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POLICY PERSPECTIVES

Tragic trade-offs accompany carnivore coexistence in the modern world

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Abstract

Two vital policy aims—biodiversity conservation and food production—are increasingly in conflict. Efforts to evaluate trade-offs between agriculture and conservation have shaped scholarly discourse around two broad strategies to agricultural production that seek to either “share” land with biodiversity or “spare” land from agriculture. However, efforts to negotiate these trade-offs are challenged by rising concern for the welfare of individual animals, both wild and domestic. We use recent efforts to “coexist” with large carnivores to illustrate how sharing and sparing strategies both create tragic, and often unacknowledged trade-offs between livestock production and carnivore conservation. We conclude the best means of conserving carnivores while feeding the world’s growing population requires explicitly confronting and adjudicating ethical trade-offs associated with sharing and sparing approaches. To accomplish this, we recommend engaging scholars trained in ethics and social justice and use of deliberative processes to synthesize disparate facts and competing values when evaluating trade-offs.

KEYWORDS

agriculture, carnivores, coexistence, land sharing, land sparing, livestock, modernization, trade-offs, welfare

Agriculture and biodiversity conservation are vital human enterprises that are increasingly in conflict. As societies work toward feeding an additional 2–3 billion humans by 2050, we also find ourselves amid a sixth mass extinction largely attributable to human activities (Ceballos et al., 2020). Efforts aimed at negotiating trade-offs between agriculture and biodiversity generally fall into one of two broad types of strategies—“land sparing” or “land sharing.” Land sharing is a strategy whereby lower-yield, less intensive agriculture facilitates persistence of some biodiversity on

lands used primarily for food production. Land sparing, in contrast, uses intensive, high-yield agricultural production to maximize yields on smaller land areas, potentially allowing for greater biodiversity on other lands (i.e., those “spared” from human use) (Phalan, 2018).

Efforts to evaluate the merits of these two strategies are providing new insights; however, these efforts are challenged by a variety of complicating factors, such as environmental heterogeneity, species range shifts, and integration of various scales of analysis (Phalan, 2018). Some

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scholars warn that viewing sparing and sharing as either-or approaches is unnecessary and unhelpful (Kremen & Merenlender, 2018). We concur that the best long-term strategies will likely utilize a combination of approaches. However, we demonstrate that emerging and underappreciated ethical considerations are inherent to both sparing and sharing strategies. These considerations not only complicate efforts to negotiate the trade-off between agriculture and biodiversity, they also indicate the need for scholars and policymakers to acknowledge and engage with a broader suite of trade-offs.

1 | EVALUATING TRADE-OFFS BETWEEN AGRICULTURE AND BIODIVERSITY: A ROLE FOR ETHICS?

Empirical efforts to evaluate sparing and sharing strategies attempt to clarify the trade-offs between two important aims: increasing agricultural output and conserving biodiversity. However, both strategies are likely to have a variety of impacts on humans, animals, and the ecosystems that support them. Recognition of these impacts points toward two underappreciated ethical considerations. The first consideration emerges from a tendency for agricultural intensification and land sparing approaches (which go hand-in-hand) to result in various forms of land tenure insecurity, including forced resettlement (to “spare” land from human use) and other injustices to already-marginalized human populations (de la Vega-Leinert & Clausing, 2016). A relatively recent example is multiple evictions of the Maasai people from large tracts of their traditional lands, including the present-day Serengeti National Park (Mittal & Fraser, 2018). Environmental justice scholars have long been critical of such actions (Kopina, 2016), yet injustices inflicted upon others remain an underappreciated and often unacknowledged outcome of empirical attempts to evaluate sparing and sharing strategies.

In contrast to the first ethical consideration, which emphasizes concern for humans, a second ethical consideration stems from increasing societal concern for the welfare of individual, nonhuman animals both wild and domestic (hereafter, animal welfare). This concern is manifest, for example, in the increasing pressure to find means to “coexist” with species commonly killed as “nuisances” (e.g., Bergstrom, 2017; Boronyak et al., 2020). Addressing concerns for animal welfare tends to reduce the range of options for how to increase livestock production while simultaneously lessening the loss of biodiversity.

