Short communication

Challenges and opportunities for cross-jurisdictional bison conservation in North America

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A B S T R A C T

Restoring free-roaming mammals that fill critical ecological roles requires large connected landscapes that cross jurisdictional boundaries. Plains bison, once nearly extirpated from North America, are now confined to several larger free-roaming herds and a number of small fenced herds in regions where they are often managed as livestock rather than wildlife. Although bison reintroduction efforts are rapidly gaining momentum, restoring free-roaming bison remains challenged by real and perceived wildlife-human conflict. Thus, developing a shared vision for bison recovery, or at least understanding and acknowledging diverse visions, could be critical to success. To address this need, we surveyed experts from government, academia, and conservation organizations to evaluate if there is a shared long-term vision for bison, and to identify the most significant challenges, promising strategies, and research priorities for achieving this vision. We found that most respondents support a future with fenced herds as well as more free-roaming (unfenced) herds, and value bison as wildlife and cultural animals, rather than for livestock. Key challenges to achieving more free-roaming bison included political will, social acceptability, and management across jurisdictional boundaries. Respondents identified successful strategies for overcoming barriers as bottom-up collaborations, economic incentives, and demonstration projects. Research priorities were largely social rather than biophysical, with a strong focus on how to motivate broad public support for free-roaming herds. As an ecological and cultural keystone species, restoring large and connected bison herds where human-bison co-existence is feasible will reap rewards for nature and people.

1. Introduction

Refaunation can catalyze the return of the ecological functions that connect diverse plant and animal communities (Svenning et al., 2016), as well as revive cultures and livelihoods of Indigenous peoples (Keyser, 2018). Many large mammals play critical ecological roles as keystone species or ecosystem engineers (Ripple et al., 2015). Yet conserving large, connected landscapes to sustain and restore free-roaming animals is a challenge globally (Perino et al., 2019). Habitat loss, over-exploitation, and human-wildlife conflict have driven the decline of most terrestrial mammals, leading to small, isolated populations across a subset of their original range (Ceballos et al., 2017). Restoring and

connecting these populations often requires working across jurisdictional boundaries (e.g., federal, state, tribal and private lands) and achieving human-wildlife co-existence, both of which can be fraught with social and political challenges (Smith et al., 2016).

American plains bison (*Bison bison bison*) once numbered in the millions across North America (Shaw, 2000). As abundant large grazers, bison played critical social and ecological roles in maintaining grassland ecosystems and cultures (Isenberg, 2000). In the 1800s bison were nearly extirpated by European colonists for their meat and pelts, and as a deliberate strategy to displace and diminish native peoples (Phippen, 2016). The establishment of protected herds enabled the eventual demographic recovery of plains bison. However, plains bison remain listed

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on the International Union for the Conservation of Nature (IUCN) Red List as "Near Threatened", and the ~20,000 wild bison that persist today are limited to several larger free-roaming herds, and many small fenced herds in Canada, the United States, and Mexico (each <400 animals; Aune et al., 2017).

Given their pivotal ecological and cultural roles (Wilkins et al., 2019), there has been a recent surge of energy and interest in continental-scale bison recovery in North America (Sanderson et al., 2008; Redford et al., 2016) and across multiple countries in Europe (Klich et al., 2018; Perzanowski et al., 2020). In North America, these efforts include a growing number of bison reintroductions on tribal lands and a continental-scale initiative (DOI, 2020). Yet, across both continents bison conservation remains rife with real and perceived human-wildlife conflict, including competition with domestic livestock for land and forage (Ranglack et al., 2015), damage to crops and rural livelihoods (Balčiauskas and Kazlauskas, 2014), risk of disease transmission (Kilpatrick et al., 2009), and concerns about public safety (Miller et al., 2018; Klich et al., 2018). Bison are also legally classified as livestock rather than wildlife in some jurisdictions (Gates et al., 2010), which may limit their recovery.

Given these challenges, developing a shared vision for bison recovery among key stakeholders, or at a minimum, understanding and acknowledging diverse visions, is critical to success. Characterizing the full suite and perceived severity of the ecological, economic and institutional challenges to cross-jurisdictional conservation, and successful strategies for overcoming those challenges through conflict mitigation (Dickman, 2010), will be fundamental to conserving and restoring bison across landscapes with multiple landowners. Finally, given limited funds for conservation, identifying and prioritizing research questions could help fill critical knowledge gaps.

