Liberalizing the killing of wolves

State of the science

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Recently, some state governments began pursuing aggressive efforts to reduce wolf populations through programs that include liberalized hunting and trapping seasons, and efforts to incentivize killing (e.g., bounties)\(^1\). These efforts represent a departure from policies of the recent past, raising the question: why are states killing wolves? Herein, we address justifications commonly provided for killing wolves and other large carnivores by reviewing the science on the social and ecological effects of these policies.

I. Increasing human tolerance for wolves

The best evidence indicates that the U.S. public at large has become more positive towards

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wolves in recent decades\textsuperscript{2}, despite some members of some interest groups (especially hunters and livestock owners) in areas with wolves have become more negative\textsuperscript{3}. States presumably sought to deal with this by liberalizing killing of wolves via regulated public hunting and trapping seasons. Governments often claim that killing wolves increases public tolerance (or decreases intolerance) for wolves and their conservation\textsuperscript{4}. However, the best scientific evidence indicates that programs that liberalize the killing of wolves have not improved tolerance for wolves in either the general public nor among would-be wolf poachers\textsuperscript{5}. Rather, it appears that these policies and programs have simply encouraged

\begin{itemize}
  \item \textsuperscript{2} A large-sample, repeated cross-sectional study of adult, U.S. residents found that attitudes toward wolves became more positive since the 1970s. The proportion of Americans expressing positive attitudes toward wolves increased by > 40\% between surveys conducted in 1978 and 2014. George, K. A., et al. “Changes in attitudes toward animals in the United States from 1978 to 2014,” \textit{Biological Conservation}, 201, 237-242 (2016).
  \item \textsuperscript{5} For measurement of human attitudes before and after policy changes that liberalized wolf-killing or conversely tightened protections for wolves, see two sets of data from Wisconsin collected since 2001 using focus groups or mail-back surveys C. Browne-Nuñez et al., “Tolerance of Wolves in Wisconsin: A Mixed-
more killing of wolves\(^6\). Specifically, studies conducted before and after the programs were


In particular, Hogberg et al. (2015) used a mail-back survey to resample individuals in 2013 after the inaugural Wisconsin wolf-hunt in 2012 and compared their responses to those of the same individuals measured in 2009. She found the largest declines in individual tolerance among men in wolf range with familiarity with hunting, the target demographic for such claims about tolerance rising after wolf-killing. Likewise, Browne-Numéz et al. (2015) convened focus groups and analyzed anonymous questionnaires filled out by the same participants to in a mixed-methods approach to understand attitudes to changes in policy that allowed government agents to kill wolves suspected of preying on livestock Browne-Numéz et al. Focus groups conducted after the change in policy showed increased calls for yet more wolf-killing and no change in tolerance for wolves or inclination to kill wolves illegally among focus group participants drawn from deer hunters, bear hunters, or livestock owners. Similar results of no differences in attitudes come from areas with and without hunting of brown bears in Slovenia P. Kaczensky, M. Blazic, and H. Gosgow, "Public Attitudes Towards Brown Bears (Ursus Arctos) in Slovenia," Biological Conservation 118 (2004).

A study that is not peer-reviewed to our knowledge from Montana Fish Wildlife & Parks is sometimes cited as counter-evidence. However the only report we could find that was entitled, “Selected results” seemed instead to report that attitudes of hunters toward state wolf policy improved when they were allowed to hunt wolves and those self-reports were retrospective recall of the respondents’ past attitudes; see: Michael S. Lewis et al., Selected Results from Four Separate Surveys of Resident Montanans Regarding Montana’s Wolf Hunt (Montana Fish Wildlife and Parks, 2012). Hogberg et al. (2015) measured both retrospective self-reports of tolerance for wolves and more objective measures of tolerance for wolves at two time points — among the same respondents — and found the two were not always congruent. Individuals whose more objective measures showed a decline in tolerance would often report no change or an improvement in their tolerance Hogberg et al.

initiated indicate they did not have the intended effect. More importantly, studies that have sought to evaluate the effect of liberalized killing policies on poaching found an increased tendency for radio-collared wolves to disappear whenever governments reduced protections for wolves. Thus, in contrast to promoting tolerance, these policies appear to have had the opposite effect (i.e., they led to increased poaching).