Herein, we show how increased attention to animal welfare impacts the conservation of large, terrestrial carnivores. These species engender chronic negative interactions with animal agriculture and tend to be a deep source

of concern to animal welfare and conservation groups alike. Though we acknowledge that the use of sparing and sharing have implications both for social justice (e.g., the aforementioned land tenure security) and animal welfare, the focus of our analyses is on the latter, which has been virtually ignored in the environmental justice literature (Kopina, 2016). We begin by demonstrating that both sparing and sharing approaches can negatively impact the welfare of carnivores and their prey. Next, we explain how such impacts complicate efforts to negotiate the conflict between conservation and animal agriculture. We conclude that discourse surrounding land use and management would benefit from considering at least four broad policy aims: biodiversity conservation, food production, social justice, and animal welfare, as opposed to the traditional two (i.e., biodiversity conservation and food production).

2 | RISING CONCERN FOR ANIMAL WELFARE AND CARNIVORE CONSERVATION

The first empirical evidence of a shift in societal values concerning animals comes from a study documenting a decrease in “utilitarian” depictions of animals in the U.S. news media beginning in the first half of the 20th century (Kellert, 1985). New empirical evidence indicates this shift continues to present day (Manfredo et al., 2020). More precisely, this research documents a shift from viewing animals as valuable primarily insofar as they serve human interests to viewing animals as morally relevant members of our communities, deserving of care and compassion. While most empirical support for this trend is from wealthier nations, recent evidence suggests it results from a broader suite of social changes observed in many parts of the world, which include increasing education, income, and urbanization (Bruskotter et al., 2017; Manfredo et al., 2020). These social changes appear to be fueling concern for the welfare of animals.

Concern for animal welfare is impacting the policy and practice of both carnivore conservation and agriculture. For example, research shows that Americans view large carnivores more favorably now than in the recent past (George et al., 2016), while many techniques used to manage carnivores’ predation of livestock (e.g., foothold traps, neck snares, shooting) are increasingly seen as inhumane (Slagle, et al., 2017). Concomitantly, there is substantial pressure to manage carnivore–livestock conflicts in a manner that is more humane (e.g., improved husbandry) and promote “coexistence” between humans and carnivores (Bergstrom, 2017). Thus, the State of Washington’s (USA) recently-developed wolf conservation and manage-

ment plan specifically favors nonlethal techniques for limiting livestock predation because “lethal control is always controversial among a sizeable segment of the public” (Wiles et al., 2011, p. 81). While the trend toward emphasizing coexistence techniques may be most prominent in WEIRD societies (i.e., western, educated, industrialized, rich, democratic societies), funding for conservation that originates from WEIRD societies can instigate changes in other countries (e.g., the United Kingdom’s ban on importing parts of African lions).

Apparent tensions between wildlife conservation and livestock production in the U.S. have been mitigated, in part, by attention to different ethical concerns. Livestock production has focused attention on the welfare of individual animals (Fraser, 2010), while recent conservation efforts have emphasized population viability (Bakker & Doak, 2009). That difference has allowed livestock production and carnivore conservation to interact with an uneasy compatibility: livestock producers were free to look after the welfare of their individual animals by killing carnivores so long as the carnivore killing did not impair the viability of carnivore populations. Harm to individual carnivores—right or wrong—tended not to be a major concern for either interest group. Indeed, at the behest of the livestock industry, Wildlife Services, a wing of the U.S. Department of Agriculture, has killed more than 70,000 coyotes every year since 1985 using a wide variety of means including cyanide capsules, foothold traps, and guns fired from helicopters or fixed-wing airplanes (Bergstrom, 2017). However, public discourse in recent years has increasingly called attention to the welfare of individual wild animals (vis à vis fair treatment by humans), particularly members of charismatic species like large carnivores. The resulting pressure manifested as broad calls for “coexistence” with wildlife and greater compassion in wildlife conservation (e.g., Boronyak, Jacobs, & Wallach, 2020). Those calls have caused consternation among communities of livestock producers and wildlife conservationists, alike. In effect, the expansion of animal welfare to include wild animals has upset the compatibility between livestock production and carnivore conservation, challenging both systems.

