Appendix 1 — Duties of a Wildlife Trustee

1. A wildlife trustee's most important duty is not to substantially impair the public asset.

I follow the standard announced in 1892 by the U.S. Supreme Court in *Illinois Central Railroad Co. v. Illinois*, that a public trustee must protect and preserve trust resources from "substantial impairment." Impairment is defined as "deterioration; injurious lessening or weakening." [1] As a scientist, I understand a resource to be impaired when any one of the following conditions are met: (a) the quantity of the resource has been substantially reduced; (b) the ability of the resource to reproduce or perpetuate itself has been weakened, reduced, or deteriorated; or (c) the quality of the resource has been weakened, reduced, or deteriorated.

In the context of the Wisconsin wolf population, I believe DNR, acting as a trustee, has a responsibility to prevent: (a) the wolf population from dropping to the state listing level of 250; (b) an impairment of the population's ability to sustain itself through reproduction; and (c) such harm being done to the population that DNR is removed as the trustee because the species has been placed back on the endangered species list, and replaced by the U.S. Fish and Wildlife Service as a trustee. so much that the state trustee is overruled by the federal trustee (in ESA delisting, the USFWS acknowledged it has a trustee responsibility [2]; and (d) repairing damage when errors are made. These are affirmative duties, meaning the trustee must act not simply to avoid harm or negligence.

This responsibility leaves us to ask the following questions about Wisconsin wolf management.

A. *Has the quantity of the wolf population been weakened, reduced, or deteriorated so much that it cannot recover by November 2021?*

In a manuscript that my colleagues and I currently have under review, [3] we address whether the state trustee has already allowed substantial impairment of the WI wolf population prior to this date. Our manuscript presents an optimistic conservative minimum loss of wolves and maximum population size, not the worst-case precautionary scenario. We conclude the trustee allowed just over 300 wolf-hunters and wolf-poachers to reduce the state wolf population by 27-33%. We predict that putting wolves back under endangered species protection for several years (without hunting or high rates of government lethal control) would allow the population to recover numerically from the 2021 impairment, if reproduction was not also substantially impaired substantially also.

B. *Has the reproductive potential of the Wisconsin wolf population—in other words, the potential for the population to replenish its quantity and quality—been weakened, reduced, or deteriorated so much that it cannot recover by November 2021?*

We do not know the answer to this question definitively, but the February 2021 wolf hunt was an unprecedented hazard for the breeding wolf packs that were hunted (whether an alpha was killed or not). A pessimistic view is that any wolf pack exposed to hunting at that critical period—including pursuit by hounds, snowmobiles, or hunters with lights at night—faced an elevated risk of failed reproduction through the resorption of fetuses, termination of estrous receptivity, separation of alphas or other pack members from the pack, and other stressors.

Packs are family units. A pack that loses a member is more likely to fail to reproduce. Each pack contains one alpha male, one alpha female, and supernumerary adults that are often genetic relatives who help protect and raise the young. Therefore, packs disrupted by hunting are less likely to raise a litter of pups in the summer of 2021. How much lower? We don't know exactly, but certainly less than under the best conditions measured by Thiel et al. [4] Their work tells us that an average of 72% of packs produce pups annually (range 57-89%) under the best of conditions (low-density, recolonizing, full federal ESA protection, no public hunting).

The February 2021 hunt was the worst situation we have seen yet, so a precautionary approach would be to take the minimum values reported by Thiel et al. at every stage of reproduction as follows: I would expect <57% of all wolf packs would breed, following Thiel and that number might decline even further once the state estimates how many wolf packs in total were exposed to hunters and poachers in 2020-2021. The safest precautionary estimate is that only the handful of wolf packs protected in Indian reservations will reproduce in 2021. Beyond estimating the number of packs that produced pups as of summer 2021, Thiel also gives us estimates for survival of pups through November when they are considered independent. Those authors reported an average of 4.8 pups per litter in July (range 3-6) with ensuing survival averaging 0.2 (range 0.05-0.72). The precautionary approach would be to assume a bad year for pups, because so many packs lost adults during the previous year, and parents and supernumerary adults help to feed and protect pups.

Taking the minimum values in each range above, only 22 pups would survive to November 2021, leading to a predicted 21% decrease in recruitment of young into the population by November. The only way to be sure this pessimistic scenario is not realized would be to count pups in July in all wolf packs and measure those pups' survival in the following 6 months. To do so, the DNR should validate counts with blind tests of interobserver reliability, given experimental evidence of inaccuracy of howling surveys used to estimate pup numbers.[5]

C. Beyond (A) the numbers of adults alive, and (B) the numbers of pups born in 2021, what can we say about the quality of the wolf population resource in 2021?

Quality is an understudied aspect of predator populations. There has been some work on ecological functionality or ecological effectiveness of large predators.[6, 7] Although there is little consensus on this topic yet, most experts agree that social, gregarious predators exert their full functional ecological effects—hunting prey, defending territories, forming social networks or families—when unexploited in wild ecosystems. Creel and Rotella[8] showed that any level of human-caused mortality is associated with slow-downs in population growth, hence reproduction is likely to be affected no matter how light the human-caused mortality.

Wisconsin has rarely had ecosystems without human influence,[9, 10] but it would not be correct to say wolves in Wisconsin exert their functional, ecological roles under any level of human disturbance and exploitation. We know that wolf packs in Wisconsin may disband when they lose alphas. [11] Disbanding represents the loss of the functional, ecological role of that wolf pack in its local area for one year or more. We also know that small Wisconsin wolf packs (2-3 adults) were more likely to fail to reproduce and disband than large wolf packs, [6-11] and that smaller wolf packs were more likely to attack farm animals in Wisconsin and beyond. [12-15] Also, Santiago-Ávila et al.[16] studying wolf-killing in the neighboring state of Michigan, reported that risk for cattle tripled after only one wolf was killed in a neighboring township. The net change in risk across all spatial scales was +25% after one or more wolves was killed and regardless of the number of wolves killed at a site.

Therefore, the February 2021 wolf-hunt likely changed the functional, ecological effect (quality) of wolf packs that lost ANY individual during the hunt. The change would likely be towards more farm animal predation in 2021,

higher chance of pack disbandment, lost reproduction, and less competency in hunting, defending a territory, and raising young. Moreover, when packs disband the survivors typically disperse, which may lead to more solitary wolves. Solitary wolves outside their familiar territories suffer higher mortality,[17] may disrupt neighbors or prey on domestic animals at a landscape scale, may get into more vehicle collisions leading to property damage and loss of human life or emigrate from the state of Wisconsin to less disturbed habitats. Any tourism oriented around wolf packs may have to adjust to the disbandment of some packs and perhaps to surviving wolves' greater fear of people.

Although each statement above has a probability that it may or may not occur, the entire scenario is not speculative. We know exploited wolves respond by pack disbandment and individual dispersal.[11] All of the above changes alter the quality of the surviving wolves, above and beyond any loss of wolves or pups.

2. The second-highest priority for a wildlife trustee is to preserve uses for future generations.

Preserving a resource for future generations requires (a) prioritizing future generations' interests in preservation over current users' interests in exploitation; (b) regulating use by current generations to sustainable levels with precautions against errors; and (c) eliminating illegal, unregulated, or undetected uses that drain the public asset. Illegal uses should count against the share for legal consumptive users, not be discounted. When counting current users among the many beneficiaries, the trustee should distinguish those users who expend the asset for private benefit or for the benefit of the government and prioritize users who do not expend the asset. These are affirmative duties meaning the trustee must act protectively and remedially not simply to avoid harm or negligence.

A. Few Wisconsin Current Adults Want to Hunt Wolves. [19]

Even among hunters, our surveys showed how few hunters wanted to use dogs or traps. [20, 21] Yet >80% of wolves were killed by hound hunters and our 2021 manuscript under review estimates that 218 hunters and <105 poachers took >27-33% of the population.[3]

B. NRB Focused on Maximizing Hunter Access.

Rather than acknowledging the competing interests in wolves (tribal versus state first by federal treaty, then future generations versus current generations, then state non-consumptive users versus consumptive users), the NRB (and to a lesser extent DNR) focused on maximizing hunter access and opportunity by discussing low fee structures, emphasizing no zone closures, and doubling the number of permits issued.[18] Non-consumptive users are also disenfranchised by the payment structure created by the government (wildlife feeding requires a permit called a hunting permit, donors to wolf compensation funds were anonymous until 2012; state park fees are not counted towards the wildlife budget).[22, 23]

C. Illegal Uses Of Wolves Were Not Counted Correctly And Were Not Counted Against the Quota.

Since 2014, I expressed concern that DNR was not counting mortality correctly, and specifically that it had under-estimated poaching in 2012 and 2014.[24] In 2017, we proved this arithmetically twice.[25, 26] In 2019 and again in 2020, we showed that collared wolves in Wisconsin were disappearing at very high rates most likely due to illegal killing, and we showed the DNR how to estimate and model that rate more accurately.[3, 27-31] We also showed that illegal killing outpaced legal killing since 1980, and that illegal killing increased when wolf-killing was legalized and liberalized. None of this was properly accounted for on February 15, 2021, when DNR recommended a quota for legal wolf-killing and claimed background non-harvest human-caused mortality was 14%. As a result of taking our estimates into account, scientists would find that half of the recommended quota would already be dead from poaching and additional, new mortality between November 3, 2020 and April 14, 2021.[3] That in itself would have more than halved the recommended quota.

D. The affirmative duties of a trustee include strict enforcement against illegal uses and reparations for losses of public assets.

Performing the duties of a trustee might include conducting law enforcement investigations, community policing, and public relations campaigns informing hunters the legal quota would be diminished by illegal killing. We did not see such efforts and indeed, collection of information from legally killed wolves was curtailed. For example, DNR did not ask hunters to turn in wolf carcasses for inspection, as would have fallen within its discretionary authority.[3] Such carcass inspections are valuable for discerning causes of death, sexing wolves, aging wolves, and collection of reproductive tracts to estimate how many breeding females were killed.[32] Hunter self-reports are no substitute because they lack information on reproductive status of females, and age estimation is guesswork by untrained individuals. Even DNR biologists have made substantial errors in age estimation based on size of wolves.[25] Furthermore, failure to collect more than the 20 carcasses voluntarily turned in by hunters made it impossible to measure whether illegal methods such as hound bites or poison had been used.

3. The third-highest priority for a wildlife trustee is to prove transparently that it is doing the above priorities effectively and cost-efficiently.

This type of transparency requires (a) sophisticated, clear accounting using the best available science for wildlife protection and regulation of human uses; (b) accountability to all the beneficiaries; (c) correcting errors in the record forthrightly and honestly; and (d) the trustee must be incorruptible and independent of beneficiaries.

A. Balancing competing interests among beneficiaries

For the relationships to beneficiaries and trustee accountability, I draw the DNR's attention to work on the duties of public trustees.[23, 33-40] [41-46]

One of the most challenging actions for a trustee will be to balance competing interests among legitimate beneficiaries. I provide an example below that includes future generations as first priority, then current users secondary with a federally imposed balance between Ojibwe tribal interests and wolf-killing interests as a subcomponent of current users, though not the entire universe (see above). For example, the decision to hunt wolves (or to challenge an existing hunting system) would pit current adult human groups against each other, such as the Ojibwe tribal governments against the largely Euro-American, male carnivore-hunters in Wisconsin.[47-49] We present a hypothetical example of the very different demands each such current human group might make in **Figure 1**. Similar competing interests might be analyzed and considered equitably for non-anthropocentric interests, which would not play out quantitatively in terms of wolf-killing but qualitatively in terms of individual, community, and aggregated biotic well-being and health. The caption of **Figure 1** explains why a trustee-advocate would have to understand the science, the ethics of decision-making, the law, and the competing interests within their constituency to balance those interests and argue for their constituents as a whole." Internal citations updated).[38]

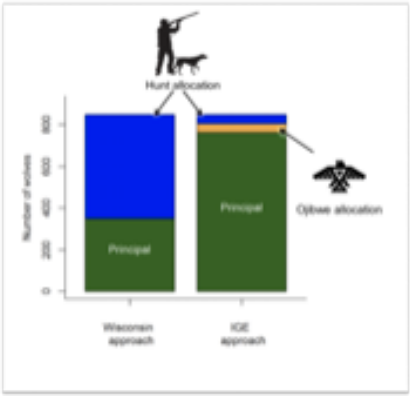

Figure 1. Schematic drawing of hypothetical competing interests between two current adult human groups. These are just two of the current adult human groups that have an interest. LEFT: The Wisconsin approach represents state government policy as of 2020 with a population goal at 350 wolves (green), the remainder of the wolves being allocated only to wolf-killing interests, i.e., private citizens hunters, trappers, and livestock owners via permits (blue). RIGHT: The Intergenerational Equity (IGE) approach is a hypothetical one in which the legacy of 815 wolves transferred from the U.S. federal government to the state and tribes in 2012 would be defined as the principal for future generations (green). Then federal treaty rights negotiated with Ojibwe nations grant equal authority (orange). Finally, current users would be allocated only half of the interest on the principal (narrow blue slice) equaling half of annual growth. The competition would be over how many wolves to preserve (green) and how many to use (blue). This debate is highly anthropocentric and includes trivial human desires such as recreation (wolf-hunters Treves & Martin. 2011; Santiago-Ávila et al. 2018) and intangible interests such as spiritual preferences (Ojibwe traditionalists, David 2009, Shelley et al. 2011, Fergus & Hill 2019) respectively, without acknowledging the interests of the wolves. Although this hypothetical example is largely between competing adult human interests it remains unjust for nonhumans.

B. B. Trustee Must Understand and Follow Science and Principles of Scientific Integrity

To know how to provide a clear and sophisticated accounting, DNR and other trustees should understand and follow the dictates of scientific integrity. Science is the best way of understanding the

universe ever found by humans, and it works by observing phenomena to explain the causes of those phenomena or predict their consequences. By observation, I mean measurements and descriptions of all sorts. By phenomena, I mean any material, process, or event. By cause and consequence, I am referring to cause-and-effect relationships among objects, events, and processes.

The fundamental building blocks, without which we do not recognize science, are transparency and reproducibility. Decades of scientific work have explored gaps in scientific integrity that reduce the validity or applicability of scientific studies. [50-105] Below I summarize the decades of work that the preceding citations represent. There are other elements of scientific integrity that are important such as enhancing fair-mindedness and protecting the subjects of research if they are sentient or can otherwise be harmed. I refer the interested reader to extensie work on these topics, but I restrict myself to the fundamental building blocks of transparency, reproducibility, and independent review because experience across many disciplines shows that this where errors in science most commonly arise.

Transparency is the most fundamental principle of scientific integrity because without clear communication or representation of methods and results no one — not even the original observer — can describe what they observed and repeat it. By methods and results of observations, I include clear descriptions of all assumptions, inputs of data, materials, inputs of skills, instruments, steps, analyses, procedures, and the intermediate results and final outputs. I recommend DNR put priority on transparency of data, assumptions, analyses, and models because the history of wolf science by the state and its allied scientists has been marred by gaps in transparency, [16, 28, 36, 106] including omission of methods, omission of population models, keeping data sets secret, and failing to disclose financial and non-financial competing interests.

By reproducibility I mean the ability to repeat all methods and replicate all findings. If a result is not reproducible by the first observer to the satisfaction of others, or better yet by others following the clear instructions, the result is not science. That is how transparency is linked to reproducibility. I recommend DNR use reproducibility as a litmus test for its scientific claims. Again the history of wolf science by the state and its allied scientists has been marred by irreproducible results.[28, 36, 107-110] (See **Appendix 2** for a discussion of lessons learned about irreproducible quota-setting in 2021).

With transparency and reproducibility, the single observer on their own in the universe might do science and be satisfied. However in the real world, scientists communicate their findings to others and sometimes others choose to make use of the findings. Thus a third foundation of science is independent review. Without transparency, no such communications would be possible. If other observers cannot replicate or use the findings, the knowledge is unlikely to persist for long. Hence, independent review pre- and post-publication help to transfer knowledge and assure its utility in the long-term. I recommend DNR engage authentically independent review. with public disclosure of potentially competing interests suitably anonymized to protect individual scientists from unfair accusations or scrutiny. Again, the history of wolf science in Wisconsin shows gaps in the independence of review. [35, 36, 92, 96, 106]

With the three fundamental building blocks of transparency, reproducibility, and independent review above, I have described a system that could adjudicate between competing claims about the universe. Different observers or even the same observer holding different perspectives (or opposed hypotheses) in mind, might come up with competing observations or inferences.[111] This leads me to describe a fourth fundamental principle of science.

