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Reintroducing bison to Banff National Park – an ecocultural case study

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The reintroduction of extirpated species is a frequent tactic in rewilding projects because of the functional role species play in maintaining ecosystem health. Despite their potential to benefit both ecosystems and society, however, most well-known species reintroductions have adopted an eco-centric, “nature-in-people-out” approach. Rewilding theory and practitioners acknowledge that ignoring the role Indigenous people did and might once again play in shaping the distribution, abundance, movements, behavior, and health of wild species and ecosystems, is limiting. In this case study, we describe the technical steps we took and how Indigenous knowledge, ceremony, and cultural monitoring were woven into the recent reintroduction of plains bison to Canada’s Banff National Park. Six years later, the reintroduced bison herd has grown from 16 to >100 animals, ranges mostly within 30 km of the release site, and, if current growth continues, will likely be managed with Indigenous harvesting. Transboundary bison policy differences are shifting and may lead to bison being more sustainable. The ecocultural approach, therefore, has increased the resilience of our rewilding project.

KEYWORDS

rewilding, reintroduction, ecocultural, indigenous people, threatened species, plains bison, *Bison bison bison*

1 Introduction

Rewilding is a bold, often costly, ecological discipline aimed at reversing biodiversity loss and climate change. Strategies typically include reintroducing species in the hope that the return of ecological processes they facilitate, like dispersal, competition, predation, and mutualism, leads to broader ecosystem restoration (Bakker and Svenning, 2018; Perino et al., 2019; Svenning, 2020; Schmitz et al., 2023). The discipline, however, has been criticized for excluding local people’s current and past roles in stewarding and shaping nature (Jørgensen, 2015; Martin et al., 2021; Massenberg et al., 2023). This may be due to practitioners’ view that people are the cause of most ecological problems (Marris, 2011) but such generalizations tragically overlook the role of Indigenous practices, like hunting (Hessami et al., 2021; Farr and White, 2022) and burning (White et al., 2011a; Hoffman

et al., 2021) in creating and perpetuating the very ecosystem conditions we aspire to rewild (Fuhlendorf et al., 2009; Kimmerer, 2013). As the following case study of returning plains bison (*Bison bison bison*) to Banff National Park, Canada (BNP) illustrates a more holistic “ecocultural” approach that explicitly engages human communities and restores ecologically beneficial cultural practices, can lead to greater and more resilient rewilding outcomes (Figure 1). Other studies have highlighted the benefits of engaging local communities (Zamboni et al., 2017; Pettersson and Carvalho, 2021) but for brevity we focus specifically on the benefits of interweaving Indigenous with Western scientific knowledge in this case study.

Plains bison are ideal candidates for ecocultural rewilding: they are a keystone species and ecosystem engineer that greatly influences ecosystem processes like energy flow and nutrient cycling with their extensive grazing, wallowing, trampling, herding and migratory behaviors (Hobbs, 1996; Knapp et al., 1999; Olson and Janelle, 2022), and they are of great cultural importance to North American Indigenous plains cultures for food, clothing, lodging, and spiritual foundations (Isenberg, 2000; Aune et al., 2017; Shamon et al., 2022; Figure 1). This changed abruptly between 1860 and 1885 when tens of millions of the animals were hunted to the brink of extinction across the Great Plains, foothills, and front ranges of North America’s Rocky Mountains (Roe, 1970; Shaw, 1995), largely with the colonial intent to destabilize and remove the independence of Indigenous groups, who relied on bison, so their historic homelands could be more easily settled (Brink, 2009). Ironically, the Canadian government helped rescue plains bison from extinction around the same time as it pushed this colonial agenda. It purchased several hundred descendants of the last wild bison from two Montana ranchers and shipped them to Elk Island National Park, Alberta, and beyond in 1907. This started a 100+ year legacy of bison conservation in Parks Canada, whereby offspring from that herd, which are considered one of the purest genotypes of wild plains bison in the world, have been used to seed new populations in

Prince Albert and Grasslands national parks, and dozens of other sites, including the one in this case study (Locke, 2016; Markewicz, 2017).

