


PERSPECTIVE

A new era of wolf management demands better data and a more inclusive process

Peter Kareiva¹  | Samantha Kim Attwood² | Kim Bean³ | Desiree Felix¹ | Michelle Marvier⁴ | Madison L. Miketa⁵ | Elishebah Tate-Pulliam¹

¹Aquarium of the Pacific, Long Beach, California, United States

²#RelistWolves Campaign, Seattle, United States

³Wolves of the Rockies, Stevensville, Montana, United States

⁴Environmental Studies and Science, Santa Clara University, Santa Clara, California, United States

⁵The Humane Society of the United States, Washington, DC, United States

Correspondence

Peter Kareiva, Aquarium, Aquarium of Pacific, 320 Golden Shore, Suite 100, Long Beach, CA 90802, United States.
Email: pkareiva@lbaop.org

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Abstract

Hunting and trapping of gray wolves (*Canis lupus*) has increased dramatically in the “lower 48” states of the United States. We assess the data used to justify the intense hunting pressure on wolves, and find an absence of accessible biological data. We find there is a clear need for more transparent reporting of livestock losses, wolf kills, and especially the numbers and types of nontarget species captured in traps set for wolves. Also lacking is a full accounting of benefits and costs of hunting wolves, with a noteworthy failure to incorporate the ecosystem functions served by wolves. As apex predators, wolves warrant multi-objective management as opposed to management focused largely on livestock interests and concerns.

KEYWORDS

data needs, inclusive decisions, multiple objectives, nonlethal predator control, wolf killing, wolf management, wolf trapping

1 | EVOLVING WOLF MANAGEMENT OBJECTIVES IN THE US

The gray wolf, *Canis lupus*, once was abundant throughout most of the Northern Hemisphere. In the “lower 48” states of the US alone, wolves historically numbered at least 380,000, and likely closer to 2,000,000 (Seton, 1929). In the 1800s to the mid-twentieth century, the US government (Wildlife Services and Animal Damage Control branches of the United States Department of Agriculture, henceforth USDA) nearly exterminated wolves in the lower 48 through a program of shooting, poisoning, and trapping. Wolf numbers may have fallen as low as 300 or

400, as they were extirpated from all of the lower 48 states except Minnesota by 1970 (Musiani & Paquet, 2004).

After receiving protection under the US Endangered Species Act (ESA) in 1974, gray wolf populations underwent a remarkable recovery. The resurgence of wolf numbers to at least 6000 individuals and the successful reintroduction of gray wolves into the Greater Yellowstone area and Idaho are counted among the great conservation wins of the last century (Smith & Bangs, 2009; Wayne & Hedrick, 2011). These positive trends spurred Congress in 2011 to require the Secretary of Interior to remove the protected status of the Northern Rocky Mountain population of gray wolves (H.R.1473 – Department of Defense and Full-Year Continuing

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Appropriations Act, 2011). In 2020, gray wolves in the rest of the lower 48 states (with the exception of the Mexican gray wolf of the southwest) were delisted; a decision that was reversed in court in February 2022. USFWS scientists had recommended delisting under the assumption that state wildlife biologists would manage wolf populations responsibly, using the best available science (Ashe, 2021). However, in the 2020–2021 hunting season over 1000 wolves total were killed in Idaho, Montana, Wyoming, and Wisconsin by state-sanctioned hunting (Jones, 2022; Main, 2021; Mills, 2022; Montana Fish, Wildlife, & Parks, 2022), leading to public outcry and calls for reinstating federal protections for all wolves in the lower 48 (McNamee, 2022).

Over the course of the last two centuries, wolf management in the US shifted from the straightforward goal of eliminating all wolves to another straightforward goal of protecting wolves and recovering wolf numbers (Musiani & Paquet, 2004). Today, the heated debate between conservationists and ranchers surrounding wolf control reveals a new challenge. No longer is wolf management about eradicating vermin, and no longer is it about doing everything possible to bring wolves back from the brink of extinction. Now the objectives entail managing wolves for their ecological and intrinsic value, while learning to live with what might be locally abundant wolves and mitigating the damage wolves might do to rancher livelihoods. It is worth noting that the challenge of learning to live with fierce predators, which were once hunted to near extinction but have now bounced back, is an increasingly common phenomenon. In the US alone alligators, grizzly bears, and great white sharks represent other instances of apex predators recovering and thereby exacerbating human-wildlife conflict (Guerra, 2019; Gunther et al., 2004; Langley, 2010).