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radio-collared wolves in two populations Louchouarn et al, Santiago-Ávila, Chappell, and Treves. and three additional studies in review (Santiago-Avila, Louchouarn, in review). Collectively, each of these studies shows one or more of the following patterns of human behavior detected by changes in incidence of death or disappearance of collared wolves during periods of liberalized wolf-killing: an increase in cryptic poaching (sensu Olof Liberg et al., "Shoot, Shovel and Shut Up: Cryptic Poaching Slows Restoration of a Large Carnivore in Europe," *Proceedings of the Royal Society of London Series B* 270 (2012).) involving the concealment of evidence, an increase in documented poaching without concealment of evidence, or an increase in both incidences. In addition to the most rigorous analytical methods, the scientific manuscripts were submitted under new Open Science rules for registered reports that reduce publication biases Jeremy Sanders et al., "Transparency and Openness in Science," *Royal Society Open Science* https://doi.org/10.1098/rsos.160979 (2017). That makes these studies the best available science by the standards of evidence accepted by the global scientific community.

The only credible peer-reviewed research suggesting poaching declined when legal wolf-killing was liberalized comes from Scandinavia Olof Liberg et al., "Poaching-Related Disappearance Rate of Wolves in Sweden Was Positively Related to Population Size and Negatively to Legal Culling," *Biological Conservation* 243 (2020), https://dx.doi.org/10.1016/j.biocon.2020.108456., but it has been questioned on statistical grounds of inappropriate survival analyses and inappropriate model specifications A Treves, N.X. Louchouarn, and F. Santiago-Ávila, "Modelling Concerns Confound Evaluations of Legal Wolf-Killing," *Biological Conservation* https://doi.org/10.1016/j.biocon.2020.108643 (2020), https://dx.doi.org/10.1016/j.biocon.2020.108643.. It also did not account for the finding from neighboring Finland that the more legal killing occurred, the lower the risk of poaching because wolves were removed legally before they could be removed illegally J Suutarinen, and I. Kojola, "Poaching Regulates the Legally Hunted Wolf Population in Finland," *Biological Conservation* 215 (2017), http://www.sciencedirect.com/science/article/pii/S0006320717302148, J Suutarinen, and I. Kojola, "One Way or Another: Predictors of Wolf Poaching in a Legally Harvested Wolf Population," *Animal Conservation* 21, no. 5 (2018), https://dx.doi.org/https://doi.org/10.1111/acv.12409.. As Santiago-Ávila and Louchouarn pointed out, when the government preemptively removes wolves suspected of problems before these can be killed illegally, it’s difficult to claim tolerance has improved among affected interest groups Louchouarn et al, Santiago-Ávila, Chappell, and Treves..

The latter studies also found that poaching of wolves changed in association with census methods with the pattern apparently being one of lower poaching when more civilian volunteers supported wolf census in Wisconsin Santiago-Ávila, Chappell, and Treves.. And when the federal government liberalized wolf removal but did not alter the hazard or incidence of legal removal by its own agents, the hazard and incidence of disappearances of radio-collared wolves rose 121% Louchouarn et al., which suggests the government may have motivated cryptic poaching. The latter studies support the hypothesis that governments send a signal to would-be poachers that wolves have less value or the government needs the support of poachers to control wolf populations Chapron, and Treves, "Blood Does Not Buy Goodwill: Allowing Culling Increases Poaching of a Large Carnivore." Independent, corroborating evidence that cryptic poaching carnivore-killing comes from two studies of wolverines *Gulo gulf* in Scandinavia. For one, GPS-collared wolves were less likely to die from illegal kills in a legally hunted population Cyril Milleret et al., "Gps Collars Have an Apparent Positive Effect on the Survival of a Large Carnivore," *Biology Letters* 17, no. 6 (2021), https://dx.doi.org/10.1098/rsbl.2021.0128.. Second, incentive programs that paid for living female wolverines led to higher rates of poaching of male wolverines Jens Persson, Geir Rune Rauset, and Guillaume Chapron, "Paying for an Endangered Predator Leads to Population Recovery," *Conservation Letters* 8, no. 5 (2015).
II. Decreasing predation on domestic livestock or wild ungulates