Although more than 500,000 plains bison now exist in North America, only 4% are managed for conservation (Freese et al., 2007). The remaining 96% of bison are managed within a ranching industry where selection for weight gain, ease of handling, and fecundity continues to alter the bison genome (Stroupe et al., 2022). Of the bison managed for conservation, fewer than 8,000 roam free of fences, and only across <1% of their historic range. Most (~5,000) are in the Yellowstone area; the rest are in four isolated herds of a few hundred to over one thousand animals that are functionally disconnected from one another (Sanderson et al., 2008; Farr and White, 2022). As a result, plains bison are listed as Near Threatened on the IUCN Red List (Aune et al., 2017).

The greatest barriers to their recovery are the lack of large intact landscapes (COSEWIC, 2013; Farr and White, 2022), social intolerance (Clark et al., 2016; Jung, 2020), perceived competition with other ungulates (Jung et al., 2018), potential disease transmission to livestock (White et al., 2011b; Kamath et al., 2016), and concerns over property damage and human safety (Sanderson et al., 2008). Banff National Park (BNP), on the northwestern edge of historic plains bison range (Allen, 1876), is free of many such barriers and was recognized as a rare opportunity to restore only the fifth free roaming, unfenced population of plains bison in the world (White et al., 2001). The area, which was protected as the world’s second national park in 1885 and is part of a 23,600 km² World Heritage Site (IUCN, 2020) is big, mostly intact with healthy populations of grizzly bears (*Ursus arctos*) and is, wolves (*Canis lupus*) and all other native fauna except caribou (*Rangifer tarandus*) (Hebblewhite et al., 2010). It is also free of conflicts with domestic livestock (the nearest cattle graze ~20-50 km away), and is governed by a mandate to maintain and restore ecological integrity (Canada National Parks Act, 2000), which includes the traditional practices, like burning and harvesting, of Indigenous people (Woodley, 2010). The archaeological

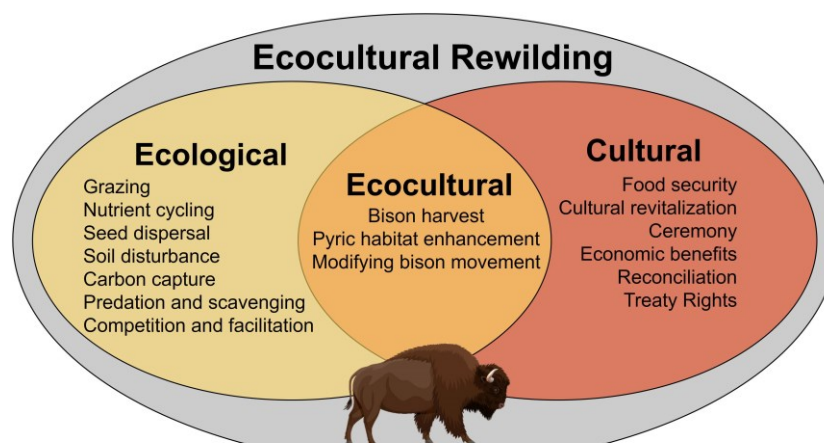


FIGURE 1

Conceptual model of how ecocultural rewilding of North American bison combines the restoration of ecological, cultural, and ecocultural processes.

(Langeman, 2004), historical (Farr and White, 2022), and dendrological (Rogean et al., 2016) evidence for such practices shaping the ecology of the region is high.