Here we discuss some of the data that ought to be brought to bear in decisions about wolf protection and management, as states seek to protect ranching livelihoods as well as restore fully-functioning ecosystems that include their top predators. We argue that decision-making about wolf management will be best served by (1) greater transparency and data standardization and (2) a more complete consideration of the costs and benefits of wolves, wolf hunting, and alternative management approaches. This is not to suggest wolf management is simply a matter of data and science. The many stakeholders invested in the fate of wolves represent diverse values, a variety of economic interests, and different cultures. While science and data cannot resolve these differences, they can provide a common platform of evidence about which to debate and negotiate.

2 | LACK OF TRANSPARENCY AND AN ABSENCE OF REAL-TIME DATA ACCESS

Basic biological data that should inform wolf management decisions include, but are not necessarily limited to, estimates of wolf numbers, damage to livestock caused by wolves, number of wolves killed, and nontarget animals unintentionally trapped. Key data often are not easily accessed and, in some cases, are obtainable only through Freedom of Information Act requests.

The primary sources of data are USDA reports on livestock losses, the USDA Wildlife Services reports on wolf hunting and trapping, and each state's individual wildlife reports. USDA livestock losses are reported at most once every 5 years. Meanwhile, state wildlife reports tend to be annual reports. Unfortunately, the data from these annual reports are not curated in any centralized on-line database that the public and researchers could examine. Transparent, publicly available data are especially critical in light of accusations of erroneous data and public pressure on scientists who speak out against existing wolf management (Schontzler, 2010; Wuerthner, 2022).

Below, we delve into two key metrics—livestock losses attributable to wolves and deaths of nontarget animals in traps set to capture wolves.

2.1 | The magnitude of livestock losses due to wolves

Approximately every 5 years the USDA reports estimates of livestock losses, state by state, with losses attributed to non-predator causes (e.g., weather, disease) and predator causes (e.g., wolves, coyotes). Using the most recent USDA reports available (USDA, 2015 for cattle and USDA, 2020 for sheep) we focused on the four lower 48 states that harbor substantial wolf populations and that recently increased hunting and trapping of wolves (Idaho, Wyoming, Montana, and Wisconsin). In these four states, 3% of total cattle inventory and 10% of total sheep inventory were counted as “unwanted losses.” Of those unwanted losses, the vast majority of livestock deaths were due to non-predator causes, such as health problems, weather, parasites, and birthing problems (Figure 1). In contrast, the percent of livestock killed by wolves never exceeded 0.21% for sheep and 0.05% for cattle (Figure 1).

These minimal livestock losses attributed to wolves are even more noteworthy because they are likely overestimated. In particular, the USDA combines confirmed cases (kills) and “probable” cases into one “loss” figure,

