Title: Can killing individual, wild animals directly protect their population?

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Abstract: Ongoing extinctions are often accelerated by humans intentionally killing nonhumans. Not uncommonly in Western conservation thinking, killing is seen as a strategy to prevent extinction. The hypothesis that killing one animal can protect the survivors of the same species (conspecifics) requires a direct cause-and-effect mechanism between the death of the target and the outcomes or consequences for the surviving conspecifics. Otherwise, an indirect pathway with an additional step must be described and evaluated. We find rare direct causal logic to support the 'kill one to save many conspecifics' idea. Rare circumstances involve threats posed by the animal killed. To explore the more likely indirect, two-step causal logic, we describe the study designs needed for comparative evaluations of killing versus non-lethal alternatives. For those seeking science-informed decisions, our analysis clearly indicates a gap in available data and a narrow set of conditions in which one should 'kill a few to save many conspecifics'.

Key words/phrases: biological mechanisms, preservation, nonlethal methods, lethal management, conservation hunting

In a Nutshell

- Efforts to protect nonhumans or prevent extinction of their populations require clear cause-and-effect logic about the outcomes of interventions.
- We focus here on the direct one-step mechanistic effect of killing a few wild animals to protect their populations.
- We contrast direct and indirect interventions. Direct, lethal interventions must kill individuals whose survival threatens surviving members of the same species (conspecifics).
- For science-informed policy, lethal and non-lethal alternatives could be tested experimentally against each other to evaluate which protects the population more effectively.

Introduction

Decisions to intervene have two fundamental and independent components. First, will the intervention achieve the expected effect? This is a scientific question about causal mechanisms (Platt 1964). Second, should we act to intervene in that way? That is a normative concern tied to values, morals, and ethical reasoning (Castelló and Santiago-Ávila 2023; Allen *et al*. 2025). Here we restrict ourselves to the first question.

We focus only on the causal, mechanistic effect of killing one or more wild animals with the aim of protecting conspecifics in the same population. There are only two possible causal pathways that could achieve this effect (Figure 1).

Figure 1.

We do not address which pathway in Figure 1 should be followed or what value system or ethical or moral reasoning is at play. We ask only under what conditions will the left-hand pathway work? We cite selected sources to show that our question is not an academic exercise but rather an implicit assumption in many past and contemporary management decisions or evaluations of evidence for science-informed policy. For example, the concept 'kill few to save many conspecifics' surfaces repeatedly in 20th-century Western notions of 'conservation' and persists today. An early explicit statement came from U.S. President T. Roosevelt, who discussed sport hunting, "…wild animals only continue to exist at all when preserved by sportsmen,… in reality, the genuine sportsman is by all odds the most important factor in keeping the larger and more valuable wild creatures from total extermination." The enduring influence of Roosevelt's endorsement is evident in its quotation on the government website of the USA Fish & Wildlife Service (https://www.fws.gov/story/hunters-conservationists accessed 8 February 2026). Similar claims surface in lethal management by government agents. For example, North American and European wildlife agencies routinely justify the killing of individual wildlife deemed problematic by asserting that public tolerance for the surviving wild animals necessitates sacrificing the few problem individuals (Hoare 2001; Loveridge *et al.* 2007; Treves 2009; Epstein 2017) for elephants (*Loxodonta africana*, *L. cyclotis*, *Elephas maximus*), carnivores and particularly wolves (*Canis lupus*). Although such claims might be accurate in some cases, but generalizing requires more evidence.

Private interest groups have also promoted the notion that killing as protection, asserting 'hunting is conservation' (Rocky Mountain Elk Foundation https://www.rmef.org/how-we-conserve/hunting-is-conservation/ accessed 14 February 2026 and related groups' communication strategies (https://deerassociation.com/hunting-is-conservation-heres-why/

accessed 14 February 2026). However, these claims often confuse and conflate their interests with empirical evidence supporting the prevention of extinction.

The concept of 'killing a few to save many conspecifics' emerges in peer-reviewed scholarly work also, both as general language (Treves *et al*. 2018) and in concise phrases such as populations "need" to be hunted (Howard 1988). For example, referring to grizzly bears (*Ursus arctos*) (Mincher 2002) suggested that "…a regulated harvest will not impair the viability of the GYE [Greater Yellowstone Ecosystem] grizzly bear population but might increase their range and distribution by shifting human-induced mortality to male bears… Classification of the grizzly bear as a game animal can only improve the acceptability of grizzly bears to the GYE public…" p.288-290 (Mincher 2002).