3 | LAND SPARING AND SHARING BOTH CHALLENGE CARNIVORE COEXISTENCE

Efforts to conserve carnivores without resorting to killing them in areas with livestock tend to take one of two general approaches: (i) preventative, nonlethal methods to reduce losses of livestock to predators (hereafter, depredations); and (ii) offsetting depredation losses with economic incentives (e.g., compensation for depredations, payment

for ecosystem services). Both approaches—designed to “share” land with carnivores—are likely to entail pernicious and underappreciated trade-offs, as we demonstrate next (see Figure 1).

Preventative nonlethal techniques that reduce depredations also effectively reduce carnivores’ supply of food (Wang, et al., 2014), which could reduce carnivore abundance, and thereby, the ability to perform their ecological functions (Soulé, et al., 2003). One might anticipate reductions in carnivores’ food supply caused by the loss of livestock-prey to be offset by carnivores’ increased reliance on wild prey. However, the ability of carnivores to switch to wild prey depends on a number of factors, such as prey availability, human hunters’ tolerance for competition with carnivores over wild prey, and crop producers’ tolerance of crop losses to wild ungulates. Until research demonstrates otherwise, it would be prudent to assume prevention of livestock losses either limits carnivores’ food supply or displaces the costs of conserving these species to other humans (those not using preventative techniques). In our experience, the potential harms associated with such nonlethal techniques are generally unacknowledged.

Offsetting losses, which attempts to engender tolerance for carnivores by mitigating the negative economic effects associated with their conservation, also results in trade-offs. Specifically, increasing tolerance for carnivores can promote other losses in production, such as lost weight of livestock due to increased activity or decreased foraging to avoid predation (Ramler et al., 2014). Ultimately, increased tolerance can decrease the efficiency of livestock production (kg of livestock per ha). That inefficiency could be offset by raising livestock on more land. However, more shared land area effectively exposes more livestock to carnivores, thereby increasing the likelihood of carnivore–livestock interactions and subsequent depredations. Depredations not only represent an inefficiency of production, but also result in livestock suffering, which has the tragic consequence of pitting conservation against animal welfare.

Steep trade-offs between conservation and animal welfare also accompany land sparing strategies (Figure 1). Specifically, sparing efforts are made possible by maximizing efficiency in agricultural production. Yet intensive livestock production tends to raise concerns about the welfare of livestock, especially where the movement or behavior of livestock are importantly restricted or altered (Segall & Nussbaum, 2009). In addition to the harms to human populations through such sparing actions as forced resettlement, concerns arise from the use of various techniques used to spare agricultural lands (e.g., fences, predator control). Fences, for example, can be hazardous for certain species and may prevent migration, which could lead to malnourishment and starvation (McInturff et al., 2021).