Some observations and inferences are stronger than others where better refers to their accuracy, precision, or reliability (validity hereafter). I have written extensively about strength of inference. [112] At times, competing scientific claims or competing methods are applied to the same societal questions and these competing scientific claims or methods can be judged relatively more or less valid. Even untrained observers can learn to distinguish more and less valid scientific findings by their methods. Take for example, the difference between pure observation and controlled experiments. The history of science is littered with hundreds of examples of where controlled experiments have superseded observations or even sophisticated correlations because the method of controlled experimentation yields stronger inference. Likewise, methods of observation are weaker or stronger as the steady progress of technological advances in microscopes has illustrated. Similarly in other areas of science, weak methods of observation have been superseded by stronger ones, such that one can no longer publish science with out-of-date methods. Progress in science reflects both advances in methods and improvements in independent review to detect shortcomings in research submitted to that review.

Anything that interferes with independent review should be suspect. For an academic scientist like me who cannot claim any research is valid evidence until it has passed peer review, I look askance at many scientific claims made by wildlife agencies that are never subjected to authentic independent review. Scientific journals engage anonymous peer review commonly to bring non-experts such as editors together with content experts (peer scientists) to confer on a new submission before publishing it. Yet post-publication review is equally important because peer review is fallible. And ultimately post-publication review is stronger and lasts forever as peers try to replicate findings and advance understanding of the phenomena, their causes, and their consequences. Scientific journals have begun to recognize the problem that independent review may introduce bias because editors and peer reviewers may be more likely to advance (approve) novel or exciting results and less likely to advance uninteresting confirmatory or counter-theoretical findings. This has resulted in a bias towards publishing flashy results, many of which have proven irreproducible, and not publishing results that reject flashy findings, null results that do not confirm or reject widespread theories, or reject replications of findings that reviewers assumed true.

To counter these biases that can slow the progress of science and lead to wasted resources on false results, many publishers and editors are instituting review processes that begin with independent review of methods prior to data being collected or results analyzed. Therefore, independent review first evaluated the soundness of methods while naive to the wresults. A second round of review follows after data are collected or results analyzed. This form of scientific publication is called a registered report and protects both researchers and reviewers from bias. Although common now in journals, it has only been so in the last few years. A consequence of this is that almost none of the wolf science used in Wisconsin

has undergone such rigorous protection against publication bias. However, one article on Mexican wolf mortality published in 2020 was a registered report. [113]

This method for producing the best available science has direct and highly relevant implications for Wisconsin wolf science today. The article on Mexican wolf mortality replicates a scientific study of Wisconsin's wolves in many particulars. [31, 113] It deserves the attention of DNR because it quantifies how much cryptic poaching increases (121% on average) after loosening endangered species protections on wolves. It also shows that poaching switched from more overt to more cryptic during periods with less federal protection and did so independently of the number of wolves removed by the USFWS. [113]

D. Common Pitfalls In Scientific Integrity Often Arise in Scientific Claims Made by Wildlife Agencies.

The most common pitfall that affects both trained and untrained observers is to judge the validity of science based on whether we like or dislike the results. Stated this way, it seems obvious that an unscientific personal value judgment has interfered with unbiased evaluation of the scientific methods used. There is a common and widely accepted defense against this human weakness when it comes to doing science. That is the method of multiple working hypotheses. [111] Although in practice many scientists fail at this, it is at least accepted if not enforced. In our current context there are a few examples of failures from Wisconsin wolf science. For example, some papers have approached our work with a preference for a particular result, yet provided zero additional evidence for their their preferred negative density-dependent growth in Wisconsin's wolf population from 1995 to2012.[114-116] As we demonstrated, two show antipathy to the result they are attempting to discredit, and one (Ison et al.) makes errors and shows a double standard about evidence that basically suggests they are right because they and state agencies say so. [109, 110] Arguments without evidence are unscientific. The previous debate illustrates the problem of favoring results rather than better methods.

Another common pitfall is to dismiss science for spurious reasons to conceal that politics or other influences prefer policies that are not supported by the science. Common objections to science that agencies do not like in my experience is to label it retrospective (this is nonsense because all science is retrospective at some point), or of limited generality because it focuses on one locale or one point in time (this may be a fair criticism if evidence is presented for the greater generality of another finding but in isolation the criticism is anti-science because it asks the listener to trust the greater understanding and experience of the critic without substantiating their own claims. Another common criticism is that the analysts lack experience or authority or a deep understanding of the situation on the ground. Again until evidence is presented for scientific findings that are more transparent, reproducible, or reliable through independent review, this too is an unscientific criticism. Finally, a common pitfall is to take a shortcut through independent review. This takes two forms such as cherry-picking the reviewers so they are like-minded or beholden to the scientist seeking to publish or use the research. A variant is to deny post-publication review and claim that the peer review that allowed something to be published is sufficient. Peer review before publication is necessarily flawed by two common features of scientific review. First, time is short and few if any peer reviewers have the time, resources, or skills to reproduce

findings so they are limited to reading and perhaps re-analyzing data. Second, many peer reviewers have competing interests, often undisclosed ones that are non-financial when their careers are built on or advance by endorsing certain results. [106]

Finally, a common pitfall in scientific methods is incomplete transparency. Often assumptions are not laid bare. Assumptions can materially influence results and there is a clear example of this in Wisconsin wolf science. [36] The population model presented in the 1999 wolf management plan[117] and 2006/2007 addendum[118] assumed negative density-dependence on wolf population growth and under-estimates state carrying capacity, while simultaneously omitting mention of changes in census methods that would have required an alternative hypothesis for the pattern of population changes. [36] Arguably, those unstated and in some cases clearly erroneous assumptions got us in the controversy we now find ourselves. These are not ancient history given the 1999 wolf management plan is still a regulatory mechanism today. Furthermore, we reported a change in poaching rates when wolf census methods changed,[31] so I alert DNR to the need to study the effects of switching to the occupancy model as it might raise poaching rates. Likewise, we found a very strong effect of winter on the disappearance of radio-collared wolves,[31] which argues for heightened law enforcement during snow-covered periods without federal protections. In sum, from the standpoint of scientific integrity (and trustee duty to act effectively against illegal actors), cherished assumptions about wolf population growth, census methods, poaching, and legal, lethal management should be reviewed in light of the latest, best available science, with a lens for which science is most transparent, reproducible, and underwent the most strenuous independent review.

Appendix 2 — Lessons Learned from 2020-2021

I have examined the lessons learned from Wisconsin's wolf policy between April 15, 2020 and February 28, 2021, based on scientific evaluation of documentary and oral reports by the DNR and NRB. Of particular interest was the February 2021 wolf-hunt which was unprecedented in several features:

- The hunt was held during the last week in February, so it would overlap with wolf mating season. The state has never held such a hunt before.
- The February hunt allowed night-time hunting, pursuit by hounds in deep snow, and pursuit by snowmobile.
- To my knowledge there has never been any peer-reviewed research about the effects of this combination of methods and timing of a hunt on a wolf population.
- Finally the NRB's explicit desire to set a "conservative" quota for hunting Wisconsin's wolves,[18] suggests a different approach than was taken in the February 2021 hunt. As a scientist, I interpret conservative assumptions or conservative methods as those that are less likely to cause error. Given the DNR did not present opposed hypotheses and presented only a single quota recommendation, I assume the nature of the concern about a conservative quota reflects the NRB's concern with an error or an outcome that would be criticized by outside parties as excessive; either excessive in the sense of risking the wolf population, or excessive in the sense of an outcome that would shock observers and trigger an action undesirable to the NRB.

I. Sources of Information

In addition to my own research on wolves in Wisconsin since 2000, I had five official pieces of information for my review dating from April 2020 to February 15, 2021: the 2021 greensheet; [119] an oral testimony from a transcript of the February 15, 2021 NRB special meeting,[18] an informal, unsigned document in pdf format distributed with the NRB agenda on 22 January 2021; [120] and the state wolf population report for April 2020. [121]

Accordingly, I evaluated the wolf science used by the DNR to recommend a quota for the February 22-24, 2021 Wisconsin wolf-hunt. I also consider the responses of the NRB when they set the legal quota. Hereafter I refer to 200 as the recommended quota to distinguish it from the actual legal statewide quota (119) after tribal declaration or actual kill (218). I looked for three elements in particular: an evidence base that seemed as accurate, precise, and reliable as might be expected from current knowledge and technologies, scientific integrity in how evidence was handled (transparency, reproducibility, independent review), and a conservative quota.

II. Evaluation of DNR's Conclusions and Methods

A. DNR's Objective.

The 2021 greensheet made "Quota recommendations to maintain the current population." [119] That quotation matches the stated objective of the wolf-hunt published by DNR in several other official sites and communications as "to allow for a sustainable harvest that neither increases nor decreases the state's wolf population…The DNR is actively working to prepare for a fall 2021 wolf harvest season through a transparent and science-based process." (https://dnr.wisconsin.gov/topic/hunt/wolf/index.html accessed April 15 2021). I treat the above two statements as equivalent and treat them as the intended goal of DNR.

Despite DNR's objective not to decrease or increase the current wolf population, I note that the NRB questioned that objective several times in oral proceedings, apparently because several members of the NRB seemed to express an interest in lowering the wolf population to the 1999 population goal of 350 wolves outside of Native American reservations.[18]

Neither the DNR objective to maintain the current population nor the NRB mention of 350 wolves are scientific issues per se. They are not scientific issues because they represent value judgments about how many wolves should be allowed to remain alive in Wisconsin. Science does not tell us what we ought to do. That decision was a value judgment in 1999 not a scientific output [36] and remains a value judgment today. Nevertheless, the DNR objective to "maintain the current population" and recommend a quota that would attain that objective are recommendations that can be evaluated scientifically. For example, one can ask "Will the recommended quota maintain the current wolf population? What are the risks of decrease or increase? Did the DNR follow a transparent, science-based process in developing that recommendation?"

B. Science Presented on February 15, 2021.

I read the 2021 greensheet and previous greensheets from 2012-2014[122-124] and I believe that they should summarize the scientific basis for quota recommendations preceding wolf-hunts in Wisconsin.

One immediate conclusion is that the 2021 greensheet [119] is spare in details, offers one data depiction (a map of hunting zones), and contains no citations to scientific literature, in contrast to the prior years enumerated above. For comparison the 2012 greensheet contained 22 references to scientific studies, but the 2014 green sheet reduced that number to 2 but included 10 pages of text and 10 data depictions. Although the 2021 greensheet itself seems to lack specifics of the science, there is also the unsigned, informal document presented on January 22, 2021 to the NRB.[120] That document contains historical data, which I apply when appropriate below.

The 2021 greensheet [119] explains that the DNR recommended a quota after considering "several factors". The DNR named five such factors and enumerated them along with some explanation of why they may be important to "a transparent and science-based process."

(https://dnr.wisconsin.gov/topic/hunt/wolf/index.html accessed April 15, 2021) before recommending a quota. I also evaluate how the handling of factors preceding the recommendation of a quota were or were not "conservative" in the sense defined above.

C. Factors Used By DNR to Recommend a Quota.

1. The "current population" estimate.

DNR used 1,195 wolves as its current population estimate, which I believe is the central point estimate from an unpublished occupancy model due to be published soon. Note this was not the wolf population in February 2021 which would have changed from that of April 2020 by the addition of young of the year that survived to February, the deduction of deaths of any wolf before February 22 when the wolf-hunt began, and by a net change due to migration of wolves from neighboring states. Nevertheless, the common parlance holds the current population estimate to be that of last April, which is referred to as the late winter count and does not include pups born in 2020 that would have been conceived in Jan-Feb 2020 and might have survived to21 February 2021. Below, I point out scientific problems, lack of transparency, and an approach that is not "conservative" when the DNR uses 1,195 as the current population estimate.

a. April 2020 Population Estimates and How to Interpret Them.

The state population estimate for April 2020 was 1034-1057, presented in May 2020[121] and again on January 22, 2021 (p.2 item 4). [120] That estimate took into account the estimate of 1195 (957-1273) in **Figure 2** from an unpublished occupancy model. Therefore, DNR offers various population estimates ranging from 957-1573 depending on methods and their bounds of certainty. Note that the occupancy model estimates for three years running seem to fall above the official state estimate (**Figure 2**).

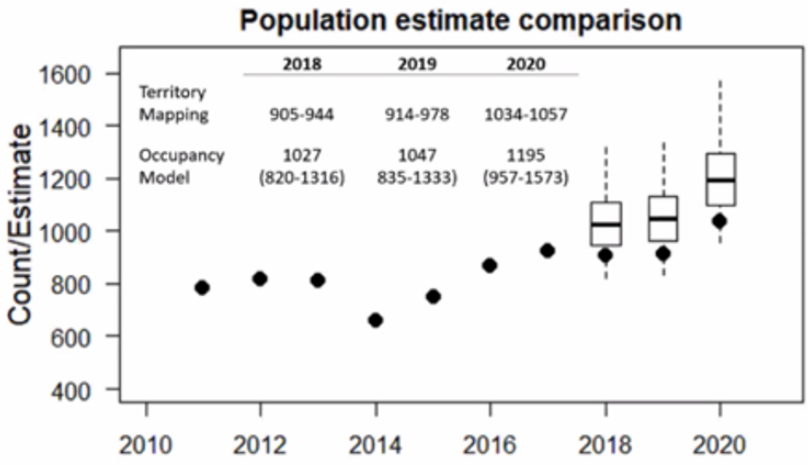

Figure 2. Wisconsin DNR data showing wolf population estimates, taken from https://dnr.wisconsin.gov/calendar/meeting/42691#:~:text=Time%3A%2011%3A30%20a.m.%20%2D%202%3A30%

20p.m.&text=The%202021%20Harvest%20Committee%20Meeting,providing%20Wolf%20Monitoring%20Program%20updates (accessed April 27, 2021).

In the last three years (2018-2020), two methods for counting wolves in Wisconsin are presented for comparison along with the respective values within the graph's frame. The occupancy model provides a range of values that appear to be box plots (open with medians (dark line in rectangles), and first and last quartiles (dashed vertical lines). The older method is presented as point estimates apparently, although they typically have lower and upper bounds as shown in the data table within the frame.

The 1,195 estimate was used in the 2021 greensheet and discussed during the oral component by the DNR and NRB during the oral session. [18, 119] However the 1.195 estimate was presented without the uncertainty attached to that estimate. In science, such point estimates are rarely presented without bounds that tell the reader the confidence one should have in the value. Given it would have been trivially easy to mention the bounds, I don't understand why it was not presented, especially given discussion of a "conservative" quota. A conservative quota would use the lower bound of 957 to reduce the risk of error. The 1.195 estimate was presented by DNR without discussion of why it was chosen and not the 1034-1057 or a range of values. Indeed, DNR had an opportunity for DNR to explain when an NRB member questioned 1,195 as too low without presenting his evidence. The DNR might have profited from his apparent interest to discuss confidence in the estimate, the alternative estimates, and why the DNR chose 1195. Finally, the DNR data presented in **Figure 2**, might have inspired the DNR to claim that 1/195 was conservative relative to the NRB member's unsupported assertion there are more wolves in the state.

Neither did DNR justify its choice of 1,195 scientifically. Indeed that would have been difficult for several reasons. First 1034-1057 is consistent with independent, scientific information on the average size of packs in WI since the 1980s (approximately 4 wolves per pack in the pre-pup late winter count in April [125]). In April 2020, the DNR reported the state contained 256 wolf packs, [121] hence one would expect 1,024 wolves in the state plus a handful of loners and transients. [125] The higher estimate of 1195 implies on average 42 packs were missed, which is unprecedented in the state wolf population estimate.

Secondly, the occupancy model tends to systematically exceed the census method that has been used in Wisconsin since 1980 (Figure 2), and when one has two independent methods for estimating the same value one does not generally choose the one that has not undergone peer review (as of writing); nor does one discard the one that has years of validation as has the older method that estimates the population with greater certainty (1034-1057 wolves). Although the occupancy model appears to correlate closely to the older method, it does appear to systematically produce higher estimates, which deserves further statistical scrutiny and perhaps adjustment of methods, rather than a single-minded focus on the new method.

Third, the official state report on wolf population monitoring includes methods additional to the occupancy sample and appears to integrate multiple sources of information. Such redundancy creates independent checks on validity as described above.