The formulation that 'hunting saved wildlife' typically serves as shorthand for the hypothesis that reduction of commercial hunting and its transformation to regulated recreation saved imperiled wildlife (Treves *et al.* 2018). That construction confuses hunting itself with the regulation of hunting as a way to save nonhuman populations (Treves *et al*. 2018). Words and phrases can influence thinking beyond their intended meaning (Johns and Dellasala 2017). Consider 'harvest'. The notion that humans kill a few to save many conspecifics may even draw upon an analogy from crop harvest, in which farmers save seeds before consuming the parent plant. That notion appears at the roots of conservation biology (Soulé 1985).

The central question we examine here 'can one kill a few to protect their population?' is discernible in Michael Soulé's (1985) landmark paper on the postulates of conservation biology. One postulate attributed intrinsic or inherent value only to species, not to individual nonhumans (p.731). This ecocentric perspective has been recently criticized for disregarding the intrinsic value of individual nonhumans (Castelló and Santiago-Ávila 2023). Soulé's (1985) footnote 2 to the paragraph on intrinsic value acknowledges that individual "hunters, loggers, and developers" (p.731) might believe in protecting biodiversity and its intrinsic value, yet engage in practices that harm individual nonhumans (Soulé 1985). This reasoning (individual human may kill individual nonhuman if the human needs or desires such) implies that so long as people are satisfied, humanity will protect surviving conspecifics. Many commentators have addressed the normative claims made in conservation biology, wildlife governance, and specific types of wildlife-killing by humans (Nie 2004; Vucetich & Nelson 2014; Allen *et al.* 2025).

We do not address the ethics of kill a few to save many conspecifics further. Although we avoid the ethical reasoning in favor of analyzing the effects of 'killing a few to save many conspecifics', we must acknowledge the ethical position our work occupies. Ours is consequentialist, i.e., we value evidence-informed decisions and actions. We do not summarize other ethical norms and worldviews. We also accept the normative value that individual nonhumans have intrinsic value or a phrase we prefer, have interests of their own that deserve moral consideration (Korsgaard 2014, Vucetich *et al.* 2015). One need not accept our position on this to understand or acknowledge the logic of cause-and-effect we analyze from Figure 1 through the main text. For practitioners who claim science-informed action and for those interested in strong inference about causal mechanisms, interrogation of the cause-and-effect might matter.

Our discussion of kill a few to save many conspecifics below addresses causal logic, meaning the single or multiple mechanistic, biological mechanisms that lead to an effect. We avoid the vague term driver or statistical effects in favor of the clearer direct mechanistic logic of cause-and-effect. We believe we address the complete set of conditions in which killing one or a few might save many conspecifics, albeit rare, extreme conditions. We address the causal logic that underlies those conditions (super-spreading epidemics of lethal disease, mass cannibalism or infanticide, drought or famine leading to mass starvation, and a related notion of 'kill a few to scare the survivors'). We examine these conditions to be thorough about situations in which the target nonhuman might threaten many conspecifics.

When does an individual reduce the survival of other members of its population?

Killing a few infected nonhumans to save many conspecifics from lethal epidemics?

If we consider a hypothetical individual that is a super-spreader of infectious, virulent pathogens that could decimate a population, then removing that individual might conceivably save its conspecifics. The crux of the latter logic is that humans kill for the benefit of survivors. Many examples exist that involve public health or safety interventions intended to protect people or domestic animals, e.g., bovine tuberculosis, SARS, avian influenzas, hemorrhagic fevers (Karesh *et al.* 2005; Bielby *et al.* 2016). When human self-interest is the priority, the case falls outside our scope because the goal is not to protect conspecifics of the target nonhuman(s).

Distinguishing human self-interest from concerns about the target's conspecifics can be difficult until the public policy debate is analyzed. For example, the interventions against chronic wasting disease (CWD) in Wisconsin, USA, were sometimes framed as concern over the health of wild white-tailed deer (*Odocoileus virginianus*). The agency proposed to kill hundreds if not thousands of deer and testing them for CWD, to minimize "the negative impact of chronic wasting disease on cervid populations, the state's economy, hunters, landowners, and other people dependent upon healthy wild and farmed populations of deer and elk" (Heberlein 2004). However, public debate focused on human health concerns over consuming infected meat and access to deer for hunters (Heberlein 2004). This example illustrates how numerous human needs and desires vie for priority with "healthy cervid populations". This Wisconsin case led to a policy of non-selective killing. Non-selective killing would remove infected and uninfected individuals with equal probability, which seems to defy or at least undermine a strategy of protecting conspecifics from the infected deer. From the standpoint of causal logic, the claim that killing infected individuals protects conspecifics requires evidence that the removed individuals are causing serious harm to conspecifics and some evidence about the selectivity of killing mainly the infected (or at least saving more healthy conspecifics than were killed).