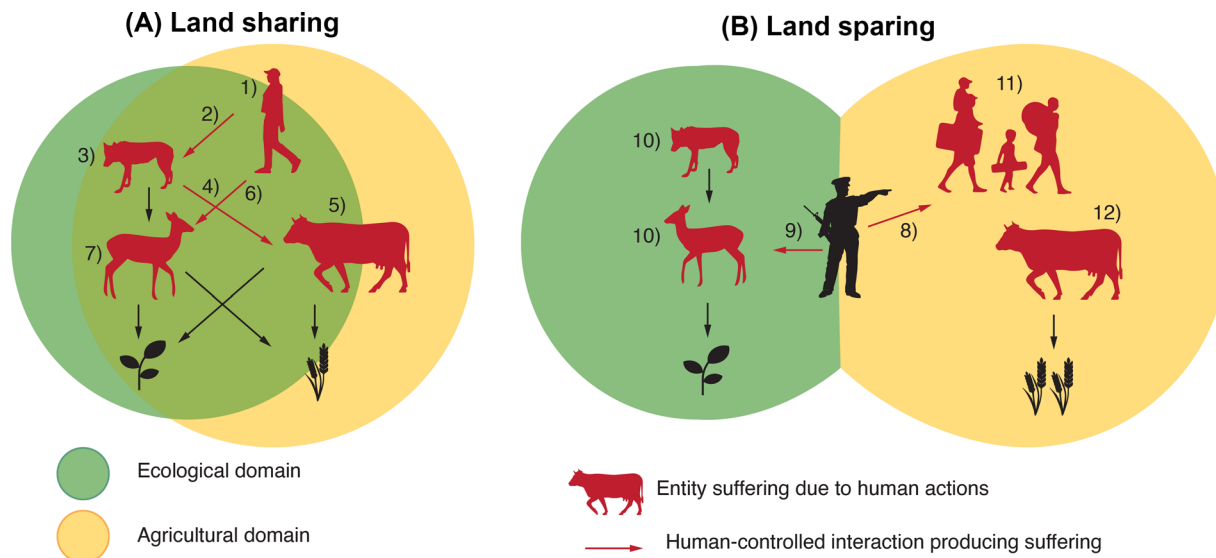


FIGURE 1 Land sharing (A) and sparing (B) approaches to conservation both result in steep and tragic trade-offs involving the well-being of various humans and nonhumans. In a land sharing scenario: human well-being is negatively impacted by livestock deprecations (1), prompting the killing of depredating carnivores (2), which impacts both the well-being of individuals carnivores, (3) and the ability of carnivore populations to fulfill their ecological function [not depicted]. Carnivores prey (or attempt to prey) on livestock (4) impacting the well-being of affected animals (5). Human agriculture subsidizes the abundance of native, wild herbivores (with crops) but humans kill herbivores that eat crops (6), which impacts the well-being of individual herbivores (7) and the ecosystem functioning of populations of wild herbivores [not depicted]. In a land sparing scenario: humans are displaced from strictly protected areas (8), and wildlife are excluded from intensive agricultural landscapes (9), which impacts the well-being of affected wildlife (10), displaced humans (11), and livestock (12). Land sparing also results in intensified agricultural livestock husbandry, which impacts the well-being of livestock [not depicted]

Moreover, unlike the production of row crops, livestock production is often reliant upon range quality, which is not easily improved. In effect then, land sparing may not be a viable alternative for intensifying livestock production especially given instances where forage quality of range land has declined due to climate change (Lee, et al., 2021).

Beyond carnivore conservation, concern for animal welfare also complicates the conservation of large ungulates and other herbivores prone to conflicts with agricultural production (e.g., elephants and bison). For example, recent increases in the abundance of bison in Yellowstone National Park prompted concerns about the potential for disease transmission from bison to domestic livestock, resulting in efforts to keep bison confined to the park and conflicts over their treatment (Plumb et al., 2009). In response to such conflicts, wildlife managers increasingly employ nonlethal approaches such as fencing, planting of diversionary crops, and use of repellants and noisemakers (Conover et al., 2018). Thus, many of the same concerns we describe here apply to conservation of terrestrial vertebrates more broadly.

To some extent, the infusion of animal welfare (as a policy aim) into the conflict between agriculture and biodiversity is a result of human population growth. Expanding human populations increase demands for limited natural resources, making conservation trade-offs both more

apparent and resulting policy choices more likely to impact other policy domains. For example, both wild and domestic animals increasingly serve as vectors of zoonoses, which has prompted recognition that “the rate of future zoonotic disease emergence or reemergence will be closely linked to the evolution of the agriculture–environment nexus” (Jones et al., 2013, p. 8399). This recognition illustrates a general principle: the more the global human population and rates of human consumption expand, the more likely conservation-related trade-offs are to manifest and to “bleed over” into other policy realms.