Fourth, the occupancy model did not exist at the time of the 2012-2014 wolf-hunts (Figure 2) thereby creating the appearance of mixing apples and oranges. Namely they had a comparable population estimate for 2012-2014 with quotas [120], yet they chose to use the output of the new method for counting wolves when deciding on a quota for a wolf-hunt that entailed novel timing with novel methods for hunting.

Finally, the 22 January 2021 NRB meeting at which they chose not to recommend or set a quota, the DNR used 1034 [120]. Altogether, the DNR use of population estimates looks capricious and unscientific.

Scientifically, the conservative approach is to take the lower bound (less likely to make an error that would concern the NRB such as depleting the wolf population too much) which would be 957 for the new method, or use the lower bound of the estimate that is time-tested (1034). My concern resurfaces about applying the new occupancy model below when the DNR claims to apply 2012-2014 experiences in 2021.

Given the DNR emphasis on 1195 in the 15 Feb 2021 NRB meeting and greensheet [18, 119], it seems reasonable to assume that they used that estimate of 1195 when they performed the science described below prior to recommending the quota.

b. Use of April 2020 population estimate Rather than Predicting February 2020 Population.

Regardless of the value selected for the April 2020 "current population estimate, recommending a quota based on April 2020 rather than February 2021 is bound to provide lower confidence in the quota than using the population estimate from February 2021 as the "current population estimate". Indeed, it is somewhat perplexing that they did not use the information they had at hand on average population growth, births, and deaths. I expect they would answer that they did consider change in the "current population size" from April 2020-February 2021 but did so behind the scenes within other factors. Transparency is better served by explicit mentions. In this case, being transparent would have meant that they would make some effort to estimate the number of births and deaths from April 2020-February 2021.

A population is stable or stabilized when births = deaths in a given reproductive cycle. For wolves that reproduce once per year, when the annual birth rate - the annual death rate = 0 the population should be more or less stable from one year to the next. I write "more or less" for two reasons. First, migration in and out of wild populations is sometimes a large enough factor to be included in the equation ad births - deaths = net migration (immigration - emigration) = 0 but it is common to assume zero migration and I assume DNR dismissed migration given it never mentioned migration in the meeting in which the quota was set. [18] The second reason I write "more or less" is the inevitable fact of measurement error and the inevitable influence of environmental variability that make estimates of birth rates and death rates uncertain. But DNR made mention of the uncertainty about their estimates of death rates during the meeting setting the quota, and no mention at all of birth rates.

To explain why I assert this, I should explain that wolves in the Western Great Lakes region have one birth season each year in May, that pups are counted as adults by November, adults mate in January or February, only one pair per pack mates each winter, and the cycle repeats. [126, 127] Therefore, the "current population estimate" in February 2021 would have been estimable from the April 2020 estimate plus births - deaths.

Although migration in and out of the state undetectably creates some error, migration has been dwarfed in magnitude by the residents' births and deaths since the 1990s. [4, 25, 128] Therefore, the DNR could have at least mentioned estimating wolf population size in February 2021 using scientific studies they are well aware of. For example, we have estimated the survival of individual radio-collared wolves and adjusted that survival rate for federal delisting that took place on November 3, 2020. [31] We did so in relatively short time frame in a paper under peer review at present and we share it here. [3]

Even if DNR chose not to attempt to estimate births and deaths (an uncertain process), itcould have adjusted the expected growth rate since April 2020 using our thrice validated estimates of decrements in population growth after that delisting, as predicted in a prior study. [108] which has recently been replicated in different population. [113] The DNR was aware of both estimates and they were published open access (free of charge), in top international scientific journals. Indeed, a lively debate in 2017 that involved authors they work with closely ensures they knew of the work. [110] Moreover all of the results had been presented to the USFWS in 2019 in my official peer review of the Federal Register proposed rule for delisting wolves nationwide including in Wisconsin (with which the WI DNR has long been closely working towards delisting). Also I sent in written testimony to DNR in January 2021, and pointed it to my official peer review for the USFWS and my memo to the White House in September 2020/ [129] In prior years 2012-2016, I had also informed Dr. D. MacFarland of the findings at various times in oral and written communications. In short, these studies were known to Dr. MacFarland of DNR, but DNR either did not use this science or was not transparent about it.

DNR should have acknowledged the likely reduction in the population size since April 2020, estimated it, or explained what science they were using to estimate the actual current population size. Neither I nor anyone can assess if they were conservative because the 2021 greensheet presents insufficient information to know how they recommended the quota.

2. "The population's response to harvest in the 2012-2014 seasons."

The 2021 greensheet does not explain what "the population's response to harvest in the 2012-2014 seasons" means. One has to assume the DNR looked at quotas and subsequent population reductions and made some simple assumption that the Wisconsin wolf population response in 2021 would resemble that of wolf-hunts held three times from 2012-2014. I describe several concerns with that assumption in 2A below.

As noted previously, DNR switched to a new method of estimating the population size without justifying that choice. It now claims that consideration of the quotas from 2012-2014 in light of the respective populations counted by the older method would yield insight into its quota recommendation. Common sense in science would have warned them of the potential for error in so doing. If the new census method is highly uncertain (as it is shown to be in **Figure 2**) then the risk posed by a quota of size x is correspondingly uncertain. They should have selected the more certain estimate of 1034-1057 to argue explicitly that the wolf population responses from 2012-2014 would have produced a similar change once adjusted for the recommended quota of 200.

A rebuttal of comparing apples to oranges above might claim DNR considered the ratio of the quotas to the population estimates and the associated estimate of population changes. If so, why didn't it write that? Regardless, the wolf-hunts in 2012-2014 were so different that they might not be comparable. I noted the unprecedented timing and methods used in the 2021 wolf-hunt. [120] In 2012, hounds were prohibited by court order. In 2013-2014 as far as I know night-time hunting was prohibited by order of the governor. The 2012-2014 wolf-hunts all ended before December 31 in their respective years. All of the differences were predictable, therefore, in my expert opinion DNR only looked at past quotas and population reductions qualitatively. Indeed, oral testimony by Dr. D. MacFarland suggests DNR used a value drawn from the scientific literature (Section 4 below) rather than some synthesis of past wolf-hunts. This factor lacks transparency.

3. "The Current Management Plan."

The current management plan refers to the 1999 wolf management plan and its 2006/2007 addendum. It is unclear to me what element of that plan the DNR would have used other than the above-mentioned reference to the 1999 "population goal" of 350 wolves. Our research has shown that the 1999 wolf population goal was a value judgment not the product of scientific analysis. [28, 36] Moreover, our research has shown that any scientific analysis presented in that plan was flawed by omission of important information about changes in the wolf census methods and a misleading blurring of the line between value judgments and outputs of scientific models. Therefore, I either ignore the reference to "current management plan" as only implying compliance with the law. Either way I do not address it further with regard to recommending a quota because it lacks transparency, conservative methods, or usable science.

In section 4, I examine the nature and quality of the scientific literature used to recommend the quota. I find the DNR was not transparent about scientific studies that should have informed its recommended quota and failed to weigh which scientific studies were more reliable based on internationally accepted standards of transparency, reproducibility, and independent review. [50, 82, 106]

4. "The Scientific Literature"

No scientific literature was cited in the 2021 greensheet but during the February 15, 2021 NRB meeting two scientific studies were mentioned by name. [18, 119] DNR representative Dr. David MacFarland only mentioned two articles from the scientific literature by name (Fuller et al. 2003 and Adams et al. 2008).

They claimed there are two studies when there are at least four such studies in actual fact. Below, I explain why this inaccuracy undermines the scientific basis for the recommended quota, and examine if the scientific literature was examined for birth or mortality.

a. Inaccuracy Undermines Basis for Recommended Quota.

Dr. MacFarland identified two published scientific articles they used to estimate sustainable mortality (24% between the Fuller et al.[127] model predicting an average of 22% and the Adams et al.[130] model predicting an average of 29%). Dr. MacFarland appears to assert these are the only two reviews of wolf population dynamics that estimated a sustainable rate of human-caused mortality. [18] That assertion is incorrect.

One review by Creel and Rotella[8] who wrote "Contrary to current conventional wisdom, there was a strong association between human offtake and total mortality rates across North American wolf populations. Human offtake was associated with a strongly additive or super-additive increase in total mortality. Population growth declined as human offtake increased, even at low rates of offtake." (abstract) and that the rate of human-caused mortality annually that would lead to no average reduction or increase in the population was 24.5% (15-34%) for populations other than those of the Northern Rockies. [8. Note the wide margin of uncertainty that makes the lower bound conservative 15%, not the 24% rate allegedly used by DNR. [18] Also Vucetich[131] reported overall lower rates of human-caused mortality needed to stabilize population abundance, in addition to agreeing with Creel and Rotella[8] that any level of human-caused mortality would trigger a reduction in population growth without compensatory mortality. Vucetich added that that downward trend seemed to accelerate as human-caused mortality increased. Therefore, there are more than two studies relevant to DNR recommending a quota.

DNR chose to use a rate of human hunting of 24% and claimed it was conservative, but it did so while seeming to suggest the lower bound was 22% (Fuller) and the upper bound was 29% (Adams), whereas actually the lower bound was 15% or lower. I had pointed this issue out to DNRin 2017. [23] Nor didDNR mention that the recent reviews they omitted found no compensation but rather super-additive mortality and accelerating losses as human-caused mortality increases. Therefore 24% is far from a conservative estimate of sustainable human-caused mortality.

b. DNR did not Consider Relevant Scientific Literature.

Below I explain why I find DNR did not consider all of the relevant scientific literature from Wisconsin, did not mention the most recent literature from Wisconsin, nor did it mention that it did (or should) weigh the quality of the science it used compared to the quality of the science it chose to ignore.

Oral testimony is necessarily concise and fragmentary. Nevertheless, the DNR (MacFarland) identified the non-harvest mortality rate DNR used (14%) without citing a source. I assume DNR used Stenglein et al.'s body of work to come up with 14% background rate of non-harvest, human-caused mortality[133-138]

but I should not have to assume. It would have been simple and transparent to cite her in the greensheet as DNR has done in prior years. [122] That fails the test of transparency. Moreover, DNR's estimate is too low as recent studies show. I summarize that evidence below.

However, fixing the oversight in using 14% as the annual mortality rate is not settled by citing its source. Several questions remain for a scientist presented with the above information. Why was 14% presented without uncertainty (bounds of error or variability that all scientific estimates come with when one considers measurement error and uncertainty due to annual variability among other things). I see nothing stopping DNR from recommending a range of quotas based on a range of background mortality rates. That would have transparently communicated uncertainty and allowed the NRB to select a single number from within that range of values. That is precisely what we recommended. [36]

Mortality in particular should always be presented with bounds of uncertainty because there is great uncertainty about wolf deaths in the wild, even when estimating background mortality only from radio-collared wolves. I had explained the problems with mortality estimation to D. MacFarland directly in 2014, [24] addressing an official DNR document of the time so he is aware of the issue from me and because he is himself a published scientist used to estimating mortality rates. The omission of citation and confidence bounds was not a scientific oversight.

DNR's 14% background non-harvest, human-caused mortality rate does not accord with the published estimates of total mortality of which I am aware. Stenglein et al.[135] estimated mortality in the years preceding 2012 at 21-24% for radio-collared wolves and Treves et al.[25] estimated it for adult radio-collared wolves at 19% (standard deviation or sd 9%) and non-radio-collared wolves at 47% (sd 19%). As stated, DNR's 14% estimate was "non-harvest, human-caused". Therefore, if their 14% estimate is to accord with Stenglein's estimate they must have deducted the nonhuman component. However, we have proven with simple algebra that Stenglein et al. miscalculated legal human mortality from 1980-2012 which led to an under-estimate of other human causes of mortality by 17-36 expressed as a percentage of all deaths.[26] Converting this to an annual rate and using her published 21-24% rate cited above, suggests non-harvest human-caused mortality would actually be 15.5-17.8%. Therefore I infer that the DNR under-estimated the background mortality rate, even if one accepts Stenglein's estimate as accurate for non-collared wolves, which I do not.

Furthermore, Stenglein's estimate comes from radio-collared wolves but I provided an estimate for non-radioed wolves that make up the vast majority of Wisconsin's wolf population and we hypothesized that non-radio-collared wolves suffer higher annual mortality rates, [25] which could be more than double the rate of radio-collared wolves. Similar differences between collared and uncollated individuals among Alaskan gray wolves, [139] Polish gray wolves (forthcoming), and wolverines (forthcoming). Furthermore, the most recent estimate published in the best scientific journal to yet publish Wisconsin wolf mortality rates[31] estimated the background mortality closer to 40-60% (not annually but since a wolf underwent collaring for radio-telemetry, from which one can deduct the cumulative incidence of nonhuman mortality which DNR wished to estimate. Therefore, the conservative approach would be to use the

upper bound of mortality estimates from radio-collared wolves as a minimum and available estimates of mortality among non-radioed wolves to recommend a quota. Neither was done.

c. Failure to Consult with Available Experts.

I am just down the road from the DNR headquarters and easily reachable by phone or by email yet the DNR has not consulted me on wolf mortality since 2012. We made these scientific studies freely available at my lab website, on the publisher's page, referred to them in numerous media reports, and shared with DNR our report to the USFWS on the subject, so I see no reason why Dr. MacFarland would be unaware of the work.

5. Estimated Impacts of Harvest Quotas.

DNR also calculated the quota based on "estimated impacts of various February 2021 harvest quotas resulting from population model projections." Without citation to published scientific studies or transparency about the scenarios, one cannot evaluate what DNR did in the background to recommend a quota.

I surmise the background work employed the models of Stenglein cited previously and van Deelen. [28] For each one, I mention a concern with the work that raises questions about the design of the model and validity of their findings. For all but the last study, I have previously published my concerns. [28, 36]

- Van Deelen 2009 used an inaccurate estimate of carrying capacity and omitted mention of changes in wolf census methods that significantly altered the inter annual variability in wolf counts. By representing only one scenario for "maximum sustained yield" (sic), he inserted his own personal value judgment into a state policy debate but did so non-transparently. Furthermore, that model erroneously assumed negative density-dependence without evaluating the evidence that argued against such an assumption.

- Stenglein et al. 2015 did not present reproducible evidence for negative density-dependence on recruitment of juveniles, assumed the effect of policy periods which were fictitious, and failed to account for changes in wolf census methods.Nor did this paper publish data on birth, juvenile survival, and mortality to allow replication.

- Stenglein et al. 2016, 2018 have some of the above flaws and the 2018 papers add a new one. Its model apparently supporting compensatory mortality in Wisconsin's wolves from 2004-2013 took methodological steps that were neither conservative nor justified scientifically. They pooled nonhuman causes of death with unknown causes (cases in which the recovered wolf carcass' cause of death could not be ascertained). We showed that the timing of unknown deaths since collaring was inconsistent with such pooling. [25, 31] Furthermore, that step tends to under-estimate human-caused mortality adding to the problems noted above.

III. February 2021 Hunt Lacked Scientific Hallmarks Of Sustainability.

Several scientific criteria must be met to claim that killing a quota during a wolf-hunt, "neither increases nor decreases the state's wolf population". This is called stabilizing the population or managing human-caused mortality to keep it stable. Our work under review at present [3], suggests a 27-33% decrease in the wolf population since April 2020. Therefore by the common scientific interpretation of the question, the February 2021 wolf-hunt was not sustainable because it did decrease the state wolf population. This interpretation is also consistent with the four studies from other wolf populations cited above (Fuller, Creel, Vucetich, Adams).

However, a common everyday use of sustain instead refers to withstanding. Can the Wisconsin wolf population withstand another wolf-hunt or two? That is a different question and one that mingles value judgments with scientific claims. Therefore, I end with a brief look at the NRB's decisions in February

DNR does not deserve all the criticism for the many instances in which the recommended quota was not conservative. Despite the explicit concern by the NRB that the quota be conservative,[18] there are two additional aspects of the February 2021 wolf-hunt that, to a scientist, almost guaranteed over-shooting the state quota. The first was the NRB countermanding the DNR recommendation on issuing 10 times the quota in permits (which are opportunities to legally kill a wolf during the season) and deciding to issue 20 times the quota. Because DNR reports being required by statute to alert hunters to impending closures of a zone 24 hours before closing that zone, the high number of hunters holding permits who might have killed wolves after a zonal quota raised the probability that the zonal quotas would be exceeded.