To address these needs, we used an 'expert' survey (Martin et al., 2012) to address the following research questions: 1) To what degree do bison experts associated with universities, governments and non-profit organizations share a long-term vision for bison in North America?; 2) What are the most significant challenges to achieving this vision?; 3) What strategies have been used to overcome these challenges, and under what contexts have they been implemented successfully?; 4) What are the top priorities for research needed to achieve bison conservation?; and 5) How do these perspectives vary across individuals associated with government agencies, academia, and conservation organizations?

2. Methods

We distributed an online survey to scientists and managers with bison expertise at academic institutions, government agencies, and non-profit organizations in Mexico, the United States, and Canada. The survey included closed-ended and open-ended questions about respondents' long-term vision for bison in North America, the top challenges to achieving that vision, strategies for overcoming those challenges, and top priorities for research (Appendix A). Closed-ended questions included a set of discrete responses (e.g., 16 possible challenges to restoring free-ranging bison), with the option to provide open-ended responses explaining their choices. Response options were developed based on previous visions and challenges (e.g., Kilpatrick et al., 2009; Ranglack et al., 2015) and our team's collective understanding of bison ecology and conservation.

This survey was approved by Colorado State University IRB Protocol 19-8502H, and was distributed through the online platform Qualtrics (Qualtrics, Provo, UT). The list of respondents was assembled based on the authors' knowledge of the bison conservation community, inquiries to colleagues, Google Scholar searches for authors of papers focused on bison, and snowball sampling (Stier et al., 2017). Our list of potential respondents was necessarily limited by the number of individuals with known professional bison expertise. The survey was distributed to 185 individuals from the following self-identified stakeholder groups in Mexico, the United States and Canada: federal and state natural resource

agencies ($n = 106$), tribal governments ($n = 14$), non-profit organizations ($n = 27$), academic institutions ($n = 26$), and other private entities (e.g., landowner groups; $n = 12$). Response rates for tribal groups and other private entities were low (<25%); thus, these data were included in most analyses, but excluded from comparisons among stakeholder groups.

Survey results were compiled and analyzed in Microsoft Excel and STATA. Summary statistics were generated for all closed-ended questions. We used chi-square analyses to test for significant differences among individuals from academic, government, and non-profit sectors in: 1) how bison were valued, and 2) factors identified as top challenges. Qualitative responses to questions were coded and categorized using thematic content analysis (Braun and Clarke, 2012). For the most commonly reported themes for each open-ended question, we present 1–2 quotes that were most illustrative of each theme.

3. Results

We received 74 responses from experts in government ($n = 46$), non-profit ($n = 14$), academia ($n = 9$), tribes ($n = 3$), and other private entities ($n = 2$), with an overall response rate of 40%. Respondents strongly valued bison as wildlife (93%) and for their cultural significance (78%; Fig. 1). Less than half of respondents valued bison as livestock (13%), or as an economic (21%) or hunting resource (39%). Respondents from non-profits and government sectors were 20–40% more likely to value bison as culturally significant relative to academic respondents (Fig. 1), but these differences were not significant (X^2 (3) = 5.68, $p = 0.13$).

A strong shift toward mostly free-roaming bison with some herds fenced was the most common vision across all sectors (Fig. 2). Many respondents noted that this vision is the most realistic; one respondent (non-profit) shared: *"A bison utopia is far-fetched, but bison managed on large areas on tribal, public and private lands can be achieved"*. The only experts that favored maintaining the status quo came from the government sector. Only individuals from government and academic sectors thought bison should be free-roaming everywhere, and no respondents felt that all bison should be restricted to fenced herds.