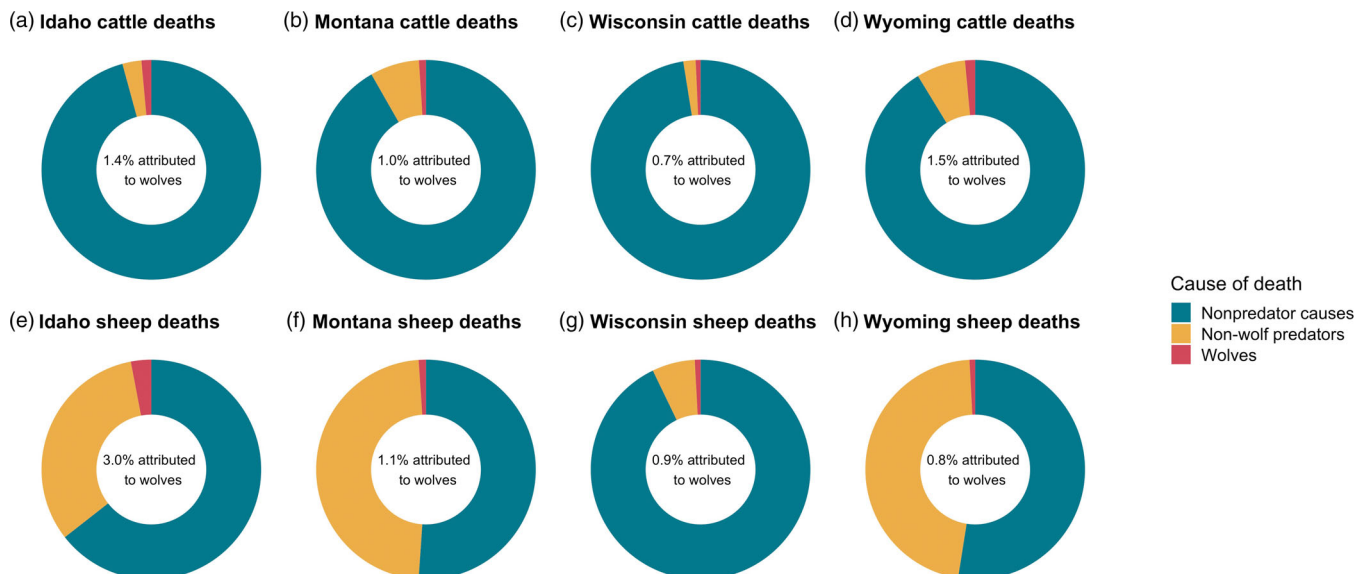


FIGURE 1 Causes of unwanted livestock deaths. (a–d) Causes of unwanted cattle deaths in (a) Idaho, (b) Montana, (c) Wisconsin, and (d) Wyoming. (e–h) Causes of unwanted sheep deaths in (e) Idaho, (f) Montana, (g) Wisconsin, and (h) Wyoming. Data for cattle from USDA (2015); data for sheep from USDA (2020)

which will be biased upward unless every “probable” kill is in fact caused by a wolf. Second, the USDA’s livestock loss estimates are based on unverified mailed surveys, which are then extrapolated to a statewide estimate (USDA, 2015). To get a sense of the accuracy of the wolf depredation extrapolations reported by the USDA, we compared these USDA estimates to the number of confirmed wolf-caused kills reported by on-the-ground state wildlife agencies. This exercise revealed greater than a tenfold difference between livestock kills confirmed by state biologists and those extrapolated by the USDA from mailed surveys. For example, in 2015 the USDA reported a total of 2834 cattle losses due to wolves across the three states of Idaho, Montana, and Wyoming. Meanwhile, wildlife agencies across these same three states in the same 2015 calendar year confirmed only 148 total cattle killed by wolves (Coltrane et al., 2015; Idaho Department of Fish and Game, 2015; Wyoming Game and Fish Department et al., 2018). Given the historical vilification of wolves and the discrepancies in available data, there is a clear need for better verification of wolf-caused deaths. Consider, for example, that in Idaho confirmed wolf kills have included livestock with no bite marks or injury under the assumption that “the cattle exert so much energy trying to escape wolves that they later die from the effort” (Ridler, 2018).

Further complicating the attribution of livestock deaths to wolves is the fact that multiple species prey upon livestock in any given region. The cause of death for livestock is not always clear, and if there has been any decomposition before inspection it is much harder to

determine. In addition, a whistleblower from the USDA Wildlife Services has publicly charged the Wildlife Services with corrupt practices (Roberts, 2022). This whistleblower, who was the Director of Wildlife Services for the state of New Mexico, remarked, “My guys in the field were going and rubber-stamping anything these people asked them to.” While this New Mexico report applies to Mexican gray wolves, a USDA Wildlife Services district supervisor in Montana reports similar corruption in Montana due to the influence of the ranching lobby, stating “we were the hired gun of the livestock industry” (Roberts, 2022).