The second decision made by the NRB and emphasized by the chair and at least one other NRB member was to vote on a motion that specified no zone would be closed until the zonal quota was met. Keeping zones open until zonal quotas are met can easily lead to over-shooting the statewide quota. A simple example illustrates why this would be. If the statewide quota were met by over-shooting one or a few zones, the entire wolf-hunt should (by law) end within 24 hours. But if an open zone were not closed until its quota was met, the statewide death toll might continue to climb (as it did) before the statewide wolf-hunt was closed. Therefore, coordinated effort across zones by hunters intent on killing more wolves would not be stopped by DNR in the statutory 24 hour notice period. The alternative, and more conservative approach would be to stop the wolf-hunt when the statewide quota was about to be met, regardless of zonal quotas.

In setting the quota, the NRB[18] expressed concerns that zones would be closed too early, that hunters would have to pay too much, that the wolf population was larger than scientists estimated, and that the 1999 state population goal had been exceeded in recent years. In the future, I recommend the NRB and DNR work more closely to achieve sustainable outcomes using scientifically cnservative criteria.

Appendix 3 — Killing Wolves Does Not Raise Tolerance or Reduce Poaching

One sentence summary: The hypothesis that one can kill animals to conserve their populations requires an indirect mechanism, which has failed to materialize in four independent tests on wolf populations.

1. Introduction

Just as the hydra sprouted two heads where Hercules had chopped off one, some ideas multiply and regrow after decapitation. The idea that people need to kill a few animals to protect the rest (kill to conserve) seems to be such an idea. Called 'hunt to conserve' when first exposed to scientific tests, the idea has grown into newer notions sometimes called, 'blood buys goodwill' or 'tolerance hunting'. The underlying idea has deep roots and seems to reincarnate in a new form even if it fails a scientific test. Here we offer opposed hypotheses for why the idea of 'kill to conserve' re-emerges in new guises. First, we examine the idea stripped down to its essentials, and second, we present three parallel lines of evidence from wolves that refute the newest variants sprouting from the idea.

Many readers might wonder at the counter-intuitive idea that killing an animal might help to protect the survivors in its own population. We emphasize that we are not discussing killing used to eliminate a diseased animal that threatens the health of other species, nor killing used to remove one species to protect others as is commonly used with non-natives or super-abundant populations harming rarer ones. We are examining the common claim of hunters and some government agencies[140] that one should kill a few to save their fellows. In human affairs this statement only makes sense if the individual killed poses an existential threat to other members of society and cannot be stopped feasibly in any other way. Take for instance an individual transmitting a deadly pandemic or consider mass murderers, and one begins to see the extremely rare circumstances in which killing the threatening individual might directly save others In its own population. By contrast, the idea behind 'kill to conserve' typically involves killing the average animal. And that average animal is doing what comes naturally to its species.

Similarly, people may claim they need to kill wild animals to avoid overpopulation and starvation of those animals. Although decimation of animals may free up resources for the survivors, in the absence of humans the effects of starvation, thirst, and disease decimate some but not all of a population in a process called natural selection (since Darwin). It is vanishingly rare or even impossible that every wild animal in a population takes too little nourishment to survive, so the entire population perishes. In virtually every case, a subset of individuals die and a subset survive. Perhaps the dominant, the skilled, or the lucky access enough resources to survive. Human inclination to step in and decimate animals is simply an intervention by people for people, not a favor to animals or assistance to nature or some such construction. The animals chosen for such mercy killing are usually considered desirable or undesirable by the human killers and the survivors likewise chosen artificially. We might agree this is artificial selection, but it is not conservation of the population being decimated. In sum, the introduction of human value judgments in this field requires careful disentanglement, [36] lest we delude ourselves into thinking we are helping others as we help ourselves.

So, we return to the idea of killing a few to save many of their fellows. Setting aside the rhetorical ideas of mass murderers, mass starvation, and pandemic disease, there is no **direct** benefit to the population associated with killing one or a few of its members. Therefore the direct causal mechanism of kill to conserve has been decapitated. One has to consider an indirect effect instead.

The fundamental assumption that one should kill the few to conserve the many requires that a proponent identify the **indirect** benefit to its surviving fellows. When we consider indirect mechanisms in conservation over the decades, we see regrowth of three different ideas about indirect causes.

One relatively new idea is 'hunter self-restraint'. This idea mutated out of the widely acknowledged 19th and 20th century rise of regulation of commercial hunting and the rise of the sportsmen and gentlemen hunters, among whom President Teddy Roosevelt is often cited. [141, 142] As commercial hunting in the United States and Canada was gradually driving edible wildlife extinct, the hunters who agreed to restrain themselves and police and regulate those who did not, are credited with preventing over-kill. In this formulation of kill to conserve, the elite white males generally could kill so as to conserve. Law enforcement would not get credit for saving wildlife populations from overkill, but rather the credit belongs with hunters who showed restraint. We have previously addressed doubts about this logic, [143] which we can summarize by the same analogies used above. It is folly to credit the restraint of a mass murderer or typhoid Mary, when the credit belongs with law enforcement and public health officials respectively. Certainly, celebrate law-abiding hunters. But celebrate more effective laws. Over-killing is prevented by stopping killing animals, not by the act of killing animals. We examine the indirect mechanism further below.

The second re-sprouted hydra head is that animal killers contribute money or data to conservation (hunting for conservation). This is a proper indirect causal connection between killing a few to conserve the many. But is it enough? We examine the indirect mechanism further below.

The third new idea is that without being legally permitted to kill animals, some people will kill many more illegally (blood buys goodwill). We examine the indirect mechanism further below.

These indirect mechanisms require evidence about human attitudes, and behavior in addition to measures of animal survival and population persistence. Indirect mechanisms need careful scientific evaluation, just as medicines do not reach the market based on correlation or epidemiological evidence alone.

2. Hunter Self-restraint

North American and European governments managed to prevent extinction of numerous wildlife populations (bison, white-tailed deer, Canada goose, and other popular so-called 'game' species that people generally eat) by reducing commercial and unregulated killing by people among other protections. We believe the latter fact is undisputed. Might not controls on over-kill like those for game animals be effective in protecting non-game?

Because the survivors of hunts sometimes live long enough to reproduce and the longer-term reproduction may lead to the recovery of their populations, some observers have credited the hunters' self-restraint that leaves survivors, rather than crediting the restraints imposed by rules and law enforcers; [143] and disregarding the distinctions between ecologically minded hunters and others.[144] Therefore, some commentators have promoted the permitted hunting that remains after regulations limited over-kill as the important conservation intervention, rather than the regulatory mechanisms that limited over-kill.[143]

Yet, frequent calls for reducing non-game, predator populations in the USA and Canada have led to doubts that hunter self-restraint will protect wolves, grizzly bears, cougars, and other large carnivores (which incidentally compete for the game that hunters prefer and sometimes eat domestic animals that most of the public eats). Will hunters restrain themselves from killing predators to leave survivors that might prevent local extinctions? Are government regulatory mechanisms enforced? And if enforced, are they sufficient to conserve carnivore populations? These questions persist because humans kill most large carnivores worldwide[145] and unregulated killing is the major source of death for wolves and grizzlies in the USA.[26, 130, 146, 147] Therefore, hunter self-restraint is not obvious outside the writings of Roosevelt and his gentlemanly ilk. [141] Also U.S. government policies for carnivores have repeatedly been questioned on the grounds of sustainability. [23, 97, 148-150] So we are left wondering if hunters' own self-restraint is sufficient to prevent over-kill so it can be credited — in the absence of laws and their enforcement — with conservation even of non-game species?

3. Hunting for Conservation?

Another common assertion about indirect interventions by hunters is the belief that money and information contributed by hunting as an industry has been essential to government agencies charged by law with conserving native species. The idea is that money and data have helped protect the animals that survived hunts or their essential habitats, which has been reviewed critically for evidence.[144, 151] The mere fact that some game species have enjoyed recoveries does not prove that hunting fees or data helped protect the survivors. The issue of scientific information was studied by way of a survey of 667 North American management plans for hunted species. [100, 101] These authors revealed that an uncertain number of hunters left an unknown number of surviving animals with unknown effects on their populations, in a large majority of those plans. One may find a counter-example perhaps, e.g., [152] but that does not outweigh the vast majority of 667 plans that lacked evidence that hunting data contributed to management plans and without information about population abundance, hunter take, survival, it is unclear how such plans advance conservation. [100, 101] Closely related and perhaps more persistent is the suggestion that money paid directly by hunters went directly to conservation. [153] Believers will go to great lengths to defend the claim, such as compiling lists of signatories and rebutting dozens of scientific and ethical challenges, [154, 155] or presenting hunting as central to legal doctrines or 'models' of wildlife conservation. [156, 157] The debate over sport or trophy hunting for conservation has raged on despite years of systematic, scientific reviews lamenting the shortages of data [151, 158-162] and the hunting for conservation idea has also sustained legal and social scientific challenges. [163-166]

4. Blood Buys Goodwill?

The second idea is that the government must allow some killing or the frustrated would-be killers will react angrily or retaliate systematically to commit over-kill. This idea itself sprouted two new notions. 'Blood buys goodwill' and 'tolerance killing' have attracted scientific attention because proponents assume that organizational or governmental policies can influence the rate of such killing to avoid over-kill. [[140, 167-170]] For example, some decision-makers hypothesize that one can change the benefit-cost valuation of an animal by changing the status of wildlife to a game species (tolerance killing) or by permitting some legal killing so would-be unregulated killers desist (blood buys goodwill).

The strongest inference about whether policies that liberalize (legalize or expand) killing of animals would buy goodwill or foster tolerance for conservation, would derive from a randomized, controlled experiment testing the effect of a treatment that liberalized killing for some jurisdictions and not others. This is called the gold standard in biomedical and other fields. The next best standard, which we have called silver standard, [[112]] would analyze before-and-after comparison of intervention (BACI without randomization). Statisticians have explained the resulting weakening of inference compared to the gold standard. [[171-173]] Using the silver standard, data from wolves have been used repeatedly to test these hypotheses ever since the U.S. Fish & Wildlife Service (USFWS) argued unsuccessfully in federal court in 2006 that blood buys goodwill and killing for tolerance would help recover endangered gray wolves [[168]] and have resumed claiming this in 2020 (http://faculty.nelson.wisc.edu/treves/archive_BAS/Treves%20letter%20Frazer%20USFWS%20Sklar%20CA%20FG%20Commission.pdf, which example I return to later. Five wolf populations have been studied to test tolerance killing and blood buys goodwill (gray wolves in Finland, Scandinavia, and the upper Midwest US, Mexican wolves in the southwest US, and red wolves in North Carolina, US).

5. Research On Wolves To Test Tolerance Killing And Blood Buys Goodwill

Although the motives of wolf-killers are not well understood, [[174]] attitudes toward wolves are well-studied generally, [[175]] and intentions to kill predators illegally have been measured many times. [[27, 176-179]] Unregulated and often illegal wolf-killing is the major cause of death in every U.S. wolf population studied [26], with similar patterns in Europe. [[140, 180, 181]] The predominant hypotheses for the motivation to kill wolves illegally is competition for wild or domestic ungulates, resistance to government, or identity group politics (peer group pressures) treating the wolf as a symbol of political rivalries. [[174, 182-184]] In 2014, we presented a perspective on the state of knowledge about tolerance for predators [178]; namely that economic benefit - cost perceptions of people was only one factor, and not necessarily the strongest, shaping people's willingness to coexist peacefully with predators such as jaguars, wolves, and bears, e.g., [[177]] and that other factors such as government policies, peer group pressures, and instinctive emotional responses might play even stronger roles in tolerance and intentions to kill predators. [[178]]

Since 2015 and the last review, [178] many independent teams of investigators have generated three parallel data streams on human attitudes, on hazard and incidence rates of individual wolves, and on dynamics of populations of wolves in relation to policy changes that liberalized wolf-killing. If the tolerance killing or blood buys goodwill notions have merit, these silver-standard tests using data on humans and data on wolves should reveal their merit.

The idea that tolerance will change if wolves are managed lethally predicts that human attitudes are associated with changing policies for legalizing or prohibiting legal wolf-killing. Since our 2014 review of tolerance for predatory wildlife mentioned above, two studies with silver-standard designs have been published. The first study led by Dr. Christine Browne-Nuñez used focus groups with mixed qualitative and quantitative methods to show that relaxing U.S. Endangered Species Act (ESA) protections for gray wolves in Wisconsin led to calls for yet more wolf-killing and no apparent reduction in inclinations to kill wolves illegally. [174] The second led by Jamie Hogberg used a mail-back survey to a panel of Wisconsin residents who had been sampled three times previously since 2001. [47] She showed that average tolerance for wolves declined after the first Wisconsin regulated public hunting, trapping, and hounding season in 2012, but only significantly so among older males who had experience with hunting and lived in wolf range (different from Ojibwe tribal members who were male, living in wolf range and familiar with hunting. [49]

Hogberg's result emerged from asking the same respondents the same questions at two time points between which ESA protections had been lifted, and wolf-killing had been liberalized to include both government agents killing problem wolves and public hunting and trapping, i.e., longitudinal measures of the same individuals over time.[47] When she partitioned the data by those who had approved of wolf-hunting in 2009, their tolerance showed the most significant decrease in objective measures (i.e., not asking them about their tolerance but asking them about attitudes and actions previously associated with tolerance). [47] Therefore, she concluded that tolerance hunting was unlikely. Some have argued from cross-sectional data and self-reported recollections of their tolerance`, that policies to liberalize wolf-killing did lead to greater tolerance for wolves. One study claimed erroneously that self-reports showed people were more tolerant of wolves after Montana implemented wolf-hunting but the study actually showed that respondents reported more favorable views of the government policy not of wolves. [185] More sophisticated studies have instead reported on cross-sectional measures of attitudes to corroborate tolerance killing; [167, 186, 187] also see similar claims for bears[188] and opposing views. [189] However, a longitudinal study and within-subjects analysis is needed to measure change in attitudes as the hypothesis requires, whereas sampling two different populations at two time points leaves another potentially confounding variable in place (in addition to time passing), if one unintentionally samples slightly different demographic groups. Two such cross-sectional studies showed that tolerance for wolves and approval for the ESA have increased or stayed stable over many years in the USA[190] and disapproval of lethal management has risen.[191] But such studies do not reveal if policies affected the responses.

Hogberg et al. also compared self-reported tolerance before liberalized wolf-killing, using this question 'My tolerance for wolves would increase if people could hunt them' (2009) to a similar self-report after

the policy change in 2012, 'My tolerance for wolves has increased since people can hunt them'[47]and concluded as follows,

> "In 2013, some wolf range residents self-reported an increase in their tolerance since people have been allowed to hunt wolves (36%). These self-reports were inconsistent with the trend of declining tolerance that we measured, and show disagreement between self-reports of tolerance versus our multi-item construct of tolerance. Self-reports of tolerance that conflict with measurements of tolerance emphasize the need for longitudinal measures over cross-sectional measures, especially if different questionnaire items are compared across studies. Moreover, the majority of respondents did not report their tolerance had increased or changed since the wolf hunt. We cannot discern whether respondents were unaware of the changes we detected in their own prior responses, or if our self-report question measured something other than change in tolerance." (at p. 7)/

Although Hogberg's results like most surveys are correlational not causal, the before-and-after comparison renders them stronger than one-time surveys correlated to respondent demographics or self-reports. Regardless, the results do not support the tolerance hunting hypothesis, at least for the demographic group thought most likely to respond positively. [47]

We are not aware of social scientific evidence supporting the idea that the average of individual attitudes to predators changed to become more positive after killing was liberalized. We only know of evidence to the contrary that liberalizing wolf-killing led to calls for more killing and lower tolerance for wolves. [21, 47, 174] Because shifting social norms (in this case relaxing protections for wolves) and social facilitation are very powerful factors in pro- and anti-environmental behaviors, [192, 193] understanding both killing for conservation and illegal killing in opposition to conservation can benefit from tests and applications of criminological theory and social psychological theory. [194-196] These fields teach us to investigate the motivations of would-be wolf-killers and the opportunities they take. [27, 184, 197, 198] These insights lead us to consider next the behaviors of wolf-killers and also test whether blood buys goodwill.

Since 2015, a series of studies using the silver standard examined the effect of policy changes on individual wolf fates and the effect on the dynamics of several wolf populations, to test the main element of the blood buys goodwill hypothesis. That element was the claim that illegal wolf-killing would decrease if the government liberalized wolf-killing.