A second reason governments give to kill wolves is that it is necessary to protect other animals (both domestic livestock and valued game)\(^7\). In the case of livestock protection, the best available evidence would come from before-and-after comparisons of interventions with random sampling\(^8\). No such studies exist but a lower standard of evidence (before-and-after comparisons without random sampling) reveal no protective effect of targeted wolf-killing, in a minority of cases wolf-killing appeared effective for preventing recurrent livestock killing, but an equal or greater number of cases appear to show increase in livestock killing after lethal management\(^9\).

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\(^9\) First it should be stated clearly that none of the research on lethal management of wolves to protect livestock met the highest standard but rather fell between before-and-after comparisons without randomization or lower standard correlational analyses (e.g., A. Fernández-Gil et al., "Conflict Misleads Large Carnivore Management and Conservation: Brown Bears and Wolves in Spain," *PLos ONE* 11, no. 3 (2016), https://dx.doi.org/10.1371/journal.pone.0151541, M. Krofel, R. Černe, and K. Jerina, "Effectiveness of Wolf (Canis lupus) Culling as a Measure to Reduce Livestock Depredations," *Acta Silvae et Ligni* 95 (2011), Camille Imbert et al., "Why Do Wolves Eat Livestock? Factors Influencing Wolf Diet in Northern Italy," *Biological Conservation* 195 (2016). Second, among the better studies reviewed in Treves, Krofel, and McManus. and reanalyzing raw data from Krofel, Černe, and Jerina., we find the most careful ones to be F.J. Santiago-Avila, A.
In contrast, research indicates at least three forms of non-lethal interventions are effective specifically against wolves\textsuperscript{10}. Preventative, non-lethal methods are generally preferable over...


post hoc killing of predators because non-lethal methods (a) allow owners to avoid losses as well as associated government reimbursements (thus saving money and time)\textsuperscript{11}, (b) have not led to those counter-productive increases in livestock losses\textsuperscript{12}, and (c) avoid removing wolves, which, among other problems, diminish the benefits of wolves and may disrupt social dynamics in ways that lead to additional livestock losses, thereby probably perpetuating a cycle of killing that can spread livestock losses geographically\textsuperscript{13}.

Although eradication of all predators would, of course, protect livestock from predation\textsuperscript{14}, less drastic killing can produce variable and unpredictable results. For example, lethal management that left survivors of the same species in a majority of cases resulted in higher livestock losses as summarized on the previous page, as did lethal management that

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\textsuperscript{12} Note that at least one non-lethal method (Foxlights\textsuperscript{™}) were associated with increases in predation by carnivores other than wolves and so resulted in more livestock losses under particular circumstances, i.e., effective against pumas but not Andean foxes in Chile Ohrens, Bonacic, and Treves. and counter-productive against foxes in Australia K. Hall, and P. A. Fleming, "In the Spotlight: Can Lights Be Used to Mitigate Fox Predation in a Free-Range 4 Piggery?," \textit{Applied Animal Behaviour Science} 2 (2021). Also, sub-lethal methods such as translocation result in higher mortality of the translocated wolves and perhaps recurrent livestock losses following such removals S. H. Fritts, W. J. Paul, and L. D. Mech, "Can Relocated Wolves Survive?," \textit{Wildlife Society Bulletin} 13 (1985)..