4 | TOWARD A SOLUTION: EXPANDING POLICY AIMS AND ADJUDICATING TRADE-OFFS

The sparing/sharing discourse has been criticized for presenting overly narrow options to policymakers which are too focused on protected areas, as opposed to working lands (Kremen & Merenlender, 2018). Kremen and Merenlender (2018) contend that “the protected-area strategy alone [i.e., sparing] will not be successful without complementary working lands conservation in the surrounding landscapes.” In addition to traditional techniques (e.g., market-based incentives, regulation), they call

for community-based conservation initiatives to “create a shared vision and innovative practices that result in collective impact” (Kremen & Merenlender, 2018). Yet, while such efforts could yield gains in biodiversity conservation, they do little to address the central issue raised in this manuscript. Put simply, efforts to conserve biodiversity and improve agricultural efficiency increasingly run headlong into animal welfare concerns—concerns that are not adequately treated in scholarly discourse and are not readily addressed by science. Moreover, though social values appear to be shifting in ways that are likely to favor biodiversity conservation, these shifts are also likely to make social conflicts over conservation more acute (Manfredo et al., 2020). That is, shifting values are likely to make it considerably harder to find a widely shared “vision” for conservation.

We have characterized the rise in concern for animal welfare and associated conflicts with other policy aims as a manifestation of shifting public values. However, we emphasize that the extent to which concern for animal welfare is increasing outside of wealthy nations is still uncertain. Even where concern is increasing, we anticipate that the efforts governments make will differ considerably from place to place, and depend upon, for examples, the prevalence of use of existing techniques, the costs of implementing those techniques, and the extent of social conflict generated by the issue.

Regardless of such variability, the central message of this essay is relatively simple: The development of land use strategies desperately needs discourse that simultaneously considers *at least* four broad policy aims: biodiversity conservation, food production, social justice, and animal welfare, as opposed to the traditional two (i.e., biodiversity conservation and food production). Many conservation professionals appear to believe that ethical concerns such as animal welfare and social justice are secondary in importance to protecting biodiversity (Vucetich et al., 2021). Even those who take that prioritization for granted would do well to recognize that concern for the welfare of animals is likely to increasingly influence the practice of wildlife conservation and animal agriculture alike. That is reason enough to be interested in discourse that takes simultaneous account of all four policy aims.

The debate over land sharing and sparing strategies is valuable for emphasizing how innovations in land use give rise to trade-offs between two important policy aims, that is, conserving biodiversity and the efficient and abundant production of food for humans. However, that discourse risks lulling policymakers into believing that win-win solutions, whereby each set of aims can be reasonably met, are likely. While it is appropriate to aspire to win-win outcomes, prudence calls us to prepare for scenarios in which mutually beneficial outcomes are not possible.

In such cases, empirical assessments are no more valuable than formal ethical reasoning, as ethics is the most reliable means of discerning the least unfair outcomes.

Achieving the fairest outcomes requires discourse that accounts for a broader suite of values and associated policy aims than tend to be considered. Realizing such discourse begins with recognizing that broad expertise is needed to address problems that transcend traditional disciplinary expertise. While interdisciplinarity is valued in the fields of conservation and agriculture, it is often limited to inclusion of scientists. Yet, discourse that incorporates ethical considerations will likely require active engagement with scholars trained in ethics and social justice. Thus, we recommend efforts to better integrate ethics—and ethicists—into scientific efforts to evaluate trade-offs. This could be accomplished within universities through the establishment of collaborative, multidepartmental centers, for example.

We also recommend that when values can be reasonably quantified and traded-off, then deliberative decision-aiding processes such structured decision making may be useful (Gregory et al., 2012). When values are not so readily or reasonably quantified, an especially useful tool for synthesizing disparate facts and competing values into potential policy statements is formal argument analysis (e.g., Coals et al., 2019). We recommend that efforts aimed at solving policy problems like that described here incorporate such techniques into their processes. A likely result of such adoption would be the identification of new empirical questions to be pursued by science—questions about how different modes of food production simultaneously affect not only biodiversity, but also a wider set of values and policy aims.