We begin in reverse chronological order because Dr. Francisco Santiago-Ávila's dissertation[30] resolved a scientific debate stoked by incomplete information. Prior studies estimated the hazards and incidences of different endpoints (death or disappearance) among radio-collared gray wolves in Wisconsin from 1980-2012 and radio-collared Mexican wolves in Arizona and New Mexico, USA from 1998–2016 respectively. Both studies examined hazards and incidents in relation to repeated changes in policy from strict protection to liberalized wolf-killing and back again. Both conducted time-to-event analyses that examined the events experienced by radio-collared wolves as policies liberalizing wolf-killing, or court-ordered reversals of those policies, changed 12 times in Wisconsin and four times in Mexican wolf

range. They showed that incidence of reported illegal-killing was one-fifth and one-third the incidence of disappearances, [31] [113] which were most plausibly dominated by cryptic poaching, a term coined for illegal killing followed by destruction of evidence. Cryptic poaching provides insight into the motivations behind illegal wolf-killing, so cryptic poaching and disappearances require further discussion.

Disappearances are likely dominated by cryptic poaching because the time to disappearance was significantly briefer than for time to other causes of death, especially natural causes of death, hence battery failure is an extremely unlikely explanation for the vast majority of gray Mexican, and red wolf disappearances.[31, 113, 180, 199] Also, the disappearances rose significantly during periods of liberalized wolf-killing, without any change in rates of vehicle collisions which one might expect if long-distance migration explained the disappearances. [31, 113] Other studies corroborate that inference [180, 199] as does independent evidence of wolf migration between Michigan and Wisconsin. [25] Finally, disappearances rose during winter in Wisconsin independent of policy period and the seasonal effect most likely relates to snow cover making wolf tracks easier to follow and perhaps reducing the risk posed by law enforcement officials because people rarely use wolf habitats in winter in this temperate region. [31] Cryptic poaching betrays a concern with law enforcement that bears on our topic.

The motivation to conceal evidence and destroy or tamper with radio-collars suggests wolf-killers were more concerned with law enforcement during periods of liberalized wolf-killing than other periods. That refines our understanding beyond an early hypothesis that stated, "When the government kills a protected species, the perceived value of each individual of that species may decline. Liberalizing wolf culling may have sent a negative message about the value of wolves or that poaching prohibitions would not be enforced. "[107] We can now discount the latter possibility from the two recent studies. [31, 113] Indeed, one suggests the government sharing of radio-frequencies for the collars on the endangered Mexican wolves encouraged cryptic poaching, perhaps to protect the owners of the land where the wolves were killed or the recipients of the radio-frequencies. It is the disappearances of marked animals in the USA and in Scandinavia, as cited above, that cast the most doubt on the notion that blood buys goodwill. Because cryptic poaching spiked significantly during periods of liberalized killing, it appears that blood begat more blood.

Next we address the putative counter-evidence. Analyses that fail to take into account the exposure time of marked animals or ignore disappearances of marked animals as in cryptic poaching, enfold systematic, biasing error that makes their estimates substantially inaccurate. [200] That systematic bias is substantially larger than the effect the latter found which has been attributed to a shift from reported poaching to cryptic poaching. [31] Indeed, one would expect disappearances of marked wolves to exceed reports of illegally killed wolves given the disproportionate number of disappearances in U.S. wolf populations from Alaska to the desert southwest. [26]

Another revival of blood buys goodwill has been mounted by a Scandinavian team[201] despite concerns over both statistical and observational methods/ [29] We acknowledge the latter study is recent enough

that the jury is still out on its accuracy and precision, but the straightforward interpretation of their Figures suggests that disappearances of Scandinavian wolves rose sharply after periodic wolf-hunts began. Also, our concerns over their model specifications have not been addressed to our satisfaction. [29]

In sum, the silver-standard analyses of individual wolf survival over periods of changing policies on wolf-killing do not support blood buys goodwill, and also seem to resolve years of scientific controversy over studies of population dynamics of gray wolves, which suffered from incomplete information or methods as we explain next.

Unlike the survival analyses on individual wolves above, analyses of population dynamics are particularly prone to unsupported assumptions and confounding variables. [36, 202, 203] Although the idea that blood buys goodwill was first tested by analyzing Wisconsin's and Michigan's wolf population dynamics, it proved impossible to reject a potential confounding effect of density-dependence and a potential confounding effect of poorly documented methods for wolf census. Each slow-down in population growth seemed to coincide with a policy change that liberalized wolf-killing or a change in census methods. [28, 36] The importance of the poorly documented changes in census methods relates to uncertainty about the accuracy and precision of census methods overlooked by prior authors[133, 134] but reported in other articles. [28, 36]

For Wisconsin's wolves, Santiago-Ávila showed that hazard of reported, illegal wolf-killing (not disappearances) was not associated with the policy periods with liberalized wolf-killing, but was significantly associated with changes in wolf census methods. [31] The census period with the lowest rate of wolves reported killed illegally was 1996-2000, a period without liberalized wolf-killing, when for the first time, large numbers of civilian volunteers were engaged by the state government to track wolves for winter censuses, usually without a state biologist accompanying and typically without radio-telemetry. [28, 36] That suggests civilian wolf-trackers over five winters deterred reports of illegal wolf-killing without changing cryptic poaching. Therefore, we infer that there were two categories of illegal wolf-killing in Wisconsin 1980-2012. The first category rarely tried to destroy evidence and was deterred by the civilian trackers (at least initially), so illegal killing that left evidence and a functioning transmitter decreased in those years.; the second category was not deterred by the presence of civilian wolf-trackers engaged by the state. One might go further and hypothesize that the second category was using specialized skills. The skills and organization needed by the second category — to destroy a radio-collar, decapitate a wolf to remove a collar (usually in winter), or to illegally transport a wolf carcass with a transmitting collar to a safe location — were performed while civilian volunteers engaged by the state were conducting frequent surveys. [204] These do not seem to be commonplace skills or organizations. Therefore, blood might not buy goodwill in general or specifically for the second category of wolf-killers. We see yet another hydra head preparing to grow in the kill to conserve corpus. Proponents might argue that one should liberalize wolf-killing to appease the second category of wolf-killer that destroys evidence and seems undeterred by wolf-census-takers in the field. An intuitive alternative would be to prosecute the latter rather than appease them.

Because of the muddied history of census methods, it is difficult to be confident that population dynamics among the Michigan and Wisconsin wolves were altered by the policy or by negative, density-dependence slowing reproduction, which strongly slows birth rates or increases mortality rates as a population nears carrying capacity. Although there is legitimate uncertainty about density-dependence in Wisconsin's wolf population history[107-110, 114, 115] Mexican wolf data have recently corroborated the finding that liberalizing wolf-killing slowed population growth independent of the number of wolves killed legally and independent of potential negative density-dependence.

The endangered Mexican wolf population declined 23% during the first periods of liberalized wolf-killing (2003-2009) and then experienced a period of decline or virtually no growth during the second period (2014: 112 wolves dropped by 12.5% and then grew an average of 10% annually to recover to 118 wolves by 2017), and these precipitous drops and slow regrowths occurred despite no change in the hazard or incidence of agency removals (lethal or relocation to captivity), which suggests an new source of mortality had been added. [113]

In sum, the hydra's new heads or ideas that 'blood buys goodwill' or 'tolerance killing' are not supported by the weight of evidence at present in any wolf population studied. However, we already see new justifications for killing for conservation sprouting as 'poaching is conservation' [184, 197] or 'blood appeases dedicated wolf-killers' alluded to above. We are also concerned that government agencies cling to the rejected notions despite evidence and despite governing laws that require use of the best available science. To wit, the USFWS claimed they should kill to conserve in federal court in 2006 and repeated the claim in 2020.

6. Conclusion

A paradigm in science is a worldview that shapes the questions researchers ask and the methods they use. Paradigms in science can be powerful and useful but they can also slow progress, even tragically so/ [214-216] Their resilience to disproof is a hallmark of paradigms. The convictions of the holders of the paradigm are very hard to dislodge because of non-scientific reasons to do with personal investments and relationships tied to the paradigm. Paradigms are notoriously hard to shift, as ween with the millennia-old persistence of 'balance in nature' despite being resoundingly disproven since Darwin. Historians of science have concluded that either generational change of scientists is needed to dislodge such enduring myths or an absolutely incontrovertible test of the hypothesis must be published, replicated, and withstand the inevitable and important scientific debate about its validity. We believe the hydra of kill to conserve is near that threshold.

Appendix 4 — Killing Wolves Does Not Protect Livestock

Lethal methods of predator control have proven less effective than non-lethal methods. Lethal methods have been subject to less rigorous experimental tests than have non-lethal methods. Lethal methods have a higher risk of undesirable counterproductive effects of raising risk for livestock.

The above three statements are substantiated by the following ten systematic reviews by two dozen scientists from a dozen countries. [112, 217-225]

Appendix 5 — Collected References Cited

All publications cited in this comment and its appendices, except for books, are either available at the embedded links, or have been gathered here: http://faculty.nelson.wisc.edu/treves/archive_BAS/Public_comment_2021.zip. For access to the cited books, or if you have trouble accessing other cited publications, please contact atreves@wisc.edu.

1. Oxford English Dictionary. 2021 18 January 2021; Available from: https://www.oed.com/.
2. Department of the Interior and Department of Commerce, Revised Interagency Cooperative Policy Regarding the Role of State Agencies in Endangered Species Act Activities. Federal Register, 2016. 81: p. 8663-8665.
3. Treves, A., F.J. Santiago-Ávila, and K. Putrevu, Quantifying the effects of delisting wolves after the first state began lethal management. in review 2021.
4. Thiel, R.P., W. Hall, E. Heilhecker, and A.P. Wydeven, A Disjunct Gray Wolf Population in Central Wisconsin, in Recovery of Gray Wolves in the Great Lakes Region of the United States: an Endangered Species Success Story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 107-118.
5. Palacios, V., E. Font, E.J. García, L. Svensson, L. Llaneza, J. Frank, and J.V. López-Bao, Reliability of human estimates of the presence of pups and the number of wolves vocalizing in chorus howls: implications for decision-making processes. European Journal of Wildlife Research, 2017. 63: p. 59-66.
6. Pyare, S. and J. Berger, Beyond demography and delisting: ecological recovery for Yellowstone's grizzly bears and wolves Biological Conservation 2003. 113: p. 63-73.
7. Callan, R., N.P. Nibbelink, T.P. Rooney, J.E. Wiedenhoeft, and A. Wydeven, Recolonizing wolves trigger a trophic cascade in Wisconsin (USA). Journal of Ecology, 2013: p. https://doi.org/10.1111/1365-2745.12095. https://doi.org/10.1111/1365-2745.12095.
8. Creel, S. and J.J. Rotella, Meta-analysis of relationships between human offtake, total mortality and population dynamics of gray wolves (Canis lupus). PLoS ONE, 2010. 5(9): p. 1-7.
9. Mladenoff, D.J., R.G. Haight, T.A. Sickley, and A.P. Wydeven, Causes and implications of species restoration in altered ecosystems. BioScience, 1997. 47: p. 21-31.
10. Mladenoff, D.J., M.K. Clayton, S.D. Pratt, T.A. Sickley, and A.P. Wydeven, Change in occupied wolf habitat in the Northern Great Lakes Region, in Recovery of Gray Wolves in the Great Lakes Region of the United States: an Endangered Species Success Story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 119-138.
11. Brainerd, S.M., Henrik Andrén, Edward E. Bangs, Elizabeth H. Bradley, Joseph A. Fontaine, Wayne Hall, Yorgos Iliopoulos, Michael D. Jimenez, Elizabeth A. Jozwiak, Olof Liberg, Curt M. Mack, Thomas J. Meier, Carter C. Niemeyer, Hans C. Pedersen,

Håkan Sand, Ronald N. Schultz, Douglas W. Smith, Petter Wabakken, and A.P. Wydeven, The effects of breeder loss on wolves. Journal of Wildlife Management, 2008. 72(1): p. 89-98.
12. Harrington, F.H., M. LD, and S.H. Fritts, Pack size and wolf pup survival: their relationship under varying ecological conditions. Behavioral Ecology and Sociobiology, 1982. 13: p. 19-26.
13. Mech, L.D., Alpha status, dominance, and division of labor in wolf packs Canadian Journal of Zoology, 1999. 77: p. 1196-1203.
14. Schmidt, P.A. and D.L. Mech, Wolf pack size and food acquisition. American Naturalist, 1997. 150(4): p. 513-517.
15. Wydeven, A.P., A. Treves, B. Brost, and J.E. Wiedenhoeft, Characteristics of wolf packs in Wisconsin: Identification of traits influencing depredation, in People and Predators: From Conflict to Coexistence, N. Fascione, A. Delach, and M.E. Smith, Editors. 2004, Island Press: Washington, D. C. p. 28-50.
16. Santiago-Avila, F.J., A.M. Cornman, and A. Treves, Killing wolves to prevent predation on livestock may protect one farm but harm neighbors. PLoS ONE, 2018. 13(1): p. e0189729 10.1371/journal.pone.0189729.
17. Fritts, S.H., W. J. Paul, and L.D. Mech, Can relocated wolves survive? Wildlife Society Bulletin, 1985. 13: p. 459-463.
18. Natural Resources Board, 15 February 2021 Special Meeting, N.R. Board, Editor. 2021. p. 37 min, transcript and video available from authors. https://dnrmedia.wi.gov/main/Play/ccb5cf0361c5471e9cbc7c7a898cfc741d?catalog=9da0bb432fd448a69d86756192a62f1721.
19. Manfredo, M.J., T.L. Teel, A.W. Don Carlos, L. Sullivan, A.D. Bright, A.M. Dietsch, J. Bruskotter, and D. Fulton, The changing sociocultural context of wildlife conservation. Conservation Biology, 2020. 10.1111/cobi.13493. https://www.ncbi.nlm.nih.gov/pubmed/32128885.
20. Treves, A. and K.A. Martin, Hunters as stewards of wolves in Wisconsin and the Northern Rocky Mountains, USA. Society and Natural Resources, 2011. 24(9): p. 984-994.
21. Treves, A., L. Naughton-Treves, and V.S. Shelley, Longitudinal analysis of attitudes toward wolves. Conservation Biology, 2013. 27: p. 315–323.
22. Treves, A., R.L. Jurewicz, L. Naughton-Treves, and D. Wilcove, The price of tolerance: Wolf damage payments after recovery. Biodiversity and Conservation, 2009. 18: p. 4003–4021.
23. Treves, A., G. Chapron, J.V. López-Bao, C. Shoemaker, A. Goeckner, and J.T. Bruskotter, Predators and the public trust. Biological Reviews, 2017. 92: p. 248-270.
24. Treves, A., B.J. Bergstrom, D. Parsons, P.C. Paquet, and R.P. Thiel, Letter to the USFWS describing concerns about use of the best available science in the State of Wisconsin's post-delisting monitoring report on gray wolves. 2014: http://faculty.nelson.wisc.edu/treves/.
25. Treves, A., J.A. Langenberg, J.V. López-Bao, and M.F. Rabenhorst, Gray wolf mortality patterns in Wisconsin from 1979 to 2012. Journal of Mammalogy, 2017. 98(1): p. 17-32. DOI:10.1093/jmammal/gyw145.