\textsuperscript{13} Santiago-Avila, Cormnan, and Treves.

eliminated one species but left another species of predator\textsuperscript{15}. The counter-productive increase in property damage or losses of game after lethal management have been reported anecdotally for over half a century\textsuperscript{16}. Such anecdotes have been corroborated by systematic scientific studies of coyote-killing\textsuperscript{17} and more recently by systematic scientific studies of wolf killing in several countries as summarized in the previous page. Given that societies globally have outlawed programs of eradication of native predators\textsuperscript{18}, we conclude from the scientific evidence that non-lethal methods are the more useful alternative.

Relatedly, governments have for a century or more justified killing wolves as a means to


\textsuperscript{17} Virtually all coyote predation on sheep is done by mated pairs with pups to feed, so most lethal management kills coyotes that have not killed and will not kill sheep F. F. Knowlton, E. M. Gese, and M. M. Jaeger, "Coyote Depredation Control: An Interface between Biology and Management," \textit{Journal of Range Management} 52 (1999); also see A.D. Wallach, D. Ramp, and A. J. O'Neill, "Cattle Mortality on a Predator-Friendly Station in Central Australia," \textit{Journal of Mammalogy} 98, no. 1 (2017), DOI:10.1093/jmammal/gyw145. for counter-productive effects of killing dingoes on an Australian cattle ranch.

increase hunting opportunity for hunters seeking wild ungulates such as elk and deer. Yet, while the best scientific evidence shows that wolves are capable of reducing wild ungulate densities, wolves’ ability to limit ungulate populations likely depends on other factors (e.g., winter severity). Moreover, the most recent meta-analysis indicates that, counterintuitively, predator control can actually lead to reductions in wild ungulate abundance, juvenile survival, and adult survival.

Also, reports from all states with wolf populations indicate that opportunities to hunt wild ungulates have not been diminished by increased wolf populations. Indeed, recent records from Idaho, Montana, and Wyoming indicate that the number of elk killed by hunters in recent years is stable to increasing in those three states, as are elk populations. In Wisconsin, the thirty-year period 1980-2010 saw the state white-tailed deer population double from 800,000 to 1.6 million while the wolf population went from a handful to 700 wolves. Additionally, hunters took 200,000 deer in the 1980s to 500-600,000 in the 2000s. Collectively, these data and the scientific studies suggest that efforts to kill wolves to increase wild ungulate abundance should be undertaken rarely and that the potential for opposite, counterproductive effects be considered. Such

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22Clark & Hebblewhite (2021) concluded that “…it is unknown how effective predator removal is in decreasing predation on ungulates due to a lack of quantitative synthesis, despite the long history of implementation in North America… from 47 publications. We then conducted a meta-analysis to determine the overall effect size and factors which increased ungulate demography during predator removal. Lastly, we tested for evidence of publication bias and experimental rigour for these experiments… Focusing just on management removals, ungulate demographic responses increased only by 7.8% (95% PI = -32% to 72%)… The low and variable effectiveness of predator removal for ungulate populations might be linked to ungulates’ slow life history and the compensatory mortality of carnivores on ungulates, though effects were stronger on endangered prey. We identified the experimental design factors that led to greater uncertainty in ungulate responses to predator removal, including lack of randomization, low replication and short temporal length. Lastly, we found evidence of publication bias, where experiments with poor rigour and negative effects (i.e. reduced ungulate demography following predator removal) were under-reported.” Clark, T.J. and M. Hebblewhite, *Predator control may not increase ungulate populations in the future: A formal meta-analysis*. Journal of Applied Ecology, 2021. 58(4): p. 812-824. https://doi.org/10.1111/1365-2664.13810.

23 Data from Idaho, Montana and Wyoming were aggregated by Colorado State University Extension; a summary is available here: https://extension.colostate.edu/topic-areas/people-predators/wolves-big-game-and-hunting-8-001/

24 Also from 1975-2020, the state deer population grew from 600,000 to 1.61 million in post-hunt (Source https://www.researchgate.net/figure/Wisconsin-Prehunt-and-Posthunt-Deer-Population-Estimates-and-Goal-1960-2010-Source_fig5_324135601) during a similar period the wolf population grew from zero to 1034 in late winter counts BUREAU OF WILDLIFE MANAGEMENT, Wisconsin Gray Wolf Monitoring Report 15 April 2019 through 14 April 2020, by J.E. Wiedenhoeft et al. (Madison, Wisconsin: Wisconsin Department of Natural Resources, 2020).
predator control should only be implemented with scientific understanding and caution.