Serious discussions of wild plains bison reintroduction in BNP began when a small, fenced bison herd, which had been a popular tourist roadside attraction for 100 years (Kopjar, 1989), was shut down to restore a wildlife corridor in 1997 (Page et al., 1996). Feasibility studies for wild replacements (White et al., 2001) identified suitable habitat for up to 1,000 wild plains bison inside the park (Steenweg et al., 2016) with a low risk of disease transmission to nearby livestock (Rothenburger and Leighton, 2012). A reintroduction plan soon followed (Parks Canada, 2015b), which emphasized the Indigenous cultural, as well as ecological, benefits.

Such ecocultural emphasis is relatively new in BNP where little consideration has been given to Indigenous cultures since park establishment 134 years BP (Binnema and Niemi, 2006). Modern attempts to correct this are a priority for the Canadian government under the Indigenous Truth and Reconciliation process, which aims to heal and correct the physical and psychological trauma of past colonial practices (National Centre for Truth and Reconciliation, 2020). The restoration of culturally important plains bison populations is an ideal opportunity for government agencies and Indigenous nations to work together, heal relationships, and build trust towards a common goal (Redford et al., 2016; Crosschild et al., 2021; Shamon et al., 2022).

As a case study of an ecocultural rewilding project, we describe the recent reintroduction of bison to BNP within the context of two questions. First, was the bison reintroduction successful from an ecological rewilding perspective? Second, did it appropriately engage Indigenous peoples and restore culturally beneficial practices? We also consider how an ecocultural approach positions the project to meet future challenges, particularly around issues that other bison rewilding efforts inevitably encounter, namely range and population expansion (Sanderson et al., 2008).

2 Context

BNP is within the traditional territories of Treaty 7 Nations, which includes the Siksika, Kainai, and Piikani First Nations of the Blackfoot Confederacy, the Îyârhe Nakoda of the Chiniki, Bearspaw, and Good Stoney First Nations, the Tsuut'ina First Nation, and the Métis Nation of Alberta, Region 3. Ecologically, the area is characterized by a nearly intact pre-colonization baseline (Laliberte and Ripple, 2003) amidst rugged mountains and three ecoregions delineated by elevation (Hebblewhite et al., 2008): montane (1350 – 1500 meters), subalpine (1500 – 2300m), and alpine (2300 – 3600 meters). The montane ecoregion contains the highest-quality ungulate habitat (Hebblewhite et al., 2008) including rough fescue (*Festuca campestris*) meadows, but is largely dominated by lodgepole pine (*Pinus contorta*) conifer forests with patches of Englemann spruce (*Picea engelmannii*)- willow (*Salix* spp.) and aspen (*Populus tremuloides*). The subalpine ecoregion is primarily Englemann spruce-subalpine fir

(*Abies lasiocarpa*)-lodgepole forest, but also contains subalpine grasslands, willow-bog birch (*Betula glandulosa*) shrublands, and avalanche terrain. The alpine region is primarily bare rock and open shrub-forb meadows. The area is characterized by warm summers with short growing seasons, and cold winters with deep snowpacks, except for some steep or windblown terrain.

3 Key rewilding steps

3.1 Scoping for opportunities and constraints (1989-2012)

An early feasibility study identified a unique, globally significant bison rewilding opportunity in BNP (White et al., 2001). Supportive policy, which recognizes bison as protected wildlife, was already in place within but not outside the national park (Canada National Parks Act, 2000). This lack of legal status for bison outside the park presented significant constraints to the project design, but given the ecological and cultural opportunities, they were deemed surmountable (see Section 3.3).

3.2 Stakeholder, indigenous and public consultation (2012-15)

We solicited feedback about potential bison reintroduction at dozens of stakeholder meetings over three years. Feedback was generally positive but with some concerns (Parks Canada, 2014). For example, some ranchers, who hold allotments to graze their cattle on public lands approximately 20 km from the park, had concerns about the low risk of bison transmitting bovine brucellosis or tuberculosis to their livestock. Hunters were concerned about introducing new diseases to wildlife, and the potential for bison to compete with elk and bighorn sheep. Recreationists and horse-riding operators were concerned about public safety and potential property damage. Treaty 7 Nations and the Métis Nation of Alberta were excited by the cultural and ecological benefits, wanted to conduct ceremonies at key phases of the project, and were interested in future employment and bison harvesting opportunities. Environmental groups supported the ecological goals of the project (Figure 1), but worried about long term viability and cost, especially because bison were not considered wildlife if they ventured onto Alberta lands east of the park. Local tourism operators and the overall public welcomed new wildlife viewing opportunities (Parks Canada, 2014; Parks Canada, 2017).