26. Treves, A., K.A. Artelle, C.T. Darimont, and D.R. Parsons, Mismeasured mortality: correcting estimates of wolf poaching in the United States. Journal of Mammalogy, 2017. 98(5): p. 1256–1264. I:10.1093/jmammal/gyx052 https://doi.org/10.1093/jmammal/gyx052.
27. Treves, A., C. Browne-Nunez, J. Hogberg, J. Karlsson Frank, L. Naughton-Treves, N. Rust, and Z. Voyles, Estimating poaching opportunity and potential, in Conservation Criminology, M.L. Gore, Editor. 2017, John Wiley & Sons: New York. p. 197-212.
28. Treves, A., Peer review of the proposed rule and draft biological report for nationwide wolf delisting, U.S.F.W.S. Department of Interior, Editor. 2019, Department of Interior, U.S. Fish & Wildlife Service: Washington, D.C. https://www.fws.gov/endangered/esa-library/pdf/Final%20Gray%20Wolf%20Peer%20Review%20Summary%20Report_053119.pdf.
29. Treves, A., N.X. Louchouarn, and F. Santiago-Ávila, Modelling concerns confound evaluations of legal wolf-killing. Biological Conservation, 2020. ttps://doi.org/10.1016/j.biocon.2020.108643: p. 108643. 10.1016/j.biocon.2020.108643. ttps://doi.org/10.1016/j.biocon.2020.108643.
30. Santiago-Ávila, F.J., Survival rates and disappearances of radio-collared wolves in Wisconsin, in Nelson Institute for Environmental Studies. 2019, University of Wisconsin-Madison.
31. Santiago-Ávila, F.J., R.J. Chappell, and A. Treves, Liberalizing the killing of endangered wolves was associated with more disappearances of collared individuals in Wisconsin, USA. Scientific Reports, 2020. 10: p. 13881. /10.1038. | https://doi.org/10.1038/s41598-020-70837-x.
32. Stark, D. and J. Erb, 2012 Minnesota wolf season report. 2013, Minnesota Department of Natural Resources: Grand Rapids, MN. http://files.dnr.state.mn.us/fish_wildlife/wildlife/wolves/2013/wolfseasoninfo_2012.pdf.
33. Treves, A., K.A. Artelle, C.T. Darimont, W.S. Lynn, P.C. Paquet, F.J. Santiago-Avila, R. Shaw, and M.C. Wood, Intergenerational equity can help to prevent climate change and extinction. Nature Ecology & Evolution, 2018. 2: p. 204-207. https://doi.org/10.1038/s41559-018-0465-y.
34. Treves, A., F. Santiago-Ávila, and W.S. Lynn, Just Preservation. Biological Conservation, 2018. 229: p. 134-141. 10.1016/j.biocon.2018.11.018. https://www.sciencedirect.com/science/article/pii/S0006320718310139?via%3Dihub.
35. Treves, A. and F.J. Santiago-Ávila, Myths and assumptions about human-wildlife conflict and coexistence. Conservation Biology, 2020. 34(4): p. 811–818. 10.1111/cobi.13472.
36. Treves, A., P.C. Paquet, K.A. Artelle, A.M. Cornman, M. Krofel, and C.T. Darimont, Transparency about values and assertions of fact in natural resource management. Frontiers in Conservation Science: Human-Wildlife Dynamics, 2021. 2: p. e631998. 10.3389/fcosc.2021.631998.
37. Santiago-Avila, F.J., W.S. Lynn, and A. Treves, Inappropriate consideration of animal interests in predator management: Towards a comprehensive moral code, in

Large Carnivore Conservation and Management: Human Dimensions and Governance, T. Hovardos, Editor. 2018, Taylor & Francis: New York. p. 227-251.
38. Santiago-Ávila, F.J., A. Treves, and W.S.e.c.-a. Lynn, Just preservation, trusteeship and multispecies justice. Animal Sentience: Response to Commentary on Treves et al. on Just Preservation, 2020. 27(27): p. 393-409. 10.51291/2377-7478.1665. https://www.wellbeingintlstudiesrepository.org/cgi/viewcontent.cgi?article=1665&context=animsent.
39. López-Bao, J.V., J.C. Blanco, A. Rodríguez, R. Godinho, V. Sazatornil, F. Alvares, E.J. Garcia, L. Llaneza, M. Rico, Y. Cortés, V. Palacios, and G. Chapron, Toothless wildlife protection laws. Biodiversity and Conservation, 2015. 24(8): p. 2105-2108.
40. López-Bao, J.V., G. Chapron, and A. Treves, The Achilles heel of participatory conservation. Biological Conservation, 2017. 212: p. 139–143.
41. Wood, M.C., Advancing the sovereign trust of government to safeguard the environment for present and future generations (Part I): Ecological realism and the need for a paradigm shift. Environmental Law, 2009. 43: p. 44-88.
42. Wood, M.C., Nature's Trust. 2013, New York: Cambridge University Press.
43. Wood, M.C., Tribal trustees in climate crisis American Indian Law Journal, 2014. 2(2): p. 518-546.
44. Nie, M., State Wildlife Policy and Management: The Scope and Bias of Political Conflict. Public Administration Review, 2004. 64(2): p. 221-233.
45. Nie, M., C. Barns, J. Haber, J. Joly, K. Pitt, and S. Zellmer, Fish and wildlife management on federal lands: Debunking state supremacy. Environmental Law, 2017. 47: p. 797-932.
46. Nie, M., N. Landers, and M. Bryan, The Public Trust in Wildlife: Closing the Implementation Gap in 13 Western States. Environmental Law Reporter, 2020. 50: p. 10909-10919.
47. Hogberg, J., A. Treves, B. Shaw, and L. Naughton-Treves, Changes in attitudes toward wolves before and after an inaugural public hunting and trapping season: early evidence from Wisconsin's wolf range. Environmental Conservation, 2015. 43(1): p. 45-55.
48. Sanders, J.D., Wolves, lone and pack: Ojibwe treaty rights and the Wisconsin wolf hunt. Wisconsin Law Review, 2013. 2013: p. 1263-1294.
49. Shelley, V.S., A. Treves, and L. Naughton-Treves, Attitudes to wolves and wolf policy among Ojibwe Tribal members and non-tribal residents of Wisconsin's wolf range. Human Dimensions of Wildlife, 2011. 16: p. 397–413.
50. Allison, D.B., A.W. Brown, B.J. George, and K.A. Kaiser, Reproducibility: A tragedy of errors. Nature, 2016. 530: p. 27-29. doi:10.1038/530027a. https://www-nature-com.ezproxy.library.wisc.edu/news/polopoly_fs/1.19264!/menu/main/topColumns/topLeftColumn/pdf/530027a.pdf.
51. Attfield, R., Environmental ethics and intergenerational equity. Inquiry, 1998. 41: p. 207-222.
52. Baker, M. and K. Brandon, 1,500 scientists lift the lid on reproducibility. Nature, 2016. 533: p. 452-454.

53. Beauchamp, T.L. and J.F. Childress, Principles of biomedical ethics. 2013, New York: Oxford University Press.
54. Biden, J.R., Memorandum on Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking P.E. Order, Editor. 2021, The White House: Washington, D.C. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/memorandum-on-restoring-trust-in-government-through-scientific-integrity-and-evidence-based-policy making/
55. Bouyer, J., N.H. Carter, C. Batavia, and M.P. Nelson, The Ethics of Eliminating Harmful Species: The Case of the Tsetse Fly. Bioscience, 2019. 69(2): p. 125-135. 10.1093/biosci/biy155. https://www.ncbi.nlm.nih.gov/pubmed/30792543.
56. Callicott, J.B., Conservation Values and Ethics, in Principles of Conservation Biology, G.K. Meffe and C.R. Carroll, Editors. 1997, Sinauer Associates: Sunderland, MA p. 29-55.
57. Carroll, C., D.J. Rohlf, B.R. Noon, and J.M. Reed, Scientific Integrity in Recovery Planning and Risk Assessment: Comment on Wilhere. Conservation Biology, 2012. 26(743-745).
58. Carroll, C., B. Hartl, G.T. Goldman, D.J. Rohlf, A. Treves, J.T. Kerr, E.G. Ritchie, R.T. Kingsford, K.E. Gibbs, M. Maron, and J.E.M. Watson, Defending scientific integrity in conservation policy processes: Lessons from Canada, Australia, and the United States. Conservation Biology, 2017. 31(5): p. 967–975.
59. Clark, A. and G. Alvino, Building research evidence towards reproducibility of animal research, in PLoS ONE blog. 2018. https://everyone.plos.org/2018/08/06/arrive-rct/.
60. Clark, S.G., Educational Policy and Ethics for Human-Nature (Wildlife) Coexistence: An Inquiry, a Case, and Recommendations. Journal of Multidisciplinary Research, 2021. 13(1): p. 000-000. http://eds.b.ebscohost.com/eds/detail/detail?vid=0&sid=beea6413-0f39-434d-a65b-cce26c3d8792%40pdc-v-sessmgr02&bdata=JnNpdGU9ZWRzLWxpdmU%3d#db=aqh&AN=149083185
61. Department of the Interior, O.o.t.D.S., Part 305: Departmental Science Efforts Chapter 3: Integrity of Scientific and Scholarly Activities, D.o.t.I. Office of the Deputy Secretary, Editor. 2014, Department of the Interior Washington, DC. p. 1-17.
62. Dubois, S., N. Fenwick, E.A. Ryan, L. Baker, S.E. Baker, N.J. Beausoleil, S. Carter, B. Cartwright, F. Costa, C. Draper, J. Griffin, A. Grogan, G. Howald, B. Jones, K.E. Littin, A.T. Lombard, D.J. Mellor, D. Ramp, C.A. Schuppli, and D. Fraser, International consensus principles for ethical wildlife control. Conservation Biology, 2017. DOI: 10.1111/cobi.12896: p. DOI: 10.1111/cobi.12896.
63. Gadamer, H.-G., Hermeneutics, Religion, and Ethics. 1999, New Haven, CT: Yale University Press.
64. Goodman, S., D. Fanelli, and J. Ioannidis, What does research reproducibility mean? Science Translational Medicine, 2016. 8(341): p. 341ps12 DOI: 10.1126/scitranslmed.aaf5027.

65. Group, C.W., RePAIR consensus guidelines: Responsibilities of Publishers, Agencies, Institutions, and Researchers in protecting the integrity of the research record. Research Integrity and Peer Review, 2018. 3: p. 15. 10.1186/s41073-018-0055-1. https://researchintegrityjournal.biomedcentral.com/articles/10.1186/s41073-018-0055-1.
66. Haber, G.C., Biological, conservation, and ethical implications of exploiting and controlling wolves. Conservation Biology, 1996. 10: p. 1068-1081.
67. Iqbal, S.A., J.D. Wallach, M.J. Khoury, S.D. Schully, and J.P.A. Ioannidis, Reproducible Research Practices and Transparency across the Biomedical Literature. PLOS Biology, 2016. 14(1): p. e1002333. 10.1371/journal.pbio.1002333. https://doi.org/10.1371/journal.pbio.1002333.
68. Jonsen, A.R., M. Siegler, and W.J. Winslade, Clinical ethics: A practical approach to ethical decisions in clinical medicine. 1997, New York: McGraw Hill.
69. Kassiola, J.J., Can environmental ethics 'solve' environmental problems and save the world? Yes, but first we must recognize the essential normative nature of environmental problems. Environmental Values, 2008. 12: p. 489-514.
70. Kretser, A., Delia Murphy, Stefano Bertuzzi, Todd Abraham, David B. Allison, Kathryn J. Boor, Johanna Dwyer, Andrea Grantham, Linda J. Harris, Rachelle Hollander, Chavonda Jacobs-Young, Sarah Rovito, Dorothea Vafiadis, Catherine Woteki, Jessica Wyndham, and R. Yada, Scientific Integrity Principles and Best Practices: Recommendations from a Scientific Integrity Consortium. Science and Engineering Ethics, 2019: p. 1–29.
71. Lynn, W.S., Animals, ethics and geography, in Animal geographies: Place, politics, and identity in the nature-culture borderlands. 1998. p. 280-297.
72. Lynn, W.S., The Quality of Ethics: Moral Causation in the Interdisciplinary Science of Geography, in Geographies and Moralities: International Perspectives on Justice, Development and Place T.I.R. Lee and D.M.h. Smit, Editors. 2004, Routledge: London. p. 231-244.
73. Lynn, W.S., Between Science and Ethics: What Science and the Scientific Method Can and Cannot Contribute to Conservation and Sustainability., in Gaining Ground: In Pursuit of Ecological Sustainability, D. Lavigne, Editor. 2006, Limerick, IRL: University of Limerick. p. 191-205.
74. Lynn, W.S. and M. Bekoff, Practical ethics and human-animal relations in Encyclopedia of human-animal relationships. 2007. p. 790-797.
75. Lynn, W.S., Discourse and Wolves: Science, Society and Ethics. Society & Animals, 2010. 18(1): p. 75-92.
76. Lynn, W.S., Rewilding the Covenant of Life with Compassion: A Future for Global and Sustainability Ethics. 2018.
77. Lynn, W.S., Bringing Ethics to Wild Lives: Shaping Public Policy for Barred and Northern Spotted Owls. Society & Animals, 2018. 26: p. 217-238. http://www.williamlynn.net/pdf/lynn-2018-bringing-ethics-to-wild-lives.pdf.
78. Mathews, F., From biodiversity-based conservation to an ethic of bio-proportionality. Biological Conservation, 2016. 200: p. 140-148.
79. Meffe, G.K. and C.R. Carroll, eds. Conservation values and ethics. 1997, Sinauer Associates: Sunderland, MA.

80. Mejlgaard, N., L. Bouter, M., G. Gaskell, P. Kavouras, N. Allum, A. Bendtsen, C. Charitidis, A., N. Claesen, K. Dierickx, A. Domaradzka, A. Elizondo, R., N. Foeger, M. Hiney, W. Kaltenbrunner, K. Labib, A. Marušić, M. Sørensen, P., T. Ravn, R. Ščepanović, J. Tijdink, K., and G. Veltri, A., Research integrity: nine ways to move from talk to walk. Nature, 2020. 586: p. 358-360. 10.1038/d41586-020-02847-8.
81. Munafò, M.R., B.A. Nosek, D.V.M. Bishop, K.S. Button, C.D. Chambers, N. Percie du Sert, U. Simonsohn, E.-J. Wagenmakers, J.J. Ware, and J.P.A. Ioannidis, A manifesto for reproducible science. Nature Human Behaviour, 2017. 1(0021): p. 1-9. 10.1038/s41562-016-0021 |.
82. NAS, N.A.S.E.M., Fostering Integrity in Research. 2017, The National Academies Press: Washington, DC. https://doi.org/10.17226/21896.
83. Norton, B.G., Environmental Ethics and Weak Anthropocentrism. Environmental Ethics, 1984. 6(2): p. 131-148.
84. Open Science Collaboration, Reproducibility Project: Psychology. OSF, 2015. 10.17605/OSF.IO/EZCUJ. https://osf.io/ezcuj/.
85. Partridge, E., ed. Responsibilities to Future Generations: Environmental Ethics. 1981, Buffalo: Prometheus.
86. Patz, J.A., H.K. Gibbs, J.A. Foley, J.V. Rogers, and K.R. Smith, Climate change and global health: quantifying a growing ethical crisis. EcoHealth, 2007. 4: p. 397–405.
87. Peterson, A.L., Being Animal: Beasts and Boundaries in Nature Ethics. 2013, New York, NY: Columbia University Press.
88. Plumwood, V., Ecological Ethics From Rights to Recognition: Multiple Spheres of Justice for Humans, Animals and Nature, in Global Ethics and the Environment,, N. Low, Editor. 2000, Routledge: New York. p. 188-212.
89. Santiago-Avila, F.J. and W.S. Lynn, Bridging compassion and justice in conservation ethics. Biological Conservation, 2020. 248: p. 108648.
90. Singer, P., Ethics Across the Species Boundary, in Global Ethics and the Environment,, N. Low, Editor. 2000, Routledge: New York. p. 146-157.
91. Stone, C.D., Earth and other ethics: The case for moral pluralism. 1988, New York: Harper and Row.
92. Treves, A., Scientific ethics and the illusion of naïve objectivity. Frontiers in Ecology and the Environment, 2019. 7: p. 361. doi:10.1002/fee.2091.
93. Vucetich, J.A. and M.P. Nelson, Wolf Hunting and the Ethics of Predator Control, in Political Science, Comparative Politics, Political Theory. 2014, Oxford Handbooks Online: Oxford, UK. DOI: 10.1093/oxfordhb/9780199927142.013.007.
94. Wiley, Best Practice Guidelines on Publishing Ethics. 2020. https://authorservices.wiley.com/ethics-guidelines/index.html.
95. Zemanova, M.A., More Training in Animal Ethics Needed for European Biologists. Bioscience, 2017. 67: p. 301-305.
96. Treves, A., Standards of evidence in wild animal research. 2019, The Brooks Institute for Animal Rights Policy & Law. http://faculty.nelson.wisc.edu/treves/CCC.php/standards.
97. Artelle, K.A., J.C. Reynolds, P.C. Paquet, and C.T. Darimont, When Science-Based Management Isn't. Science, 2014. 343: p. 1311.