III. Increasing human safety

A final reason governments have given to kill wolves is to increase human safety. Although wolves can and do occasionally attack people, such encounters are extremely rare. While attacks are often linked with rabies, predatory attacks also occur. However, as a recent review concluded, “...these have been associated with a special set of environmental circumstances (absence of wild prey, heavily modified landscapes, high density of humans engaged in vulnerable activities) that are no longer present...” and consequently, “the risks of wolf attacks are currently very low”, at least in North American Europe.

In those rare cases where wolves exhibit behavior that has led to attacks on humans in the past (e.g., food-conditioning), it may be prudent to kill those specific animals that appear to be an imminent threat to safety. However, there is simply no evidence that such behavior is widespread, nor is there a reason to believe that the aggressive killing programs proposed by U.S. states would lead to a meaningful reduction of risk. Indeed, given that zero people have been killed by wild wolves in the lower 48 states in the last 50 years, attempting to justify widespread killing based upon concern for safety appears disingenuous at best.

IV. Humans, wolves, and maximizing benefits minus costs of coexistence

25 During European history, wolf attacks were more common but were associated in a majority of incidents with rabies or starving wolves apparently J. D. C. Linnell, and T. Bjerke, "Frykten for Ulven. En Tverrfaglig Utredning. (Fear of Wolves: An Interdisciplinary Study,)." Norsk Institutt for Naturforskning. Oppdragsmelding 722 (2002); see also case studies in VE; Sidorovich, LL; Tikhomirova, and B. Jedrzejewska, "Wolf Canis Lupus Numbers, Diet and Damage to Livestock in Relation to Hunting and Ungulate Abundance in Northeastern Belarus During 1990-2000," Wildlife Biology 9, no. 2 (2003), K. S. Rajpurohit, "Child Lifting Wolves in Hazaribagh, India," Ambio 28 (1998). Other precipitating conditions may include food provisioning that habituates wild wolves to finding food near people M. E. McNay, "Wolf-Human Interactions in Alaska and Canada: A Review of the Case History," Wildlife Society Bulletin 30 (2002). Given the recovery of many wild prey populations eaten by wolves and wider acknowledgment of the problem associated with supplemental feeding of wild carnivores, the conditions for wolf attacks on people have accordingly diminished. It’s unclear to us if rabies or other zoonotic diseases have changed in incidence among wild wolves, but the bidirectional nature of transmission of some of these diseases suggests that we not only need study of incidence in wild wolves but also study of their incidences in domestic animals ranging in wild habitat, if we wish to control the transmission of disease to wolves near people.


28 In a recent review, John Linnell and Colleagues identified just two fatal attacks in all of North America and Europe over the past 18 years (in Alaska and Canada). We stress, as they did, that wolves do attack and kill people, but fatal attacks are exceedingly rare. Linnell, John DC et al. “Wolf attacks on humans: an update for 2002–2020.” NINA Report 1944. Norwegian Institute for Nature Research.
Public policy debate often focuses on population size without considering individuals\textsuperscript{29}. Behavioral and cognitive scientists have shown that wolves are intelligent, cooperative individuals with personalities, complex social relationships, and cultures in their families and networks of packs\textsuperscript{30}. Genetic evidence is increasingly pointing to small demographic units such as packs and even individuals as vital repositories of unique genetic information\textsuperscript{31}, challenging the idea that management should be concerned only with populations (as opposed to individual animals). This value judgment\textsuperscript{32}—that wildlife management should not be concerned with individuals—has deep roots in American game management, which has historically been focused on the production of game for hunting and trapping opportunities\textsuperscript{33}. Recent research showing relative homogeneity (in terms of values) in state wildlife agencies\textsuperscript{34} is likely promoting resistance to recognizing the importance of smaller demographic units. One means of reducing such bias is to make agency decision processes more inclusive—that is, involving individuals trained in different traditions, and representing broad interests\textsuperscript{35}.