Until those questions are identified and addressed, the most significant gains that would raise the fewest ethical concerns pertaining to biodiversity conservation and agriculture is to reduce humans’ demands for animal-based protein (Bonnet et al., 2020). In parts of the world where this reduction should occur (i.e., wealthier nations), there would be no adverse impact to human well-being. Such a reduction would also be good for animal welfare, because it reduces the number of animals whose welfare is compromised, and good for biodiversity because livestock production is one of the greatest threats to biodiversity (Machovina et al., 2015).

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Jeremy T. Bruskotter conceived the manuscript after discussions with the coauthors. Jeremy T. Bruskotter and John A. Vucetich drafted the initial manuscript, which was revised iteratively with feedback from Sophie L. Gilbert, Neil H. Carter, and Kelly A. George.

DATA AVAILABILITY STATEMENT

This manuscript is conceptual in nature; no data were collected or reported upon.

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REFERENCES

- Bakker, V. J., & Doak, D. F. (2009). Population viability management: Ecological standards to guide adaptive management for rare species. *Frontiers in Ecology and the Environment*, 7(3), 158–165. <https://doi.org/10.1890/070220>
- Bergstrom, B. J. (2017). Carnivore conservation: Shifting the paradigm from control to coexistence. *Journal of Mammalogy*, 98, 1–6.
- Boronyak, L., Jacobs, B., & Wallach, A. (2020). Transitioning towards human–large carnivore coexistence in extensive grazing systems. *Ambio*, 49(12), 1982–1991. <https://doi.org/10.1007/s13280-020-01340-w>
- Bonnet, C., Bouamra-Mechemache, Z., Réquillart, V., & Treich, N. (2020). Regulating meat consumption to improve health, the environment and animal welfare. *Food Policy*, 97, 101847.
- Bruskotter, J. T., Vucetich, J. A., Manfredo, M. J., Karns, G. R., Wolf, C., Ard, K., Carter, N. H., López-Bao, J. V., Chapron, G., Gehrt, S. D., & Ripple, W. J. (2017). Modernization, risk, and conservation of the world's largest carnivores. *Bioscience*, 67, 646–655. <https://doi.org/10.1093/biosci/bix049>
- Ceballos, G., Ehrlich, P. R., & Raven, P. H. (2020). Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *PNAS*, 117(24), 13596–13602. <https://doi.org/10.1073/pnas.1922686117>
- Coals, P., Burnham, D., Loveridge, A., Macdonald, D. W., Sas-Rolfes, M. T., Williams, V. L., & Vucetich, J. A. (2019). The ethics of human–animal relationships and public discourse: a case study of lions bred for their bones. *Animals*, 9(2), 52.
- Conover, M. R., Butikofer, E., & Decker, D. J. (2018). Wildlife damage to crops: perceptions of agricultural and wildlife leaders in 1957, 1987, and 2017. *Wildlife Society Bulletin*, 42(4), 551–558.
- De la Vega-Leinert, A. C., & Clausing, P. (2016). Extractive conservation: peasant agroecological systems as new frontiers of exploitation? *Environment and Society*, 7(1), 50–70.
- Fraser, D. (2010). Toward a Synthesis of Conservation and Animal Welfare Science. *Animal Welfare*, 19(2), 121–124.
- George, K. A., Slagle, K. M., Wilson, R. S., Moeller, S. J., & Bruskotter, J. T. (2016). Changes in attitudes toward animals in the United States from 1978 to 2014. *Biological Conservation*, 201, 237–242. <https://doi.org/10.1016/j.biocon.2016.07.013>
- Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D. (2012). *Structured decision making: A practical guide to environmental management choices*. John Wiley & Sons.