Programs of vaccination of nonhumans seem to be alternative responses to concerns for the health of wild populations. Juxtaposing vaccinations of infected alongside killing the infected usefully raises the general question of when lethal and non-lethal interventions are more effective. Judging two candidate interventions according to which saves more conspecifics might require randomized, controlled experimental evaluations because these disentangle treatment effects (causal) from confounding effects and spurious relationships (Platt 1964; Christie *et al.* 2019, 2020). Non-lethal interventions such as vaccination or fertility control have also been considered for population protection (e.g., Smith and Cheeseman 2002) and provide a point of comparison for assessing the relative effectiveness of lethal interventions. If that comparison is made with the nonhuman population in mind (not human interests in mind), then the outcomes for the surviving conspecifics would inform us about which is the most functionally effective intervention.

Killing a few cannibals or infanticidal individuals to save many conspecifics?

Conspecific-killing among nonhumans is uncommon. For example, cannibalism in fishes can occur as an adaptation to local food scarcity (Pereira *et al.* 2017), and infanticide can happen as a part of evolutionary strategies (van Schaik and Janson 2000). Within that background rarity, infanticide is one of the most widespread forms of conspecific-killing. For example, Mincher

(2002) argued, without evidence, that human hunting of grizzly bears might reduce infanticidal threats to females and their cubs. The opposite appears in Scandinavia (Zedrosser *et al.* 2011; Frank *et al.* 2017). Removing the perpetrator (cannibal, infanticidal, and the like) seems protective of conspecifics. Perhaps small, isolated populations or unique lineages might be threatened by such perpetrators. However, the scientific explanations for conspecific-killing on evolved traits are adaptive in struggles for individual success. That means conspecific-killers typically achieve higher reproductive success on average when that is measured. Such success argues against the loss of that population. The data reveal bouts of cannibalism or infanticide are self-limiting in time and space and do not lead to extirpation of populations (Pereira *et al.* 2017; van Schaik and Janson 2000). Therefore, this seems an unlikely condition for the intervention of 'kill a few to save many conspecifics'.

Killing a few to save many in a population facing starvation or thirst?

Severe resource shortages, such as droughts or famines, may lead to high mortality rates (e.g., Hamilton 1985). Such events have prompted humans to deliberately kill a portion of a wild population to protect the rest (Proulx 2017). For instance, fenced-in elephants have been killed to prevent overpopulation (Thouless and Sakwa 1995; Kiiru 1996). Two scientific questions arise about killing by people under these conditions.

Is killing effective, and is killing more effective than some other intervention, such as lifting the area or resource limits? Regarding the effectiveness of killing, one anonymous reviewer presented an argument from population dynamics: reducing population density should allow conspecifics to survive or reproduce better if the population is regulated by density-dependent factors. Although not all populations are so regulated (Brook and Bradshaw 2006), the argument hinges on an unstated assumption that resembles the right-hand side of Figure 1.

Namely, the target will use resources that would otherwise save the lives or reproduction of many others. It does not suffice if one nonhuman is removed to allow one conspecific to survive; more conspecifics must survive as a result, or humans are simply deciding who among assumed equivalents should live. Therefore, the right-hand side of Figure 1 applies because the target must monopolize or use more of the resources than the presumed beneficiaries, and those beneficiaries must then survive and reproduce if one is to claim the benefit to conspecific persistence. See below for parsing such two-step (indirect) chains of cause-and-effect.

The second scientific question is whether killing is more effective than not killing. For example, if humans lift the area or resource limitations, will more conspecifics be saved? Again, a clear experimental evaluation of outcomes based on two or more competing treatments is the scientific way to answer such a question locally and particularly.

Kill a few to scare the remaining conspecifics?

A situation that may appear as a special case can arise in human-wildlife conflict (HWC), where a wild competitor or threat to human safety is killed to instill fear in many survivors. This is a special case because it appears direct at first glance, but we will argue that it is indirect and requires at least one and possibly two intervening implicit steps in the logic of cause and effect (right-hand side of Figure 1).

The logic is that killing the perceived offender will teach survivors to avoid people, thereby reducing future human retaliation against survivors. The latter statement may be sufficient to demonstrate the two (or even three) steps needed to achieve the desired outcome of saving many conspecifics. Next we illuminate the two or more steps needed to sustain the logic.

Evidence is clear from studies of flight initiation and travel distances from people (e.g., Martin *et al.* 2025) and experiments with approach by humans on foot (Ordiz *et al.* 2013;

Versluijs *et al.* 2022), that wild animals avoid people or vehicles. This may reflect learned or inherited aversions, possibly due to human killing of conspecifics. It does not follow that any killing (long-range shooting from cover versus ancient spearing or netting in close proximity; or traps and poison versus the encounter with a human wielding a lethal weapon) will teach fear of humans to survivors. The necessary conditions assumed for this idea would be that conspecifics sense the killing and that they learn from it (acquired) or offspring of survivors are, on average, more averse to proximity to people than the offspring of targets (inherited). Then, the survivors who acquired or inherited avoidance must not succumb to retaliation anyway. Therefore, two or three steps are required to argue killing saves many conspecifics (right-hand side of Figure 1), even setting aside all the uncertain assumptions of this idea.