Despite the negligible wolf damage evident in Figure 1, wolves are being targeted under the guise of livestock protection. For example, Idaho’s most recent wolf management progress report (Hayden, 2017), states that the current management approach prioritizes lethal management of wolves, including “public hunting and trapping as a preferred means of managing wolves.” However, if reducing unwanted livestock losses were a priority, then one would focus on better livestock husbandry and losses due to health and weather—not on the few cattle killed by wolves (Figure 1). A recent systematic review of 119 gray wolf dietary studies revealed that wolves prefer wild prey over domesticated livestock, and when they do attack livestock, prefer animals that graze freely in small numbers as opposed to larger or fenced herds (Janeiro-Otero et al., 2020). These results suggest that wildlife management that sought to build robust populations of wild prey species for wolves would not only benefit the hunting community, but also could

reduce livestock damage. An alternative hypothesis is that livestock losses are rare precisely because wolves are being vigorously hunted and trapped and consequently are sufficiently few that their damage is limited. However, as is discussed below, there is little evidence to support the hypothesis that lethal wolf control is effective at reducing livestock losses.

2.2 | Collateral damage due to wolf harvest

States differ in the methods of wolf hunting that are allowed, as well as requirements for reporting deaths

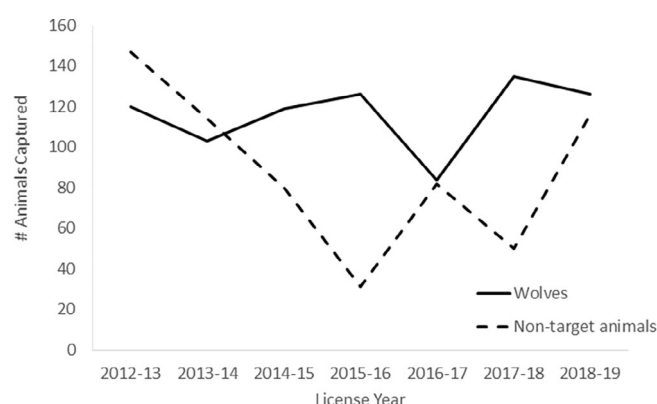


FIGURE 2 Captures of wolves and other animals for wolf traps set in Idaho during the 2012/2013 to 2018/2019 trapping seasons. A total of 813 wolves and 614 nontarget animals were reported captured for this 7-year period. Accidental captures included game species such as deer, elk, and moose, as well as mountain lions, domestic dogs, and a smattering of rare species including lynx, eagle, and wolverine. Data extracted from Cole (2020), who in turn obtained data via a public records request to the Idaho Department of Fish and Game. Reports of nontarget fish ($n = 2$) and wolves ($n = 4$) were omitted

of nontarget wildlife. Methods for killing wolves that have been sanctioned by these states include: baiting, foothold traps, snares, a wide variety of firearms often in combination with night vision scopes or thermal imaging, electronic calls, bow and arrow, hunting from airplanes, hunting with packs of dogs, and hunting from snowmobiles and other off-road vehicles. Much of the wolf hunt entails indiscriminate traps and snares that also capture other species, such as domestic dogs and cats, and nontarget wildlife such as deer and bobcats. In part because of a lack of data transparency, and also because some traps may be lost or are not checked, it is hard to quantify the full extent of nontarget deaths. However, data obtained by a FOIA request in Idaho reveal that in some years the number of nontarget animals caught is similar to, or even exceeds, the number of wolves trapped (Figure 2). Overall, between 2012 and 2019, nontarget species accounted for nearly half (47%) of the animals caught in Idaho's wolf traps (Figure 2). During this period, traps set for wolves in Idaho caught game species such as deer, elk and moose, as well as mountain lions, domestic dogs, and a smattering of rare species including lynx, eagle, and wolverine (Cole, 2020). Data from Montana indicate a similar composition of species accidentally caught in traps set for wolves (Figure 3).

Discussions of trapping and snaring wolves as a wildlife management strategy consistently fail to account for the unintended consequences of collateral damage. Any calculus of the benefits and costs of trapping wolves needs to include the inevitable harm caused to nontarget organisms—harms that include unnecessary suffering of individual animals, as well as potential population consequences. The true magnitude of these nontarget captures is difficult to know given the high likelihood of under-reporting for nontarget casualties.