\textsuperscript{33}Leopold, Aldo. \textit{Game Management}. Madison: University of Wisconsin Press, 1933.


\textsuperscript{35}For example, Schulz-Hardt et al. (2002) show that more heterogenous groups can reduce biased information seeking, leading groups to consider a broader range of information. Schulz-Hardt, Stefan, Marc Jochims, and
Research documenting changes in social values suggests that management that ignores welfare outcomes for individual animals is likely to be increasingly out of step with U.S. values and expectations for wildlife management\textsuperscript{36}. Moreover, the common conflation of animal rights and individual animal worth or individual intrinsic values is an error in defining one’s terms that all scientists should work to rectify. Research shows that majorities of people appreciate wolves\textsuperscript{37} and that the benefits people appreciate from wildlife such as wolves are both financial and non-financial. That research also shows that the U.S. public prefers non-lethal methods to lethal ones, a trend intensifying over time.\textsuperscript{38} Such views are under-represented in U.S. wildlife agencies currently\textsuperscript{39}.

Beyond these aesthetic and economic benefits, many studies suggest wolves can elicit broader ecological benefits through their effect on their prey, associated scavengers, and vegetation\textsuperscript{40}. Though these benefits are likely dependent upon certain conditions, and therefore cannot be anticipated in all cases, research suggests wolves can enhance biodiversity by direct and indirect pathways begun by limiting ungulate herbivory or by altering the competition between prey species or their relative abundances. Although more research is needed, hundreds of studies in many systems indicate that top predators play such roles in their ecosystems\textsuperscript{41}.

Moreover, the ecological effects of wolves have the potential to benefit humans indirectly. Indeed, one study found where wolf packs hunt there are fewer deer-vehicle collisions\textsuperscript{42}.

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\textsuperscript{42} From Wisconsin, preliminary findings suggest that where wolf packs hunt, counties report fewer deer-vehicle collisions with associated protection of human life and associated financial savings totaling in the millions of dollars Jennifer L. Raynor, Corbett A. Grainger, and Dominic P. Parker, "Wolves Make Roadways Safer, Generating Large Economic Returns to Predator Conservation," \textit{Proceedings of the National Academy of
Several studies in Wisconsin show benefits of wolves for forest diversity and resilience, and others suggest that wolves may lower the risk of zoonotic disease.

Collectively, the literature documenting the broad risks and benefits associated with wolves makes it difficult for scientists to understand the fact claims used by states to justify the current aggressive efforts to kill wolves. The risks associated with wolves (i.e., attacks on livestock, pets or humans; diminished hunting opportunity) is likely to be exceedingly small. At the population level, these costs are inconsequential relative to other non-wolf risks to those human interests. Although society must make the value judgment not scientists, it behooves s to point out that programs of lethal management of wolves are not cost-free so the use of public funds for wolf killing should be weighed against the benefits-costs of wolves protected from such programs and the need for public funds for other priorities.