Political willingness was consistently viewed as the top challenge across all sectors (X^2 (3) = 2.76, $p = 0.43$; Appendix Fig. 1). Respondents emphasized that the way bison are classified (e.g., wildlife or livestock) has repercussions for reintroduction and management. For example, one respondent (non-profit) stated *"Governments ultimately have the say if a species is classified as wildlife and how they are managed. If politicians are not willing to back bison as wildlife there will be little positive movement."* Respondents also felt that social acceptability was a substantial barrier to reintroduction, with no difference among sectors (X^2 (3) = 4.00, $p = 0.26$). One respondent (government) explained *"bison are large and people don't want them roaming freely on roads, in towns, and across the landscape for a wide variety of reasons from disease, competition with cattle, to property damage."* Lack of knowledge about bison and the long legacy of absence of bison from the landscape may also limit support for free-roaming bison. Another respondent (government) states*: "Bison have been absent long enough that we have forgotten how to coexist with them. It is a gap in generational tolerance and knowledge."*

No respondents viewed human health or safety as a challenge and few felt that a lack of understanding of bison's ecological role, or how to reintroduce bison, or manage their movements were critical challenges. Respondents across sectors also did not feel that a lack of bison, or conflict for forage with other wildlife, were important challenges. However, academic respondents were more likely to view disease risk and genetic integrity as significant challenges (X^2 (3) = 13.27, $p = . < 0.01$).

Respondents described promising approaches to overcoming challenges as bottom-up collaboration and partnerships, demonstration projects, and economic incentives (e.g., for willing cattle owners to switch to bison, or be compensated for destroyed crops). Among existing wild bison herds, respondents felt that those that had the least amount of human-wildlife conflict were the Henry Mountains herd (Utah, U.S.;
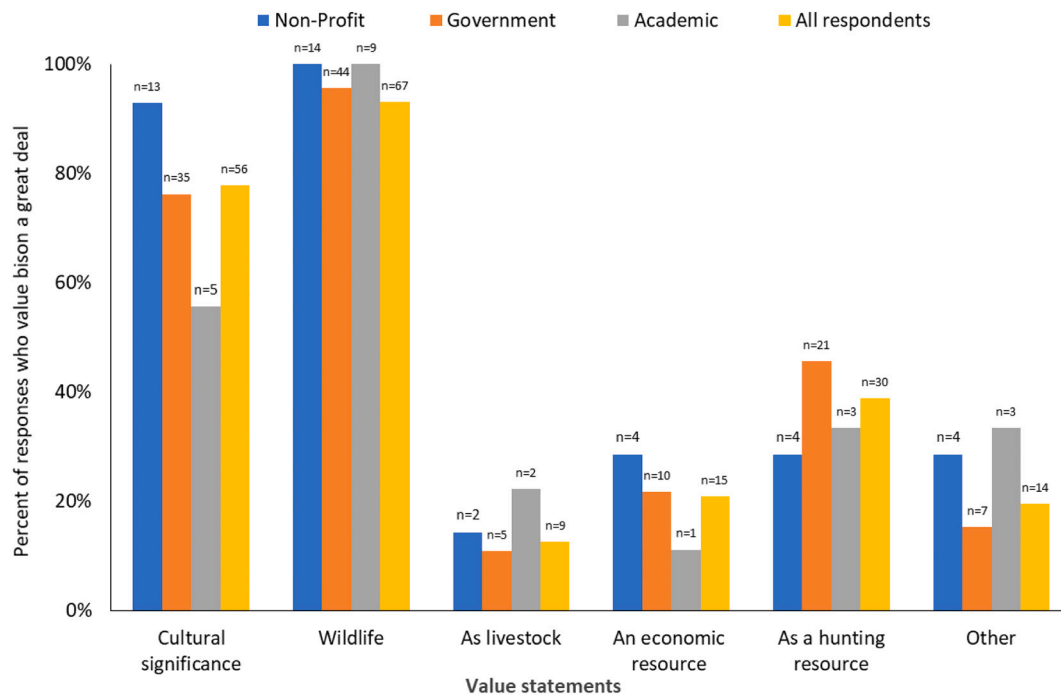
Fig. 1. The percent of all respondents, and those associated with non-profit, government, and academic sectors that valued bison "a great deal" for their cultural significance, as wildlife, livestock, and/or as an economic or hunting resource.
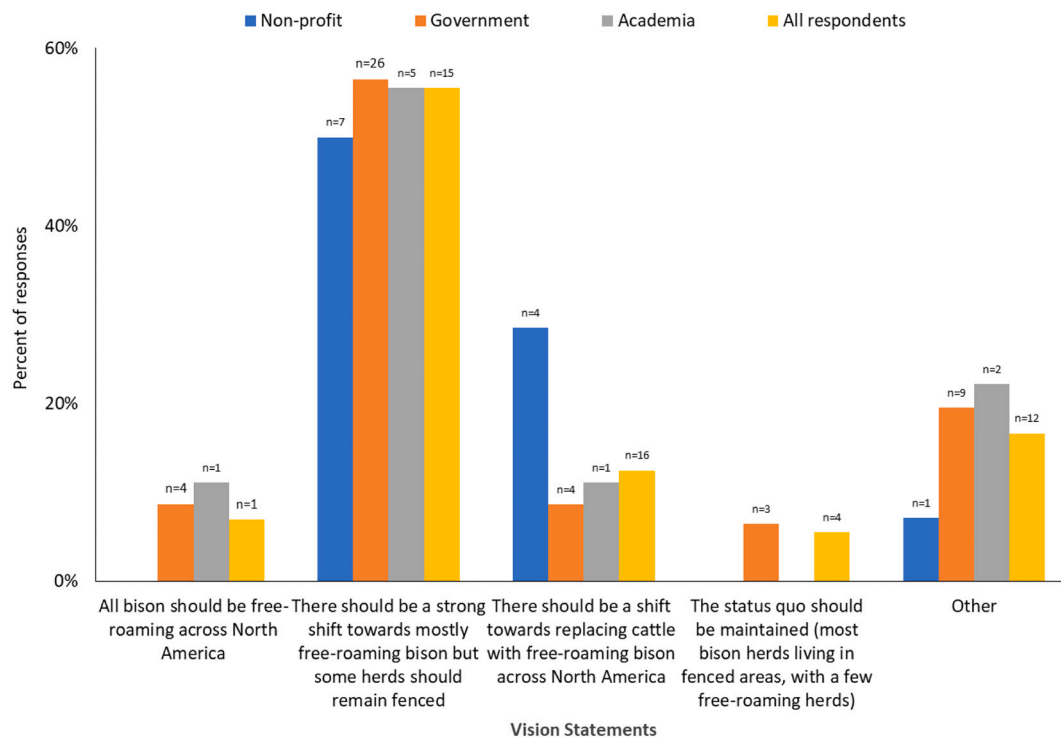