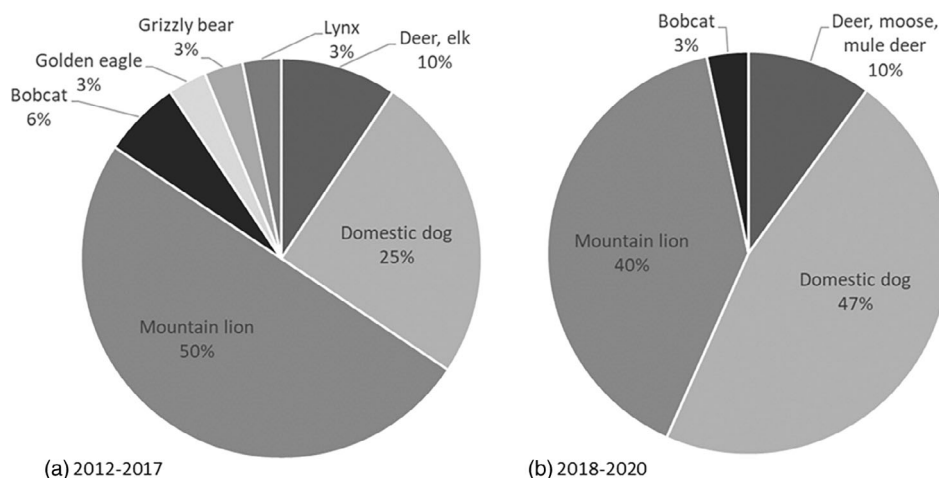


FIGURE 3 Composition of incidental captures reported for wolf traps set in Montana. (a) Thirty-two total reports of nontarget captures in license years 2012–2017. Data from Inman (2018). (b) Thirty total reports of nontarget captures in license years 2018–2020. Data courtesy of trap free Montana public lands, obtained from Montana fish, wildlife and Parks

3 | A FULLER LEDGER OF COSTS AND BENEFITS

As wolf management responds to multiple objectives, tough decisions must weigh damage to livestock against the benefits of wolves, and against the explicit costs and unintended consequences of expansive trapping and hunting programs. Currently, the economic losses experienced by ranchers have been a central focus of wolf management conversations. Ranchers and hunters should continue to have a significant voice, but their objectives must be balanced with a more thorough accounting of the economic costs and benefits of wolves and wolf management strategies, as well as the cultural value of wolves. For example, Raynor et al. (2021) examine the economic damage caused by wolves and find no evidence that wolves are a net economic negative. This is because wolves reduce deer-vehicle collisions by as much as 20% by altering the behavior, as well as the abundance, of their deer prey (Raynor et al., 2021). Wolves are also an important part of the Yellowstone National Park tourist experience, where they are estimated to bring in \$82 million annually to the states of Idaho, Montana, and Wyoming (RRC Associates, 2022).

Ecosystem benefits of wolves should also weigh heavily into decision-making. Wolves both directly and indirectly shape their ecosystems, altering productivity and functioning from the top-down (Frank, 2008; Gable et al., 2020). Historically, wolves played a major ecological role in North America as a top carnivore: their predation on elk, deer, and buffalo held these and other herbivores at sufficiently low numbers such that overgrazing rarely occurred (Hermans et al., 2014). For this reason, Treves et al. (2021) argue that wolves should be protected as predators, and ideally managed at a regional level. Some studies find that even at relatively low numbers, wolves can profoundly impact an ecosystem by reducing the intensity of grazing in riparian zones (because they either kill or scare off deer and elk). For example, riparian grazing increases the erosion of sediment into streams, and conversely the reduction of grazing due to wolves can yield less turbid water (Estes et al., 2011; Ripple & Beschta, 2003, 2012).

An additional benefit of wolves is the possibility they enhance the health of their prey populations by targeting sick and weak individuals (Stahler et al., 2006). By picking off sick prey, wolves could in theory cleanse prey populations. This hypothesis is currently being tested in response to the idea that wolves could be used “as first responders against a deadly brain disease” (chronic wasting disease) that threatens to infect Yellowstone's large elk and deer herds (Robbins, 2020). Initial analyses suggest that wolves could substantially reduce the

prevalence of chronic wasting disease in deer and elk in Yellowstone (Brandell et al., 2022). Wolves could also impact human health via their interaction with prey that harbor SARS-COV-2. Thus far SARS-COV-2 has been found in deer in 24 states, with evidence of mutation and evolution of the virus within deer populations (Mallapaty, 2022). The concern is that some new variant of the virus could jump back from deer to humans (Kuchipudi et al., 2022). While any link between wolves and reduced disease spillover from deer is speculative, it is an example of the interconnectedness of species in ecosystems and the fallacy of viewing wolves only through the prism of livestock damage.