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*Sciences* 118, no. 22 (2021), https://dx.doi.org/https://doi.org/10.1073/pnas.2023251118, rare understory plants fare better near the center of wolf pack territories Ramana Callan et al., "Recolonizing Wolves Trigger a Trophic Cascade in Wisconsin (USA)," *Journal of Ecology* 101 (2013), https://dx.doi.org/https://doi.org/10.1111/1365-2745.12095, and forests were more biodiverse in wildlife and plants, were more mature, had higher tree volumes, showed higher regeneration rates, and experienced fewer invasive species population explosions D. M. Waller, and N.J. Reo, "First Stewards: Ecological Outcomes of Forest and Wildlife Stewardship by Indigenous Peoples of Wisconsin, USA," *Ecology and Society* 23, no. 1 (2018), https://doi.org/10.5751/ES-09865-230145. These recent results have not yet been formally compared to the economic costs long attributed to wolves, so we call for such a formal analysis by economists. For example, in Wisconsin, livestock losses to wolves affected <1% of farms and a tenth of one percent of livestock, while at the same time being highly predictable in space so one might attempt to prevent even those few losses Treves et al., A. Treves et al., "Forecasting Environmental Hazards and the Application of Risk Maps to Predator Attacks on Livestock," *Bioscience* 61 (2011), A. Treves, and M.F. Rabenhorst, "Risk Map for Wolf Threats to Livestock Still Predictive 5 Years after Construction," *PLos ONE* 12, no. 6 (2017), https://dx.doi.org/http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0180043. Also, wolf-dog interactions suffer from reporting biases and notable instances where dog owners failed to take preventive precautions despite being informed of where the risks lay E.R. Olson et al., "Landscape Predictors of Wolf Attacks on Bear-Hunting Dogs in Wisconsin, USA," *Wildlife Research* 41 (2014), A. P. Wydeven et al., "Characteristics of Wolf Packs in Wisconsin: Identification of Traits Influencing Depredation," in *People and Predators: From Conflict to Coexistence*, ed. N. Fascione, A. Delach, and M. E. Smith (Washington, D.C.: Island Press, 2004). The Wisconsin public expected domestic animal owners to follow best management practices and responsible husbandry, seemingly to avoid the moral hazards that can accompany compensation programs Naughton-Treves, Grossberg, and Treves, Treves et al. Instead, compensation rules became more lax and more generous under political pressure from powerful interest groups Treves et al. At the same time, in other regions, concerns rose about the accuracy of verification of wolf predation and the reliability of compensation programs suggest that an important remedy would be third-party scrutiny of methods used and data collected by agencies José V. López-Bao et al., "Building Public Trust in Compensation Programs through Accuracy Assessments of Damage Verification Protocols," *Biological Conservation* 213 (2017), M. Agarwala et al., "Paying for Wildlife. Compensation Policy and Practice for Wolves in Solapur, India and Wisconsin, USA," *Biological Conservation* 143, no. 12 (2010), Liivi Plumer et al., "Assessing the Roles of Wolves and Dogs in Livestock Predation and Suggestions for Mitigating Human-Wildlife Conflict and Conservation of Wolves," *Conservation Genetics* https://doi.org/10.1007/s10592-017-1045-4 (2018). The increased scrutiny of compensation programs worldwide has led to population-wide economic analyses of wolf predation on livestock. Many studies show that other causes of morbidity and mortality in livestock such as disease, weather, and accidents are far more serious, especially in systems where owners have left livestock unsupervised for long periods J. D. C. Linnell, and H. Broseth, "Compensation for Large Carnivore Depredation of Domestic Sheep," *Carnivore Damage Prevention News* 6 (2003), Allen, and Sparkes, Wallach, Ramp, and O’Neill.
Moreover, it is not at all clear that aggressive killing of wolves is likely to significantly reduce these risks as we summarized in section II. Conversely, it is likely that the large-scale killing of hundreds of wolves as proposed by some states will substantially diminish the benefits associated with their presence as we summarized in the latter section.

V. Why are states aggressively killing wolves?

The scarcity of scientific evidence justifying lethal management of wolves leads to an obvious question: why are state governments promoting aggressive killing programs? Are these programs simply misguided attempts to promote the outcomes—increased safety, increased hunting opportunity, decreased livestock predation— that politicians have provided as justification? Or alternatively, are such justifications merely post-hoc rationalizations meant to make these programs more palatable to a largely skeptical, but uninformed public? And if so, what is it they truly seek to accomplish with such policy? Of course, we cannot know until policy-makers state their values and ethical reasoning more plainly.

References and Citations


Eklund, A., José Vicente López-Bao, Mahdieh Tourani, Guillaume Chapron, and Jens Frank. "Limited Evidence on the Effectiveness of Interventions to Reduce Livestock Predation by Large Carnivores." *Scientific Reports* 7 (2017): 2097 | DOI:10.1038/s41598-017-02323-w.