3.3 Building a plan (2015-2016)

In 2015, the Canadian government announced \$6.5 million over seven years to rewild bison to BNP, which sent the project into high gear. Feedback from the above consultations guided a reintroduction plan that called for a small number of bison (N=16) to be selected from a disease-free herd and tested extensively after being translocated over the first 5 years (Macbeth, 2016), and for Indigenous blessing

ceremonies to occur at all key phases of the project (Parks Canada, 2015b). The plan also included significant mitigations to anchor the bison to a target 1200 km² reintroduction zone within the park. This included holding the bison in a soft release pasture for 1.5 years in order for them to calve twice before being released, after which a mix of rugged mountain geography, short sections of wildlife-friendly drift fencing (Laskin et al., 2020), and, when necessary, herding and hazing by staff (Watt and Heuer, 2021) would keep them within the target zone. Some stakeholders had persistent concerns that were eventually overcome by framing the project as a reversible 5-year, pilot where animals would be recaptured and removed if disease was detected or the animals could not be contained within the park (Heuer and Zier-Vogel, 2016).

3.4 Initial ceremony, physical preparations, and the larger Buffalo Treaty (2016)

Indigenous blessing ceremonies helped integrate spiritual perceptions, beliefs, and knowledge from hundreds, if not thousands, of years of coexistence with bison into the rewilding effort. They helped reveal blind spots in the short timeframes normally considered in western science, and brought relevance to the traditional wisdom within Indigenous prayers, stories and songs (Lewis and Sheppard, 2005). The first Indigenous blessing ceremony for the Banff bison rewilding project, held at a road-accessible site near the backcountry reintroduction zone, occurred in September 2016. It acknowledged, celebrated, honored, and spiritually prepared the land for the upcoming return of bison. Hosted by Parks Canada, it was shaped and conducted by elders, knowledge keepers, chiefs, and councilors from the Siksika, Kainai, and Piikani First Nations of the Blackfoot Confederacy, and the Îyârhe Nakoda of the Chiniki, Bearspaw, and Good Stoney First Nations.

Parks Canada also undertook physical preparations in anticipation of bison arriving in the reintroduction zone. These included designing and building several wildlife-friendly bison drift fences to augment the rugged mountain topography on the perimeter of the target reintroduction zone (Laskin et al., 2020), prescribed burning of meadows to improve habitat quality (Parks Canada, 2015a), and building of the 16 ha soft release pasture in the backcountry (Parks Canada, 2016).

An Indigenous-led Buffalo Treaty (Crosschild et al., 2021), now signed by over 40 Indigenous nations, also took form at this time.¹ Its purpose is to “recognize buffalo as a wild free-ranging animal and as an important part of the ecological system; to provide a safe space and environment across their historic homelands, on both sides of the United States and the Canadian border, so together the buffalo can lead First Nations to nurture their land, plants and other animals and once again realize the buffalo ways for future generations”. Larger in scope than the Banff bison rewilding project alone, it nonetheless features Banff as an inspiring example of what can be done, and advocates for its continued success. One of the first resolutions of its

signatories, for example, was a formal request to the Alberta government to recognize plains bison as wildlife in 2016².