The challenge, of course, is to balance the ecosystem benefits that wolves provide with the costs of livestock losses attributed to wolves. The solution could come, at least in part, from nonlethal deterrents. Nonlethal solutions can be effective at preventing wolf-livestock conflict (Espuno et al., 2004; Treves et al., 2016). Nonlethal methods are not a silver bullet solution, but the use of fladry, enclosures, electrified fencing, and well-trained livestock guardian dogs can be more effective than lethal control, even at large scales (Bruns et al., 2020; van Eeden et al., 2018; Treves et al., 2016). Even something as simple as fencing cattle as opposed to having them range freely can make a big difference in the magnitude of livestock losses—especially if wild prey are abundant (Janeiro-Otero et al., 2020).

While ranchers may fear that nonlethal methods could be ineffective, it is worth noting that there is little evidence that lethal methods reduce livestock losses. In fact, several studies have documented instances in which lethal methods are ineffective or counterproductive because they worsen conflict (Lennox et al., 2018; Santiago-Avila et al., 2018; Treves et al., 2016; Wielgus & Peebles, 2014). There is some indication that lethal interventions against wolves may simply spread conflict to neighboring livestock owners (Santiago-Avila et al., 2018). In addition, lethal removal of wolves disrupts pack stability which results in pack dissolution, increased dispersal, and could lead to more attacks on livestock by single pack-less wolves (see Haber, 1996; Santiago-Avila et al., 2018; Wielgus & Peebles, 2014). These results may also explain why Wielgus and Peebles (2014) found that lethal wolf removal was associated with increased livestock loss at the population level the following year.

While sheep operations often use nonlethal predator control methods, cattle operations have a lower rate of uptake: only 10.1% of cattle operations in Idaho, 14.5% of cattle operations in Montana, and 14% of cattle operations in Wyoming used nonlethal methods (USDA, 2015). Economic costs likely hinder adoption of these approaches. Maintaining guard dogs and visual deterrents can be a

considerable time and financial expense for ranchers compared to shooting or trapping wolves. For example, the lifetime cost of using livestock guardian dogs as a nonlethal depredation tool was estimated at nearly \$6000 per dog (Bruno & Saitone, 2019). However, considerable public funds are also spent on lethal control measures. Idaho, for example, budgeted \$1 M to kill wolves in 2022 (Ridler, 2022). This single-year \$1 M fund could cover the lifetime costs (including purchase, food, training, and veterinary care) of 168 fully-trained livestock guardian dogs. If funds were regularly redirected to support nonlethal methods, livestock losses might be reduced without disruption of key ecosystem services.

4 | WHAT WOULD INCLUSIVE AND EVIDENCE-BASED WOLF MANAGEMENT LOOK LIKE?

Much of the discussion surrounding recent hunting of wolves has been framed in terms of extinction risk and the administration of the ESA. However, wolf management that seeks merely to avoid extirpation is a mistake, because such a framing fails to address the value of larger populations of wolves. Management plans often determine population goals based on existing population sizes, rather than incorporating community dynamics to restore ecological interactions (Soulé et al., 2003). Instead, Soulé et al. (2003) stated that “conservation plans should contain a requirement for ecologically effective population densities; these are densities that maintain critical interactions and help ensure against ecosystem degradation.” Apex predators such as wolves can have outsized or “cascading” impacts on ecosystems (Estes et al., 2011), and, because of this, their management demands special consideration. Currently, states are allowing large numbers of wolves to be killed without compelling evidence that the benefits (the presumed prevention of livestock losses) outweigh the costs, including the economic costs of lethal control programs and the ecosystem-level disruptions caused by suppressed wolf populations.