- Jones, B. A., Grace, D., Kock, R., Alonso, S., Rushton, J., Said, M. Y., McKeever, D., Mutua, F., Young, J., McDermott, J., & Pfeiffer, D. U. (2013). Zoonosis emergence linked to agricultural intensification and environmental change. *PNAS*, 110(21), 8399–8404. <https://doi.org/10.1073/pnas.1208059110>
- Kellert, S. R. (1985). Historical trends in perceptions and uses of animals in 20th century America. *Environmental Review*, 9, 19–33.
- Kopnina, H. (2016). Half the earth for people (or more)? Addressing ethical questions in conservation. *Biological Conservation*, 203, 176–185.
- Kremen, C., & Merenlender, A. M. (2018). Landscapes that work for biodiversity and people. *Science Advances*, 19(6412). <https://doi.org/10.1126/science.aau6020>
- Lee, M. A., Davis, A. P., Chagunda, M. G. G., & Manning, P. (2021). Forage quality declines with rising temperatures, with implications for livestock production and methane emissions. *Biogeosciences*, 14(6), 1403–1417. <https://doi.org/10.5194/bg-14-1403-2017>
- Machovina, B., Feeley, K. J., & Ripple, W. J. (2015). Biodiversity conservation: The key is reducing meat consumption. *Science of the Total Environment*, 536, 419–431.
- Manfredo, M. J., Teel, T. L., Don Carlos, A. W., Sullivan, L., Bright, A. D., Dietsch, A. M., Bruskotter, J., & Fulton, D. (2020). The changing sociocultural context of wildlife conservation. *Conservation Biology*, 34, 1549–1559. <https://doi.org/10.1111/cobi.13493>
- McInturff, A., Xu, W., Wilkinson, C. E., Dejid, N., & Brashares, J. S. (2021). Fence ecology: Frameworks for understanding the ecological effects of fences. *Bioscience*, 70(11), 971–985. <https://doi.org/10.1093/biosci/biaa103>
- Mittal, A., & Fraser, E. (2018). *Losing the Serengeti: The Maasai land that was to run forever*. Retrieved from <https://www.oaklandinstitute.org/sites/oaklandinstitute.org/files/losing-the-serengeti.pdf>
- Phalan, B. T. (2018). What have we learned from the land sparing-sharing model? *Sustainability*, 10, 1760.
- Plumb, G. E., White, P. J., Coughenour, M. B., & Wallen, R. L. (2009). Carrying capacity, migration, and dispersal in Yellowstone bison. *Biological Conservation*, 142(11), 2377–2387.
- Ramler, J. P., Hebblewhite, M., Kellenberg, D., & Sime, C. (2014). Crying wolf? A spatial analysis of wolf location and depredations on calf weight. *American Journal of Agricultural Economics*, 96, 631–656.
- Segall, S., & Nussbaum, M. C. (2009). Frontiers of justice: Disability, nationality, species membership. *Utilitas*, 21, 526.

- Slagle, K., Bruskotter, J. T., Singh, A. S., & Schmidt, R. H. (2017). Attitudes toward predator control in the United States: 1995 and 2014. *Journal of Mammalogy*, *98*, 7–16. <https://doi.org/10.1093/jmammal/gyw144>
- Soulé, M. E., Estes, J. A., Berger, J., & Del Rio, C. M. (2003). Ecological effectiveness: Conservation goals for interactive species. *Conservation Biology*, *17*, 1238–1250.
- Vucetich, J. A., Bruskotter, J. T., van Eeden, L. M., & Macdonald, E. A. (2021). How scholars prioritize the competing values of conservation and sustainability. *Biological Conservation*, *257*(May), 109126. <http://doi.org/10.1016/j.biocon.2021.109126>
- Wang, J., Laguardia, A., Damerell, P. J., Riordan, P., & Shi, K. (2014). Dietary overlap of snow leopard and other carnivores in the Pamirs of Northwestern China. *Chinese Science Bulletin*, *59*(25), 3162–3168. <https://doi.org/10.1007/s11434-014-0370-y>
- Wiles, G. J., Allen, H. L., & Hayes, G. E. (2011). *Wolf conservation and management plan for Washington*. Washington Department of Fish and Wildlife:

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