3.5 Transfer of bison from Treaty 6 to Treaty 7 lands (2017)

A second Indigenous ceremony acknowledged the transfer of animals from the traditional territories of Treaty 6 Nations (in and around Elk Island National Park, Alberta) to Treaty 7 and Metis Area 3 nations, whose traditional territories include parts of BNP. This included pipe ceremonies and speeches from Indigenous leaders of the Enoch Cree, Ermineskin Cree, O’Chiese, Samson and Sunchild (Treaty 6 nations) and the Siksika, Kainai, and Piikani

First Nations of the Blackfoot Confederacy, and the Îyârhe Nakoda of the Chiniki, Bearspaw, and Good Stoney First Nation (Treaty 7 nations). It also featured Indigenous drumming, singing, and dancing within a few hundred meters of the soon-to-be-transferred bison.

The bison destined for Banff were captured, separated and tested over the previous weeks. Sixteen animals were selected from the ~400 animals in the Elk Island herd, known for its relative genetic purity and lack of bovine brucellosis and tuberculosis (Markewicz, 2017; Figure 2). We selected for animals of young age (2–3 years), 10 females and 6 males, pregnancy (all females confirmed pregnant through rectal palpation), health (Macbeth, 2016), and rare alleles and unrelatedness (Wilson et al., 2023). Animals were baited and handled within Elk Island’s chute and pen system as per Parks Canada’s approved animal welfare protocols during a roundup to remove excess animals from Elk Island’s fenced population every two years (Markewicz, 2017). All animals slated for the BNP reintroduction were tested for diseases of concern by Canadian Food Inspection Agency and Parks Canada veterinarians, then held in a 2-ha. pen for a two-week quarantine period where they were acclimated to hay and limited human presence.

The Indigenous transfer ceremony coincided with the end of the quarantine period on January 30, 2017. The next day, the 16 animals were herded through Elk Island’s chute and squeeze system one last time so they could be drenched with a deworming compound

(IvermectinTM) and injected with a long-acting tranquilizer (0.3 mg/kg of Zuclopenthixol acetate) (Pohlin et al., 2019; Slater et al., 2021) and fitted with 3.8–5cm diameter rubber tubes over their horns to minimize injury to crate mates on the upcoming journey. They were then loaded in groups of three (males) or four (females) each into five standard ten-foot (2.98m-long by 2.43m-wide by 2.92m-high) metal shipping containers (Sea-Containers Ltd). These had been retrofitted with 0.01m² hatches cut into the roof for additional drug administration, by jabstick, if needed, and 0.45m-high by 1.5m-long ventilation openings cut into the top side walls. Side and back walls were reinforced with 2cm-thick by 2.4m-high plywood sheets, and anti-slip 1cm-thick rubber mats from horse trailers were

¹ <https://www.buffalotreaty.com/>

² <https://static1.squarespace.com/static/5e5fe077316ef31fa3aa0210/t/5e67227bb2fd91655fc3c4bf/1583817340118/2016+Buffalo+Treaty+Alberta+Wildlife+Bison+letter+and+resolution+signed.pdf>