Fig. 2. Percent of all respondents, and those associated with non-profit, government, and academic sectors that agreed with diverse vision statements for bison conservation and recovery over the next 100 years.

13% of respondents), followed by herds in Canada's Northwest Territories (7%), and those on tribal lands (7%; Appendix Table 1). The factors most frequently noted as preventing or alleviating conflict in these landscapes were fencing (20% of respondents), lack of competing economic or land-use interests (20%), and landscape context (large, remote, intact habitat; 13%). Disease management and herd size were viewed as less important drivers of conflict (<5%) (Fig. 3).

Understanding how to motivate support for bison recovery across stakeholders was a top research priority (Table 1). One respondent (tribal) emphasized: *"Our view of wild bison is only what we have seen for the past 150 years - fenced in and managed that way. Information and cultural history need to be shared, repeatedly, on what "wild" bison in North*
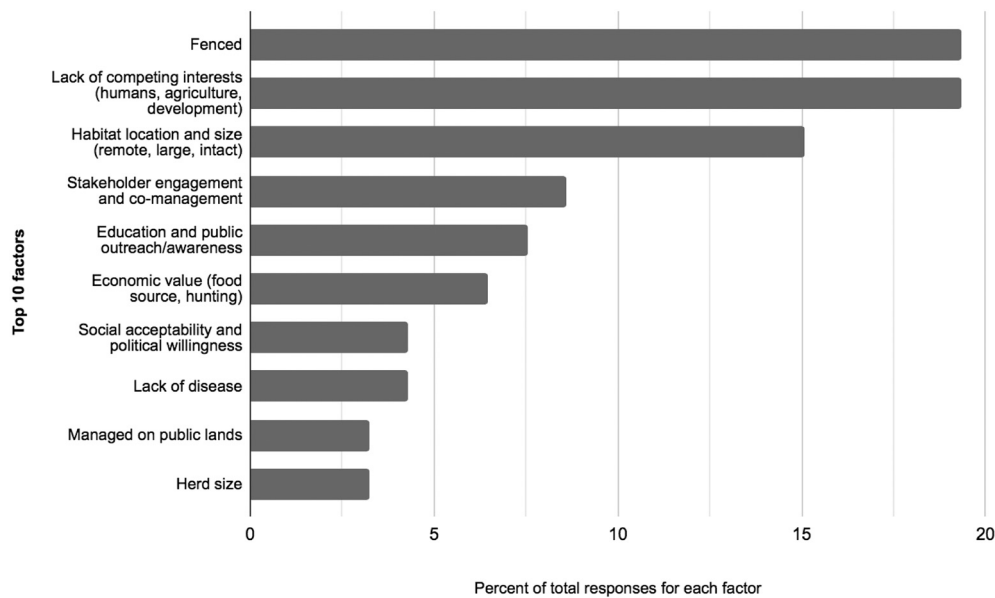
Fig. 3. The factors that respondents ($n = 66$) most frequently mentioned as important in reducing human-wildlife conflict associated with bison herds.