98. Artelle, K.A., J.D. Reynolds, A. Treves, J.C. Walsh, P.C. Paquet, and C.T. Darimont, Working constructively toward an improved North American approach to wildlife management. Science Advances, 2015. 4(10): p. eaav2571.
99. Artelle, K.A., S.C. Anderson, J.D. Reynolds, A.B. Cooper, P.C. Paquet, and C.T. Darimont, Ecology of conflict: marine food supply affects human-wildlife interactions on land. Scientific Reports, 2016. DOI: 10.1038/srep25936.
100. Artelle, K.A., J.D. Reynolds, T. A., J.C. Walsh, P.P. C., and C.T. Darimont, Hallmarks of science missing from North American wildlife management. Science Advances 2018. 4(3): p. eaao0167.
101. Artelle, K.A., J.D. Reynolds, T. A., J.C. Walsh, P.P. C., and C.T. Darimont, Distinguishing science from "fact by assertion" in natural resource management. Science Advances (eLetter), 2018. 4(3): p. eaao0167.
102. Artelle, K., J. Stephenson, C. Bragg, J. Housty, W. Housty, M. Kawharu, and N. Turner, Values-led management: the guidance of place-based values in environmental relationships of the past, present, and future. Ecology and Society, 2018. 23(3).
103. Darimont, C.T., K.A. Artelle, F. Moola, and P. Paquet, Trophy Hunting: Science on its own can't dictate policy. Nature, 2017. 551: p. 565.
104. Darimont, C.T., P.C. Paquet, A. Treves, K.A. Artelle, and G. Chapron, Political populations of large carnivores. Conservation Biology, 2018. 32(3): p. 747–749. 10.1111/cobi.13065.
105. Darimont, C.T., H. Hall, I. Mihalik, K.A. Artelle, L. Eckert, and P. Paquet, Large carnivore hunting and the social license to hunt. Conservation Biology, 2021. https://doi.org/10.1111/cobi.13657.
106. Treves, A. and C. Batavia, Improved disclosures of non-financial competing interests would promote independent review. Academia Letters, 2021. Article 514: p. 1-9.
107. Chapron, G. and A. Treves, Blood does not buy goodwill: allowing culling increases poaching of a large carnivore. Proceedings of the Royal Society B, 2016. 283(1830): p. 20152939. http://dx.doi.org/10.1098/rspb.2015.2939
108. Chapron, G. and A. Treves, Correction to 'Blood does not buy goodwill: allowing culling increases poaching of a large carnivore'. Proceedings of the Royal Society B, 2016. Volume 283(1845): p. 20162577.
109. Chapron, G. and A. Treves, Reply to comment by Pepin et al. 2017. Proceedings of the Royal Society B, 2017. 2016257(1851): p. 20162571. http://dx.doi.org/10.1098/rspb.2015.2939
110. Chapron, G. and A. Treves, Reply to comments by Olson et al. 2017 and Stien 2017. Proceedings of the Royal Society B, 2017. 284(1867): p. 20171743.
111. Chamberlin , T.C., The method of multiple working hypotheses. Science, 1890. 15 (reprinted in 1965, vol. 148): p. 92–96 (reprinted p. 754-759).
112. Treves, A., M. Krofel, O. Ohrens, and L.M. Van Eeden, Predator control needs a standard of unbiased randomized experiments with cross-over design. Frontiers in Ecology and Evolution, 2019. 7 p. 402-413. 10.3389/fevo.2019.00462.
113. Louchouarn, N.X., F.J. Santiago-Ávila, D.R. Parsons, and A. Treves, Evaluating how lethal management affects poaching of Mexican wolves Open Science, 2021. 8 (registered report): p. 200330. https://doi.org/10.1098/rsos.200330.

114. Pepin, K., S. Kay, and A. Davis, Comment on: "Blood does not buy goodwill: allowing culling increases poaching of a large carnivore". Proceedings of the Royal Society B, 2017. 284(1851): p. e20161459.
115. Stien, A., Blood may buy goodwill - no evidence for a positive relationship between legal culling and poaching in Wisconsin. Proceedings of the Royal Society B, 2017. 284: p. 20170267. http://dx.doi.org/10.1098/rspb.2017.0267.
116. Olson, E.R., S. Crimmins, D.E. Beyer, D. MacNulty, B. Patterson, B. Rudolph, A. Wydeven, and T.R. Van Deelen, Flawed analysis and unconvincing interpretation: a comment on Chapron and Treves 2016. Proceedings of the Royal Society of London B, 2017. 284(1867): p. 20170273.
117. WDNR, Wisconsin Wolf Management Plan. 1999, Madison, WI: Wisconsin Department of Natural Resources.
118. WDNR, Wisconsin Wolf Management Plan Addendum 2006 and 2007. 2007, Wisconsin Department of Natural Resources: Madison. p. 57. https://dnr.wi.gov/files/PDF/pubs/ER/ER0099.pdf.
119. Natural Resources Board, Request that the Board take action to consider approval of a quota for a February 2021 wolf hunt in accordance with the circuit court order issued on February 11, 2021 in Hunter Nation et al. v. WDNR, et al, Civ. No. 2021-CV-31 (Jefferson County). 2021, Department of Natural Resources. : Madison, Wisconsin p. 3. https://widnr.widen.net/view/pdf/sbdtbr1v2w/2021-02-2A-Special-meeting-wolf-quota.pdf?t.download=true&u=ulxjqn.
120. WDNR, NRB Wolf Information request: Agenda Item 2A –January 22, 2021 Special Meeting, D.o.N. Resources, Editor. 2021: Madison, WI. https://widnr.widen.net/s/vh58xn8lfr/2021-01-2a-additional-information.
121. Wiedenhoeft, J.E., S. Walter, M. Gross, N. Kluge, S. McNamara, G. Stauffer, J. Price-Tack, and R. Johnson, Wisconsin gray wolf monitoring report 15 April 2019 through 14 April 2020, B.O.W. MANAGEMENT, Editor. 2020, Wisconsin Department of Natural Resources: Madison, Wisconsin. https://dnr.wisconsin.gov/sites/default/files/topic/WildlifeHabitat/wolfreport2020.pdf.
122. Natural Resources Board, Adoption of Board Order WM-09012(E) relating to wolf hunting and trapping regulations, establishment of a depredation program, and approval of a harvest quota and permit level, N.R. Board, Editor. 2012, Wisconsin Department of Natural Resources: Madison, WI. p. 58.
123. Natural Resources Board, Request approval of a wolf harvest quota and number of licenses to issue for the 2013-2014 wolf hunting and trapping season. 2013, Department of Natural Resources. : Madison, Wisconsin
124. Natural Resources Board, Request approval of a wolf harvest quota and number of licenses to issue for the 2014-2015 wolf hunting and trapping season. 2014, Department of Natural Resources. : Madison, Wisconsin p. 10.
125. Wydeven, A.P., J. Wiedenhoeft, R.N. Schultz, R.P. Thiel, R.R. Jurewicz, B. Kohn, and T.R. Van Deelen, History, population growth and management of wolves in Wisconsin, in Recovery of Gray Wolves in the Great Lakes Region of the United States:

an Endangered Species Success Story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 87-106.
126. Fuller, T.K., Population dynamics of wolves in north central Minnesota. Wildlife Monographs, 1989. 105: p. 3-41.
127. Fuller, T.K., L.D. Mech, and J.F. Cochrane, Wolf population dynamics, in Wolves: Behavior, ecology, and conservation, L.D. Mech and L. Boitani, Editors. 2003, University of Chicago Press: Chicago. p. 161-191.
128. Treves, A., K.A. Martin, J.E. Wiedenhoeft, and A.P. Wydeven, Dispersal of gray wolves in the Great Lakes region, in Recovery of Gray Wolves in the Great Lakes Region of the United States: An Endangered Species Success Story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 191-204.
129. Treves, A., Memo: RIN:1018-BD60 proposed rule to remove federal protections for gray wolves nationwide. 2020: http://faculty.nelson.wisc.edu/treves/CCC.php. https://www.reginfo.gov/public/do/viewEO12866Meeting?viewRule=false&rin=1018-BD60&meetingId=6065&acronym=1018-DOI/FWS.
130. Adams, L.G., R.O. Stephenson, B.W. Dale, R.T. Ahgook, and D.J. Demma, Population dynamics and harvest characteristics of wolves in the Central Brooks Range, Alaska Wildlife Monographs, 2008. 170: p. 1-25.
131. Vucetich, J.A., Appendix: The influence of anthropogenic mortality on wolf population dynamics with special reference to Creel and Rotella (2010) and Gude et al. (2011) in the Final peer review of four documents amending and clarifying the Wyoming gray wolf management plan. Federal Register, 2012. 50: p. 78-95. https://www.federalregister.gov/documents/2012/05/01/2012-10407/endangered-and-threatened-wildlife-and-plants-removal-of-the-gray-wolf-in-wyoming-from-the-federal.
132. Gude, J.A., M.S. Mitchell, R.E. Russell, C.A. Sime, E.E. Bangs, L.D. Mech, and R.R. Ream, Wolf population dynamics in the U.S. Northern Rocky Mountains are affected by recruitment and human-caused mortality. Journal of Wildlife Management, 2012. 76(1): p. 108-118.
133. Stenglein, J., Survival of Wisconsin's gray wolves from endangered to harvested, 1980 – 2013. 2014, University of Wisconsin-Madison.
134. Stenglein, J.L., J. Zhu, M.K. Clayton, and T.R. Van Deelen, Are the numbers adding up? Exploiting discrepancies among complementary population models. Ecology and Evolution, 2015. 5(2): p. 368-376.
135. Stenglein, J.L., T.R. Van Deelen, A.P. Wydeven, D.J. Mladenoff, J. Wiedenhoeft, J.A. Langenberg, and N.J. Thomas, Mortality patterns and detection bias from carcass data: An example from wolf recovery in Wisconsin. Journal of Wildlife Management, 2015. 7: p. 1173-1184.
136. Stenglein, J.L., J.H. Gilbert, A.P. Wydeven, and T.R. Van Deelen, An individual-based model for southern Lake Superior wolves: A tool to explore the effect of human-caused mortality on a landscape of risk. Ecological Modelling, 2015. 302: p. 13-24.
137. Stenglein, J.L. and T.R. Van Deelen, Demographic and Component Allee Effects in Southern Lake Superior Gray Wolves. PLOS ONE, 2016. 11(3): p. 10.1371/journal.pone.0150535

138. Stenglein, J.L., A.P. Wydeven, and T.R. Van Deelen, Compensatory mortality in a recovering top carnivore: wolves in Wisconsin, USA (1979–2013). Oecologia, 2018. 187(1): p. 99–111. https://doi.org/10.1007/s00442-018-4132-4.
139. Schmidt, J.H., D.S. Johnson, M.S. Lindberg, and L.G. Adams, Estimating demographic parameters using a combination of known-fate and open N-mixture models. Ecology, 2015. 56(10): p. 2583–2589. http://dx.doi.org/10.1890/15-0385.1.
140. Epstein, Y., Killing Wolves to Save Them? Legal Responses to 'Tolerance Hunting' in the European Union and United States. RECIEL, 2017. 26(1): p. 19-29.
141. Roosevelt, T.D., Hunting the Grisly and Other Sketches. 1902, New York: G. P. Putnam's Sons. https://www.gutenberg.org/files/3337/3337-h/3337-h.htm
142. Roosevelt, T.D., A Book-Lover's Holidays in the Open. 1916, New York: Charles Scribner's Sons. https://www.gutenberg.org/files/34135/34135-h/34135-h.htm
143. Treves, A., K.A. Artelle, and P.C. Paquet, Differentiating between regulation and hunting as conservation interventions. Conservation Biology 2018. 33(2): p. 472–475. DOI:10.1111/cobi.13211.
144. Holsman, R.H., Goodwill hunting? Exploring the role of hunters as ecosystem stewards. Wildlife Society Bulletin, 2000. 28(4): p. 808-816. http://www.jstor.org/stable/3783835
145. Woodroffe, R. and J.R. Ginsberg, Edge effects and the extinction of populations inside protected areas. Science, 1998. 280: p. 2126-2128.
146. McLellan, B.N., F.W. Hovey, R.D. Mace, J.G. Woods, D.W. Carney, M.L. Gibeau, W.L. Wakkinen, and W.F. Kasworm, Rates and causes of grizzly bear mortality in the Interior Mountains of British Columbia, Alberta, Montana, Washington, and Idaho. Journal of Wildlife Management, 1999. 63(3): p. 911-920.
147. McLellan, B., G. Mowat, and C. Lamb, Estimating unrecorded human-caused mortalities of grizzly bears in the Flathead Valley, British Columbia, Canada. PeerJ, 2018. 6: p. e5781. https://doi.org/10.7717/peerj.5781.
148. Creel, S., M. Becker, D. Christianson, E. Dröge, N. Hammerschlag, M.W. Hayward, K.U. Karanth, A.J. Loveridge, D. Macdonald, W. Matandiko, J. M'soka, D. Murray, E. Rosenblatt, and P. Schuette, Questionable policy for large carnivore hunting. Science, 2015. 350(6267): p. 1473-1475.
149. Laundré, J.W. and C. Papouchis, The Elephant in the room: What can we learn from California regarding the use of sport hunting of pumas (Puma concolor) as a management tool? PLoS ONE 2020. 15(2): p. e0224638. https://doi.org/10.1371/journal.pone.0224638.
150. Artelle, K.A., S.C. Anderson, A.B. Cooper, P.C. Paquet, J.D. Reynolds, and C.T. Darimont, Confronting uncertainty in wildlife management: Performance of grizzly bear management. PLoS ONE, 2013. 8(11): p. 1-9.
151. Loveridge, A.J., J.C. Reynolds, and E.J. Milner-Gulland, Does sport hunting benefit conservation?, in Key Topics in Conservation Biology, D. MacDonald and K. Service, Editors. 2007, Oxford University Press: Oxford. p. 224-241.
152. Nichols, J.D., F.A. Johnson, B.K. Williams, and G.S. Boomer, Science Alive and Well in North American Wildlife Management. Science Advances (eLetter 3 April 2018), 2018. 4(3): p. eaao0167. 10.1126/sciadv.aao0167.

153. Di Minin, E., C. Bradshaw, and N. Leader-Williams, Banning trophy hunting will exacerbate biodiversity loss. Trends in Ecology and Evolution, 2016. 31: p. 99-102.
154. Dickman, A., R. Cooney, P.J. Johnson, M.P. Louis, D. Roe, and a. signatories, Trophy hunting bans imperil biodiversity. Science (Letter), 2019. 365(6456): p. 874. 10.1126/science.aaz0735.
155. Dickman, A., R. Cooney, P.J. Johnson, M.P. Louis, and D. Roe, RE: Trophy hunting: Insufficent evidence. Science eLetter, 2019. https://science-sciencemag-org.ezproxy.library.wisc.edu/content/366/6464/435.1/tab-e-letters?_ga=2.54336424.1272848709.1572268918-1293948498.1530634101.
156. Batcheller, G.R., M.C. Bambery, L. Bies, T. Decker, S. Dyke, D. Guynn, M. McEnroe, M. O'Brien, J.F. Organ, S.J. Riley, and G. Roehm, The Public Trust Doctrine: Implications for Wildlife Management and Conservation in the United States and Canada. 2010, The Wildlife Society, the Association of Fish and Wildlife Agencies (AFWA), the Western Association of Fish and Wildlife Agencies (WAFWA), and the Wildlife Management Institute (WMI): Bethesda, MD.
157. Geist, V., S. Mahoney, and J.F. Organ, Why hunting has defined the North American model of wildlife conservation. Transactions of the North American Wildlife and Natural Resources Conference, 2001. 66: p. 175-185.
158. Treves, A., F.J. Santiago-Ávila, V.D. Popescu, P.C. Paquet, W.S. Lynn, C.T. Darimont, and K.A. Artelle, Trophy hunting: Insufficient evidence. Science, 2019. 366(6464): p. 435. 10.1126/science.aaz4389. https://science.sciencemag.org/content/366/6464/435.1.
159. Macdonald, D.W., A.J. Loveridge, A. Dickman, P.J. Johnson, K.S. Jacobsem, and B. De Preez, Lions, trophy hunting and beyond: knowledge gaps and why they matter. Mammal Review, 2017. 47(4): p. 247-253.
160. Macdonald, D.W., Mammal Conservation: Old Problems, New Perspectives, Transdisciplinarity, and the Coming of Age of Conservation Geopolitics. Annual Review of Environment and Resources, 2019. 44(1): p. 61-88. 10.1146/annurev-environ-101718-033039.
161. Treves, A. and L. Naughton-Treves, Evaluating lethal control in the management of human-wildlife conflict, in People and Wildlife, Conflict or Coexistence?, R. Woodroffe, S. Thirgood, and A. Rabinowitz, Editors. 2005, Cambridge University Press: Cambridge, UK. p. 86-106.
162. Treves, A., Hunting to conserve large carnivores. Journal of Applied Ecology, 2009. 46: p. 1350-1356.
163. Bruskotter, J.T., S. Enzler, and A. Treves, Rescuing wolves from politics: wildlife as a public trust resource. Science, 2011. 333(6051): p. 1828-1829.
164. Bruskotter, J.T., S. Enzler, and A. Treves, Response to Mech and Johns. Science, 2012. 335(17): p. 795.
165. Koot, S., P. Hebinck, and S. Sullivan, Science for Success—A Conflict of Interest? Researcher Position and Reflexivity in Socio-Ecological Research for CBNRM in Namibia. Society & Natural Resources, 2020: p. 1-18. 10.1080/08941920.2020.1762953.