In conclusion, several ethical viewpoints can be articulated to justify humans to kill nonhumans (Vucetich & Nelson 2014; Allen *et al.* 2025). But if a claim is made for a one-step causal connection between 'kill a few' to 'save many conspecifics', the evidence-informed reasoning narrows substantially. For the four conditions we examined above (fatal disease spread, mass conspecific-killing, devastating resource shortages, or acquired or inherited fear of people), each applies under a narrow set of circumstances or additional steps that require their own evaluation. Therefore, if one seeks evidence to inform action, our analysis suggests indirect logic is more likely (right-hand side of Figure 1).

The indirect two-step causal logic behind 'kill a few to save many conspecifics'

A common, indirect argument for killing a few to save many in the same population is that the benefits generated by the killing redirect efforts to protecting the surviving conspecifics (Loveridge *et al.* 2007), i.e., two or more steps between intervention and effect. For example, fees pay for added protection; or higher human tolerances redirect behaviors of exploiters to become protectors; or data from dead animals are more valuable than data from the same animals when alive (Treves 2009). Furthermore, these indirect benefits should specifically protect the surviving conspecifics. Much ink has been spilled about indirect benefits of killing a few to save the many conspecifics (e.g., over a dozen teams wrote about trophy hunting in Science Letters and eLetters.2019, 365(6456); doi 10.1126/science.aaz0735), reflecting a lack of consensus that might be alleviated by more experimental research and more data.

For those concerned with evidence- or science-informed decisions to act, which is an ethical stance, we offer two recommendations resulting from our analysis of claims depicted in Figure 1. If one wishes to evaluate the indirect two- or three-step pathway (right-hand side of Figure 1), then the multi-step chain of cause-and-effect should be made explicit. This focuses attention on cause-and-effect, not just vague claims that 'benefits accrue therefore surviving conspecifics will do better.' To be reliable, future inference would require robust study designs (Christie *et al.* 2019*;* 2020), and measures of outcomes for survivors. Those measures should recognize individual variations, and short- to long-term effects; these include the effects of removal of essential individuals, their genes, or knowledge (Kopf *et al.* 2024); long-term selective influences on populations (Zedrosser *et al.* 2011); and short-term, perverse outcomes (Treves *et al*. 2009). For examples of perverse outcomes, many studies of the effects of killing large carnivores to protect domestic animals inferred that more domestic animals died following such killing (Peebles *et al.* 2013; Bielby *et al*. 2016; Santiago-Avila *et al.* 2018; Preiss-Bloom *et al.* 2025; Treves *et al.* 2026). The more steps in causal logic, the more chance of unexpected outcomes.

This leads to our second recommendation for those seeking evidence-informed decisions about 'kill a few to save many conspecifics' regardless of whether one or both sides of Figure 1 are being evaluated. Measures of effectiveness of interventions are rarely binary success or failure. Instead, effect sizes reveal strength of interventions, dose effects of variable intensities of intervention, unintended short- and long-term outcomes, and other vagaries of intervention outcomes. Therefore, we encourage explicit comparison of lethal interventions to non-lethal ones for those seeking scientific evidence before action. Even in our subfield of human-carnivore conflict and coexistence that has yielded numerous randomized, controlled trials of the effectiveness of non-lethal methods (Khorozyan 2022), experimental comparisons of lethal methods to non-lethal methods in the same trials are exceedingly rare (van Eeden *et al.* 2018). Furthermore, when experiments are conducted to compare different methods of killing with methods that do not result in death — such as control of bovine tuberculosis in the U.K. (Bielby *et al.* 2016) — the null hypothesis is 'often do nothing', rather than comparing killing with non-lethal treatments (Treves *et al.* 2026). Regarding lethal and non-lethal treatments as candidate interventions whose effects can be meaningfully compared would provide even more useful science-informed evidence for public policy debates. If decision-makers value evidence of effectiveness, other questions of feasibility and other criteria can be weighed alongside more than one candidate intervention (Treves *et al.* 2009; Allen *et al.* 2025).

Statement of Compliance

This article does not use any original data or code. The authors comply with ESA's Open Research Policy.

Disclosures

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Figure Captions

Figure 1. Only two causal pathways lead from killing an individual (top, blue box) to protecting its conspecifics (bottom, open box). The pathway on the left is “direct” (one step) and the subject of this article. The pathway on the right is “indirect” takes two steps because the effect of killing one or more nonhumans generates some other unspecified way to achieve the same goal (smaller blue box, right). The dashed line indicating a second causal mechanism must be evaluated. The pathway on the right is not the topic of this article.