The failure to consider the negative impacts of wolf killing is especially noteworthy in the case of trapping and snaring wolves from Yellowstone National Park (hereafter YNP). In only six months of the 2021–2022 hunting season in Montana, at least 25 wolves from YNP were killed when they wandered outside the park boundary a number that represents one fifth of the YNP wolf population (Partlow, 2022). The Superintendent for YNP asked Montana Governor Gianforte to limit wolf hunts in the northern neighborhood of the park, but his requests were ignored, and the Governor himself trapped and killed a radio-collared wolf from YNP in 2021 (Associated

Press, 2022). It is highly unlikely that these Yellowstone wolves represent a threat to livestock, since in the last 3 years there has been only one documented livestock kill attributed to wolves in the county that encompasses the hunting districts bordering YNP (Partlow, 2022). Almost 5 million people visited YNP in 2021—that is more than four times the size of the entire population of Montana. Montana ranchers certainly deserve a voice in wolf management, but so too do the many visitors who come to see YNP's spectacular wildlife.

In recent decisions to kill increasing numbers of wolves, the goal of protecting ranchers from livestock losses has played an outsized role. But wolf management largely takes place on, and certainly has major implications for, public lands. As such, wolf management cannot be beholden to any single special interest group, whether that group is ranchers, hunters, or nature viewers. Decisions about wolf management should inclusively involve all stakeholders, including Native American tribes whose lands overlap with wolf populations. Species do not exist in a vacuum. The public and cultural value of wolves must be balanced in management decisions. It is not surprising that some ranchers resent any restrictions on their ability to kill what they may view as vermin, especially when advocates for wolves are “outsiders”. But just as the rancher's perspective warrants consideration, so too do the concerns of the broader public who may view wolves and Yellowstone as a national treasure. A multi-objective and thoughtful decision process could bridge these differences and yield a balanced solution.

Yet even the most inclusive and best-run stakeholder discussions will get nowhere without transparent and up-to-date data that provides all parties with key information. That foundation of data is currently lacking for wolves. Certainly, it is challenging to coordinate and standardize data collection across a variety of state and federal agencies. Yet such standardization has been achieved in other contexts. An example of a complex fish and wildlife management challenge that is well supported by on-line data across state boundaries can be found in the Columbia River Basin DART (Data Access in Real Time—see <https://www.cbr.washington.edu/dart/overview>). DART includes a glossary, metadata, maps of all data sites, and both annual and monthly real-time data from 47 different sites across three states (<https://www.cbr.washington.edu/dart/dartmap>). While DART does not resolve conflicting objectives such as tribal harvest, salmon conservation, and irrigation, it does focus the debate around a standardized data set to which everyone has easy access. Given the iconic role of wolves as top predators in North America, we advocate for a concerted effort to collate data on wolf numbers, wolf depredation of livestock, wolf losses to hunting and

trapping, collateral damage from indiscriminate trapping, and the costs and impacts of nonlethal methods—in a standard way across states. If coordinating methods across states proves impractical, at least any and all relevant data should be made easily available. Currently, public debate about wolf management is confused and confusing because of an absence of a transparent database around which different viewpoints can assess their merits.

The fundamental question is how best to balance the full ledger of ecological, economic, and social/cultural costs and benefits associated with wolves, wolf hunting, and alternative methods of wolf management. Moving forward, wolf management should be inclusive and embrace a systems approach that takes a broader perspective on the overall costs and benefits.

AUTHOR CONTRIBUTIONS

Desiree Felix and Elishebah Tate-Pulliam scoured state fish and wildlife reports to find salient data on wolf kills and wolf hunting regulations. Madison Miketa took the lead on nonlethal methods and analyzing USDA data on livestock losses. Kim Bean provided information on the conflict between ranchers and wolf advocates. Michelle Marvier and Peter Kareiva wrote the first draft of the manuscript after synthesizing input provided by co-authors. Samantha Atwood edited the manuscript and helped design the research from the very beginning. All authors read, reviewed, and edited the manuscript.

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CONFLICT OF INTEREST

None of the authors have any conflicts of interest or financial interests that are pertinent to this research.

DATA AVAILABILITY STATEMENT

All data are from USDA or State Wildlife Agency reports and websites and are publicly available. These public sources are cited in the text. No original data were collected for the manuscript.

ORCID

Peter Kareiva  <https://orcid.org/0000-0002-5330-2585>

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