Table 1

Percent of respondents that ranked research areas as either their top priority, or among their top three priorities for restoring more free-roaming bison herds in North America.

Research area	1st priority	Among top 3 priorities
How to motivate support for bison reintroduction	26%	16%
Disease (e.g., transmission among livestock, wildlife and bison)	17%	8%
Prioritizing areas for bison reintroduction	15%	14%
The circumstances under which bison are socially acceptable	9%	14%
Economic costs and benefits of restoring free-roaming bison	9%	9%
How to manage bison and cattle on a shared landscape	8%	11%
How to facilitate successful cross-boundary collaboration	6%	7%
Assessing the values held about bison across stakeholders	5%	6%
Bison movements across large landscapes	3%	6%
Effects of bison on ecosystems and ecological communities	2%	4%
How best to conserve genetic diversity of bison	0%	4%

America means. And how a tribal herd would cross boundaries". Identifying and prioritizing reintroduction sites was also viewed as a priority; one respondent (government) noted: *"It seems logical to identify areas where bison reintroduction is most appropriate. Then you can start to bridge the gap and understand the local perspectives, socioeconomic and cultural issues within those areas"*. Addressing stakeholder concerns related to disease and conflict with livestock were also considered important research priorities (Table 1). Another respondent (government) stated *"The transmission or perceived transmission of disease to cattle is one of the single largest stumbling blocks to existing herd managers being able to work across jurisdictions to widen the landscape across which their bison can be free ranging"*.

4. Discussion

Restoring megafauna to sustain species, ecosystems and human cultures is rapidly gaining momentum (Malhi et al., 2016). Yet whether

and how to restore free-roaming large herbivores such as bison remains a challenge globally (Decker et al., 2010; Fuhlendorf et al., 2018). Our findings suggest that the long-term vision for bison in North America is relatively consistent across experts in government agencies, non-profit organizations and academic institutions, but there is not complete alignment. The majority of our respondents agreed that an increase in free-roaming herds, while retaining some bison in fenced herds, is the most realistic and a desirable vision for achieving recovery goals, while also mitigating conflict. However, bison can elicit diverse values and perspectives (Hermann et al., 2013), and we found that visions vary widely from a desire for 100% free-roaming herds to the status quo (most herds fenced). Most respondents recognized that free-roaming herds will not be possible everywhere due to habitat loss, fragmentation and greater potential for conflict (Ziółkowska et al., 2016). However, respondents also recognized that maintaining herds indefinitely in small fenced areas, although likely to reduce conflict and require less cross-jurisdictional cooperation, is also problematic due to the intensive management needs of such herds (Hartway et al., 2020), and because small herds do not restore large-scale ecological processes (Knapp et al., 1999). Overall, our respondents coalesced around a long-term vision for bison recovery that is largely consistent with previous statements (Sanderson et al., 2008), but place greater emphasis on social over ecological barriers to recovery (Balčiauskas and Kazlauskas, 2014).