166. Virtanen, P., Local management of global values: Community-based wildlife management in Zimbabwe and Zambia. Society and Natural Resources, 2003. 16: p. 179-190.
167. Ericsson, G. and T.A. Heberlein, Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. Biological Conservation, 2003. 111: p. 149-159.
168. Humane Society of the U.S. et al. v U.S. Department of the Interior. 2006, District Court, Washington D.C.
169. Mincher, B.J., Harvest as a component of Greater Yellowstone Ecosystem grizzly bear management. Wildlife Society Bulletin, 2002. 30(4): p. 1287-1292
170. Refsnider, R., The Role of the Endangered Species Act in Midwest Wolf Recovery, in Recovery of gray wolves in the Great Lakes region of the United States: An endangered species success story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 311-330.
171. Murtaugh, P.A., On rejection rates of paired intervention analysis. Ecology, 2002. 83: p. 1752–1761.
172. Popescu, V.D., P. de Valpine, D. Tempel, and M.Z. Peery, Estimating population impacts via dynamic occupancy analysis of Before-After Control-Impact studies. Ecological Applications, 2012. 22: p. 1389–1404.
173. Stewart-Oaten, A., On rejection rates of paired intervention analysis: comment. Ecology 84, 2795–2799, 2003. 84: p. 2795–2799.
174. Browne-Nuñez, C., A. Treves, D. Macfarland, Z. Voyles, and C. Turng, Tolerance of wolves in Wisconsin: A mixed-methods examination of policy effects on attitudes and behavioral inclinations. Biological Conservation, 2015. 189: p. 59–71.
175. Bruskotter, J.T., J.A. Vucetich, S. Enzler, A. Treves, and M.P. Nelson, Removing protections for wolves and the future of the U.S. Endangered Species Act (1973) Conservation Letters, 2013. 7: p. 401-407.
176. St. John, F.A.V., A.M. Keane, G. Edwards-Jones, L. Jones, R.W. Yarnell, and J.P. Jones, Identifying indicators of illegal behavior: carnivore killing in human-managed landscapes. Proceedings of the Royal Society B-Biological Sciences, 2012. 279: p. 804-812.
177. Marchini, S. and D.W. Macdonald, Predicting ranchers' intention to kill jaguars: Case studies in Amazonia and Pantanal. Biological Conservation, 2012. 147: p. 213-221.
178. Treves, A. and J.T. Bruskotter, Tolerance for predatory wildlife. Science, 2014. 344(6183): p. 476-477.
179. Kahler, J.S. and M.L. Gore, Beyond the cooking pot and pocket book: factors influencing noncompliance with wildlife poaching rules. International Journal of Comparative and Applied Criminal Justice, 2012. DOI:10.1080/01924036.2012.669913.
180. Liberg, O., G. Chapron, P. Wabakken, H.C. Pedersen, N.T. Hobbs, and H. Sand, Shoot, shovel and shut up: cryptic poaching slows restoration of a large carnivore in Europe. Proceedings of the Royal Society of London Series B, 2012. 270: p. 91-98.
181. Chapron, G., P. Kaczensky, J.D.C. Linnell, M. von Arx, D. Huber, H. Andrén, J.V. López-Bao, M. Adamec, F. Álvares, O. Anders, L. Balčiauskas, V. Balys, P. Bedő, F.

Bego, J.C. Blanco, U. Breitenmoser, H. Brøseth, L.k. Bufka, R. Bunikyte, P. Ciucci, A. Dutsov, T. Engleder, C. Fuxjäger, C. Groff, K. Holmala, B. Hoxha, Y. Iliopoulos, O. Ionescu, J. Jeremić, K. Jerina, G. Kluth, F. Knauer, I. Kojola, I. Kos, M. Krofel, J. Kubala, S. Kunovac, J. Kusak, M. Kutal, O. Liberg, A. Majić, P. Männil, R. Manz, E. Marboutin, F. Marucco, D. Melovski, K. Mersini, Y. Mertzanis, R.W. Mysłajek, S. Nowak, J. Odden, J. Ozolins, G. Palomero, M. Paunović, J. Persson, H. Potočnik, P.-Y. Quenette, G. Rauer, I. Reinhardt, R. Rigg, A. Ryser, V. Salvatori, T. Skrbinšek, A. Stojanov, J.E. Swenson, L. Szemethy, A. Trajçe, E. Tsingarska-Sedefcheva, M. Váňa, R. Veeroja, P. Wabakken, M. Wölfl, S. Wölfl, F. Zimmermann, D. Zlatanova, and L. Boitani, Recovery of large carnivores in Europe's modern human-dominated landscapes. Science, 2014. 346(6216): p. 1517.

182. Nie, M.A., Wolf recovery and management as value-based political conflict. Ethics, Place and Environment, 2002. 5(1): p. 65-71.

183. Lute, M.L. and M.L. Gore, Stewardship as a path to cooperation? Exploring the role of identity in intergroup conflict among Michigan wolf stakeholders. Human Dimensions of Wildlife, 2014. 19(3): p. 267-279.

184. Kaltenborn, B.P. and S.M. Brainerd, Can poaching inadvertently contribute to increased public acceptance of wolves in Scandinavia? European Journal of Wildlife Research, 2016. 62(2): p. 179–188.

185. Lewis, M.S., G. Pauley, Q. Kujala, J.A. Gude, Z. King, and K. Skogen, Selected Results from Four Separate Surveys of Resident Montanans Regarding Montana's Wolf Hunt, in HD Unit Research Summary No. 34. 2012, Montana Fish Wildlife and Parks. p. 8.

186. Heberlein, T.A. and G. Ericsson, Public attitudes and the future of wolves Canis lupus in Sweden. Wildlife Biology, 2008. 14: p. 391-394.

187. Majic, A. and A. Bath, Changes in attitudes toward wolves in Croatia. Biological Conservation, 2010. 143: p. 255-260.

188. Majić, A., A. Bodonia, D. Huber, and N. Bunnefeld, Dynamics of public attitudes toward bears and the role of bear hunting in Croatia. Biological Conservation, 2011. 144(12): p. 3018-3027.

189. Kaczensky, P., M. Blazic, and H. Gossow, Public attitudes towards brown bears (Ursus arctos) in Slovenia. Biological Conservation, 2004. 118: p. 661–674.

190. Bruskotter, J.T., J.A. Vucetich, K.M. Slagle, R. Berardo, A.S. Singh, and R.S. Wilson, Support for the U.S. Endangered Species Act over time and space: Controversial species do not weaken public support for protective legislation. Conservation Letters, 2018. ;e12595: p. 1-7. https://doi.org/10.1111/conl.12595.

191. Slagle, K.M., J.T. Bruskotter, A.S. Singh, and R.H. Schmid, Attitudes toward predator control in the United States: 1995 and 2014. Journal of Mammalogy, 2017. 8(1): p. 7-16.

192. Kinzig, A.P., P.R. Ehrlich, L.J. Alston, K. Arrow, S. Barrett, T.G. Buchman, G.C. Daily, B. Levin, S. Levin, M. Oppenheimer, E. Ostrom, and D. Saari, Social Norms and Global Environmental Challenges: The Complex Interaction of Behaviors, Values, and Policy. Bioscience, 2013. 63: p. 164–175.

193. Byerly, H., A. Balmford, P.J. Ferraro, C.H. Wagner, E. Palchak, S. Polasky, T.H. Ricketts, A.J. Schwartz, and B. Fisher, Nudging pro-environmental behavior: evidence and opportunities. Frontiers in Ecology and the Environment, 2018: p. doi:10.1002/fee.1777.
194. Gore, M.L., J. Ratsimbazafy, and M.L. Lute, Rethinking corruption in conservation crime: insights from Madagascar. Conservation Letters, 2013. 6(6): p. 430-438.
195. Gore, M.L., ed. Conservation Criminology. 2017, John Wiley & Sons: New York.
196. Filteau, M.R., Deterring Defiance: 'Don't Give a Poacher a Reason to Poach'. International Journal of Rural Criminology, 2012. 1(2): p. 236-255.
197. von Essen, E., H.P. Hansen, H.N. Kallstrom, M.N. Peterson, and T.R. Peterson, The radicalisation of rural resistance: How hunting counterpublics in the Nordic countries contribute to illegal hunting. Journal of Rural Studies 2015. 39: p. 199-209.
198. Kaltenborn, B.P., T. Bjerke, and J. Nyahongo, Living with problem animals - Self-reported fear of potentially dangerous species in the Serengeti region, Tanzania. Human Dimensions of Wildlife, 2006. 11(6): p. 397 – 409.
199. Agan, S.W., A. Treves, and L. Willey, Wild red wolf Canis rufus poaching risk. bioRxiv, 2020. https://doi.org/10.1101/2020.12.08.416032.
200. Olson, E.R., J.L. Stenglein, Victoria Shelley, Adena R. Rissman, Christine Browne-Nuñez, Zachary Voyles, A.P. Wydeven, and T.V. Deelen, Pendulum swings in wolf management led to conflict, illegal kills, and a legislated wolf hunt. Conservation Letters, 2015. 8(5): p. 351-360.
201. Liberg, O., J. Suutarinen, M. Åkesson, H. Andrén, P. Wabakken, C. Wikenros, and H. Sand, Poaching-related disappearance rate of wolves in Sweden was positively related to population size and negatively to legal culling. Biological Conservation, 2020. 243. 10.1016/j.biocon.2020.108456.
202. Suutarinen, J. and I. Kojola, One way or another: predictors of wolf poaching in a legally harvested wolf population. Animal Conservation, 2018. 21(5): p. –9. https://doi.org/10.1111/acv.12409. https://doi.org/10.1111/acv.12409.
203. Suutarinen, J. and I. Kojola, Poaching regulates the legally hunted wolf population in Finland. Biological Conservation, 2017. 215: p. 11–18. http://www.sciencedirect.com/science/article/pii/S0006320717302148.
204. Troxell, P.S., K.A. Berg, H. Jaycox, A.L. Strauss, P. Struhsacker, and P. Callahan, Education and Outreach Efforts in Support of Wolf Conservation in the Great Lakes Region, in Recovery of Gray Wolves in the Great Lakes Region of the United States: an Endangered Species Success Story, A.P. Wydeven, T.R. Van Deelen, and E.J. Heske, Editors. 2009, Springer: New York. p. 297-309.
205. Frazer, G., Letetr to Eric Sklar, President, California Fish and Game Commission FWS/AES/DCC/BDFS/073807, U.S.F.W. Service, Editor. 2020: Washington, DC. http://faculty.nelson.wisc.edu/treves/archive_BAS/Frazer%20USFWS%20to%20Sklar%20CA%20FG%20Commission.pdf.
206. Atkins, Summary Report of Independent Peer Reviews for the U.S. Fish & Wildlife Service Gray Wolf Delisting Review. 2019, Atkins: https://www.fws.gov/endangered/esa-library/pdf/Final%20Gray%20Wolf%20Peer%20Review%20Summary%20Report_053119.pdf.

https://www.fws.gov/endangered/esa-library/pdf/Final%20Gray%20Wolf%20Peer%20Review%20Summary%20Report_053119.pdf.

207. Obama, B., Presidential Documents: Improving Regulation and Regulatory Review. Federal Register, 2011. 76(14): p. 3821-3823.

208. USC, Endangered Species Act of 1973, amended 2006, in 16 U.S.C. §§ 1533(a)(1)(A-E). 2006.

209. Department of Commerce, N. and F. Department of the Interior, Revised Interagency Cooperative Policy Regarding the Role of State Agencies in Endangered Species Act Activities. Federal Register, 2016. 81: p. 8663-8665. http://www.fws.gov/endangered/laws-policies/policy-state-agencies.html accessed 12 April 2016.

210. Epstein, Y. and J. Darpö, The Wild Has No Words: Environmental NGOs Empowered to Speak for Protected Species as Swedish Courts Apply EU and International Environmental Law. Journal for European Environmental and Planning Law, 2013. 10(3): p. 250–261.

211. Epstein, Y., Governing Ecologies: Species Protection in Overlapping and Contiguous Legal Regimes, in Faculty of Social Sciences. 2013, Uppsala. p. 26.

212. Epstein, Y. and G. Chapron, The Hunting of Strictly Protected Species: The Tapiola Case and the Limits of Derogation under Article 16 of the Habitats Directive. European Energy and Environmental Law Review 2018. June: p. 78-87.

213. Epstein, Y., J. Lopez-Bao, A. Trouwborst, and G. Chapron, EU Court: Science must justify future hunting. Science, 2019. 366(6468): p. 961.

214. Mukherjee, S., The Emperor of All Maladies: A Biography of Cancer. 2010, Mew York: Scribner.

215. Mukherjee, S., The Gene: an Intimate History. 2016, New York: Simon & Schuster.

216. Kricher, J., The Balance of Nature: Ecology's Enduring Myth. 2009, Princeton, NJ: Princeton University Press.

217. Eklund, A., J.V. López-Bao, M. Tourani, G. Chapron, and J. Frank, Limited evidence on the effectiveness of interventions to reduce livestock predation by large carnivores. Scientific Reports, 2017. 7: p. 2097 | DOI:10.1038/s41598-017-02323-w.

218. Khorozyan, I. and M. Waltert, How long do anti-predator interventions remain effective? Patterns, thresholds and uncertainty. Royal Society Open Science, 2019. 6(9). 10.1098/rsos.190826.

219. Lennox, R.J., A.J. Gallagher, E.G. Ritchie, and S.J. Cooke, Evaluating the efficacy of predator removal in a conflict-prone world. Biological Conservation, 2018. 224: p. 277-289.

220. Miller, J., K. Stoner, M. Cejtin, T. Meyer, A. Middleton, and O. Schmitz, Effectiveness of Contemporary Techniques for Reducing Livestock Depredations by Large Carnivores. Wildlife Society Bulletin, 2016. 40: p. 806-815.

221. Moreira-Arce, D., C.S. Ugarte, F. Zorondo-Rodríguez, and J.A. Simonetti, Management Tools to Reduce Carnivore-Livestock Conflicts: Current Gap and Future Challenges. Rangeland Ecology & Management, 2018.

222. Treves, A., M. Krofel, and J. McManus, Predator control should not be a shot in the dark. Frontiers in Ecology and the Environment, 2016. 14: p. 380-388.
223. van Eeden, L.M., A. Eklund, J.R.B. Miller, J.V. López-Bao, M.R. Cejtin, G. Chapron, M.S. Crowther, C.R. Dickman, J. Frank, M. Krofel, D.W. Macdonald, J. McManus, T.K. Meyer, A.D. Middleton, T.M. Newsome, W.J. Ripple, E.G. Ritchie, O.J. Schmitz, K.J. Stoner, M. Tourani, and A. Treves, Carnivore conservation needs evidence-based livestock protection. PLOS Biology, 2018. l 16(9). e2005577. https://doi.org/10.1371/journal.pbio.2005577.
224. van Eeden, L.M., M.S. Crowther, C.R. Dickman, D.W. Macdonald, W.J. Ripple, E.G. Ritchie, and T.M. Newsome, Managing conflict between large carnivores and livestock. Conservation Biology, 2018. doi: 10.1111/cobi.12959.
225. Khorozyan, I. and M. Waltert, Not all interventions are equally effective against bears: patterns and recommendations for global bear conservation and management. Scientific Reports, 2020. in press. 10.1098/rsos.190826.