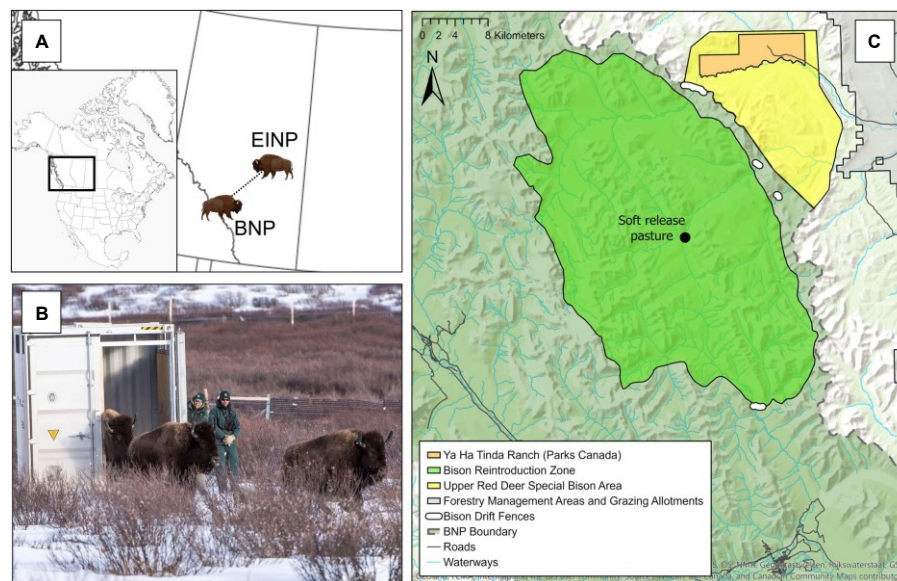


FIGURE 2

The 2017 reintroduction of Plains bison to Banff National Park (BNP). Sixteen bison were transferred from Elk Island National Park (EINP) to BNP (A), released into a soft-release pasture and held for 18 months (B), then released into the 1200 km² core reintroduction zone (C).

borrowed to use on the floors. The containers were strapped and secured to five waiting 1-ton flatbed trucks, where the bison were loaded using the ramp of Elk Island's chute system.

The loaded trucks were driven 400 km from 5pm to 12am in -20° C temperatures (Figure 2). A single visual check was made at the halfway point of the journey using a ladder and headlamp; all animals were well settled, with half standing and half bedded. This settled behavior persisted to the end of the road journey and for the remainder of the night while the trucks sat parked at the end of a gravel road within 20km of the reintroduction zone. A Kamov KA-32 helicopter with a lifting capacity of 4,500 kg arrived at daybreak, and, using a 30m longline, slung each of the loaded containers ~25 km over the final mountain ridge to the soft release pasture in the center of the backcountry reintroduction zone. Containers were attached to the long line by way of a swivel hook and a 4-point cable harness which connected to the top corner pockets of the metal shipping containers. A 2m-diameter drogue chute, tied to a bottom corner of each container, minimized spin during flight, and two 3m ropes tied to two other bottom corners helped ground crews orient containers upon landing. This aerial lift system was tested the day prior to animal translocation using an identical container filled with a volume of hay and compressed feed to approximate the weight of 4 bison.

3.6 Bison soft release pasture (2017-18)

All 16 animals emerged into the soft release pasture with only minor skin abrasions and fed on hay and drank from water troughs within an hour (Figure 2). Only 2 bison exhibited ataxia, presumably from the long-acting tranquilizer. They moved normally within 10 minutes of exiting the containers.

Animals were held in the soft release pasture for the next 18 months where they calved twice, which bison ranchers advise is important when anchoring animals to a new location (Kremeniuk, 2016). Each female gave birth to their first calf 3-4 months after translocation, sired by bulls in Elk Island the previous summer, which added significant genetic variation to the founder herd (Wilson et al., 2023). All 10 females then bred with one of the 6 translocated bulls while still in the soft release pasture the following summer (2017) and gave birth to a second crop of calves, which were mostly born before all the animals were released in July 2018. The location of the 18-ha soft release pasture was of moderate bison habitat quality (Steenweg et al., 2016; Keery, 2019) and was selected due to its central location in the target reintroduction zone and the presence of existing infrastructure (a Parks Canada backcountry patrol cabin, fenced horse pasture and corral and tack shed; Figure 2). These were temporarily retrofitted to meet the needs of the project. For example, the 6-ha horse pasture was converted to the main bison paddock, where the animals were fed hay and compressed alfalfa cubes for most of the year, and a larger (12ha) summer pasture was constructed beside it, where the animals grazed on natural vegetation in the summers and were exposed to steep slopes, burned forest, and a river. Both pastures were enclosed with 2.4m-high knotted page-wire game fence (Tree Island Steel) with a 30cm band of plastic snow fencing attached at bison-eye-height (~1m) for visibility. The page-wire was stapled to 2X4 dimensional lumber screwed to the 1.2m-high pressure treated posts that were already dug around the perimeter of the old horse pasture (4m spacings), augmented by 3.6m-high, 7.3cm diameter metal posts sunk 1.2m into the ground to brace gate openings and corners. The summer pasture was similarly fenced, but with 2.8m-long metal T-posts driven 40 cm into the ground in lieu of the preexisting wooden posts, and black windscreen tarps and plywood

