson chi-sq=80,  $p < 0.0001$ ) because 79% of lethal interventions followed livestock depredations.

Because the permits for lethal control were issued and rescinded several times during the study period (Refsnider 2009), year was also significantly correlated to intervention category (chi-sq=18,  $p < 0.0001$ ).

Therefore we took into account all three factors (year also) in the following analysis.

Research question 4: Taking into account the nature of the complaint (livestock depredation, livestock threat, pet depredation, perceived threat to person or pet), the year and the type of intervention (Inaction, non-lethal, or lethal) could we predict time to subsequent depredation (latency)? Preliminary answer: no

A parametric survival analysis using a Weibull distribution for latency  $t$  found significant associations with the category of complaint (df=3, chi-squared=23,  $p < 0.0001$ ) and year (df=1, chi-squared=241,  $p < 0.0001$ ) but not intervention (df=2,

chi-squared=5,  $p=0.09$ ). The association with year was a decrease in latency over time (heteroschedastic latency so we used a Spearman  $r_s=-0.52$ ,  $p<0.0001$ ). The association with the category of complaint showed that livestock depredations had the shortest latency ( $676 \pm 1022$  days) followed by livestock threat and pet depredation ( $1191 \pm 1064$  days and  $1267 \pm 1361$  days, respectively) with the longest latency for perceived threat to person or pet at  $1552 \pm 1045$  days.

We also removed year and tested category of complaint and intervention simultaneously. Intervention was less significant in that model ( $p=0.46$ ) yet complaint category was more significant ( $df=3$ ,  $\text{chi-sq}=30$ ,  $p<0.0001$ ).

Repeating the tests of the research questions at the two larger spatial scales did not change the results much but tended to increase the strength of the association with intervention category. Namely, category of intervention was a weakly significant predictor (compared to complaint category) but its strength increased at the scale of a township or a neighborhood of 9 townships. The only significant association was that lethal control following a livestock threat had a significantly shorter latency of  $82 \pm 42$  days.

Recommendations: don't kill wolves because of threats., it made the situation worse at a scale of 9 neighboring townships.

Furthermore, killing wolves did not delay subsequent depredations at any scale in any complaint category.

Non-lethal interventions were the most effective.