The most substantial barriers to free-roaming bison in North America were described as the lack of political will, social acceptance, and working across jurisdictions. These mirror many of the challenges associated with bison restoration in Europe, which include concerns about threats to livelihoods in rural communities (Decker et al., 2010; Hofman-Kamińska and Kowalczyk, 2012), lack of public awareness (Balčiauskas and Kazlauskas, 2014) and the difficulty of restoring free-roaming and connected herds while minimizing conflict over large landscapes (Ziółkowska et al., 2016). However, in contrast to Europe, our respondents reported little concern about direct risk to human health (Bergsten, 2014) or crop damage (Hofman-Kamińska and Kowalczyk, 2012).

Research priorities emphasized by our respondents largely reflected challenges. Although priorities identified by academics tended to focus on disease and genetics (Freese et al., 2007), there was otherwise broad agreement that identifying how to motivate broad public support for reintroduction of free-roaming herds is a top research need. We suggest that a conservation social science research agenda focused on bison

should include studies on the influence of outreach and education strategies on public support and political will (Klich et al., 2018), how to bring diverse stakeholders together to reduce conflict (Bates and Hersey, 2016), the impact of incentives on social acceptance (e.g., Ranglack and Du Toit, 2016), and spatially explicit studies on the social "habitat" or "carrying capacity" for bison (Jung, 2020) to identify areas where reintroductions will be successful and sustained.

The strategies for success that our respondents most commonly cited included bottom-up partnerships, economic incentives, and demonstration projects. Fencing was also listed as an important tool for reducing human-wildlife conflict while still being permeable to other species (Laskin et al., 2020), although most of the herds cited by our respondents as models of success are not fenced (Appendix Table 1). This apparent paradox could be because unfenced herds tend to occur in sparsely populated places with fewer barriers to human-wildlife co-existence. Fencing in areas with higher densities of people has made some bison restoration efforts possible by alleviating concerns about land-owner livelihoods and public well-being. Yet, ironically, the lack of fencing in some cases (e.g., Henry Mountains) may have forced stake-holders to come together and forge compromises, leading to less conflict over the long term (Bates and Hersey, 2016).

We found respondents valued bison as wildlife, but there was disparity among sectors in regard to cultural and economic values. Academic respondents, who were less likely to assign cultural value to bison, were mostly natural scientists (89%) who may view bison con-servation through the lens of their own disciplines, which could fall short of recognizing the broader cultural and economic values held by society. Few respondents in our expert survey placed high value on bison as livestock or as hunted species. Yet, recognizing these values may be critical for building cross-jurisdictional partnerships, since bison require large landscapes that are home to people with diverse values and live-lihoods, and movement of megafauna beyond intended boundaries can lead to human-wildlife conflict (Ziółkowska et al., 2016, Jung, 2017).

Although our findings provide new insights into the potential for a shared agenda for bison reintroduction and recovery in North America (Sanderson et al., 2008), we also note several study limitations. Our survey was limited to people with direct professional expertise with bison. Understanding the perspectives of other groups (e.g. policy-makers, private landowners, public) was beyond the scope of our study, but will be essential to bison recovery (Balčiauskas and Kazlauskas, 2014). Furthermore, although our response rate was typical for online surveys (Poynton et al., 2019) and relatively consistent among our three primary response groups, our study was limited by unequal sample sizes among sectors, which has the potential to bias our results toward perspectives shared by the dominant group (e.g., government experts). In particular, although tribes are widely regarded as leaders and innovators in bison restoration and stewardship, and we reached out to tribal members, they were not well represented in our survey response. Fully incorporating Indigenous perspectives on bison in North America may necessitate moving beyond online surveys to engage in meaningful dialogue that is more inclusive of traditional ways of knowing and sharing information (David-Chavez, 2019). Future research could also build on our findings by exploring which visions include replacing or complementing cattle with bison, and whether stakeholders hold multiple visions for bison in North America.

Our survey demonstrates that there is broad support among multiple groups of bison professionals for more free-roaming bison in North America. As evidenced by other megafauna reintroduction efforts (Fuhlendorf et al., 2018), we suggest that restoring free-roaming bison is most likely to be achieved if diverse groups can work collaboratively to manage bison in ways that alleviate conflict and strengthen connectivity across political and social boundaries. Restoring bison across large spatial scales will also require political will and broad public support for this ecological and cultural keystone species.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2021.109029.

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