slats suspended across the Panther River on adjustable 5mm cables at two locations. All fence components were slung in by helicopter and constructed, by hand, by park staff, volunteers and local contractors (Parks Canada, 2016).

Once the bison were translocated, one to two Parks Canada staff at a time worked 9-day shifts for the 544-day soft release period (Feb 2017 to July 2018). Access and egress normally required two days travel by horseback or ski. Duties at the pasture included feeding bison hay and alfalfa cubes, pumping water into troughs, shoveling and stockpiling manure, and recording bison health observations.

Adult bison consumed an average of 0.3 square bales of hay per day per individual (9 kg), which increased to 0.6 bales/day/individual (18 kg) when the 10 females nursed calves. An additional 1.14 - 2.7 kg of alfalfa cubes were fed and consumed per bison per day. Drinking water was pumped from the river directly into troughs in summer or transported via slip tank and snowmobile in winter and pumped into propane-heated troughs. Water consumption for the entire herd was 300 liters per day for 16 animals at the beginning of the soft release period, and grew with the number of animals, to a maximum of 470 liters a day for 31 animals just before they were released.

We fed minerals via 2 horse/cattle salt blocks (Windsor Salt Ltd.) which contained granulated salt, zinc, iron, manganese, copper, iodine, cobalt, and selenium. We also provided a similar loose mixture in two nearby wood bunkers to avoid aggressive interactions due to competition.

Animals were fed chopped hay from wooden bunkers for several days before release, into which a deworming crumble (Safeguard™) was distributed and consumed. This was a follow

up to the deworming drench applied while the animals were still at Elk Island. Feces were tested 7 days after both treatment and negligible amounts of common parasites, such as *Eimeria*, were detected after both treatments, with no other significant parasites. This may have been partially due to significant efforts to remove manure from feeding and bedding areas every day while the animals were in the soft release pasture: an average of 16 kg of manure per animal per day was shoveled and stockpiled for each of the 544 days.

3.7 Creating an indigenous advisory circle (2018)

With the release date of the bison fast approaching, the need for a forum where Indigenous nations could advise Parks Canada on the management of wild bison became apparent. This led to the establishment of the BNP Indigenous Advisory Circle (Parks Canada, 2019). Inspired by the reintroduction of bison, its scope quickly grew to cover all park management issues. The inaugural meeting in May 2018 was a milestone in Parks Canada's reconciliation journey; it marked the first time Indigenous groups had a voice in how the park was managed since it was established 133 years before.

3.8 Releasing the bison (2018)

A third Indigenous ceremony was held days before the final release of the bison at the remote soft release pasture in late July

2018. Twelve chiefs, elders, knowledge keepers, councilors, and consultation staff, representing all Treaty 7 nations (the Siksika, Kainai, and Piikani First Nations of the Blackfoot Confederacy, the Îyârhe Nakoda of the Chiniki, Bears paw, and Good Stoney First

Nations, the Tsuut'ina First Nation, and the Métis Nation of Alberta, Region 3) were flown in by Bell 212 helicopter to conduct ceremonies at the backcountry site where bison were soon to be released.

Three days later, on July 29, 2018, the fence was cut, and the herd (which had almost doubled to 31 animals over 2 calving seasons) was released. Remote camera imagery shows the animals found the opening 8 hours later and exited in the middle of the night. A 300m-long trail of manure roughly bounded by piles of dead wood proved fruitless in guiding them to the nearest meadow system: as soon as they reached the end of it, the animals turned sharply into thick forest, traversed a steep canyon, and climbed above tree line, settling in a high subalpine basin 6 km from the release site, where they remained for the next 1.5 months. Such elevational migrations became common for the bison over the next 3 summers (Zier-Vogel and Heuer, 2022). Although it is normal for native mountain grazers to move upwards to access palatable and nutritious vegetation as it emerges from the melting snow (Hebblewhite et al., 2008), the speed at which the bison – which were just translocated from the flatlands of Elk Island- adapted to their new mountain environment was remarkable.

3.9 Wide-ranging bison prompt small changes to transboundary policy

Most of the herd remained within the target reintroduction zone that first month except for two separate bulls, which wandered outside the park. One was recaptured and the other destroyed within a few days, but both were lost to the project. This prompted the Government of Alberta to establish the 240 km² Upper Red Deer Special Bison Zone adjacent to the park, which protects bison in a small corner of the province of Alberta until Parks Canada can redirect them back into the park.³ This was driven by a concern that the rest of the herd might follow the wandering bulls, which did not happen, largely because of mitigations like drift fences and herding, which work better for larger and less obstinate groups of female bison with young. Drift fences prevented bison from leaving the park 57 times over the first three years (Laskin et al., 2020; Zier-Vogel and Heuer, 2022), while herding them away from boundary areas worked on all 7 occasions it was tried (Laskin et al., 2020; Watt and Heuer, 2021; Zier-Vogel and Heuer, 2022).

Recent (2021) changes to provincial policy, which now recognizes Wood bison (*Bison bison athabasca*) as wildlife in discrete areas of northern Alberta, provide a model for how plains bison might be accommodated outside the park in Banff but have yet to be realized⁴.

³ <https://open.alberta.ca/publications/upper-red-deer-river-special-bison-area>

⁴ <https://www.alberta.ca/wood-bison-regulation>

3.10 Ecological and cultural monitoring point toward a transboundary future (2018–2023)

Most of the research and monitoring of the bison centered around location data from GPS collars fitted to 5–10% of the population via chemical immobilization from horseback over 5 years (Vectronics Aerospace Inc.). Collar data shows bison movements have stabilized since the animals were released in 2017 (Zier-Vogel and Heuer, 2022) but visits to boundaries of the target reintroduction zone persist, mostly in a northeast direction (Figure 3B). Drift fencing (Figures 4B, C) and herding (Figure 3A) has helped contain such extralimital movements (with the exception of a few bulls – Figure 4A) but habitat and movement modelling suggests such exploration will continue (Hebblewhite, 2016; Verzuh and Merkle, 2022). This is more likely given the herd's rapid growth (Figure 3C – 38% per year), presumably because the animals are accessing a high-nutrition diet, especially in summer (Verzuh and Merkle, 2022) and have experienced low mortality (Parks Canada, 2022). Only two bison calves are known to have been lost in the young herd so far, likely due to wolf predation.

Despite high growth of bison numbers, qualitative rangeland health assessments have not identified overgrazed areas in BNP so far, with bison having only accessed a small portion of the available forage. Evidence for bison spatiotemporal home range overlap with GPS-collared elk or bighorn sheep is minimal, although resource selection analyses have revealed shared habitat preferences that suggest competition may occur if bison densities increase (Martin and Hebblewhite, 2022; White, 2022).

A cultural monitoring survey of the BNP bison was completed in 2020 (Stoney Nakoda Nations, 2022). The first biocultural study of its kind in BNP, it consisted of Indigenous technicians interviewing elders in advance of riding, by horseback, through the bison area for 5 days (Figure 5) and reporting back to elders with photos and videos. It differed in approach from western methods but arrived at some similar recommendations. In addition to future Indigenous harvesting of bison, it called for the animal to be considered as wildlife outside the park, and greater interjurisdictional cooperation for its future management (Stoney Nakoda Nations, 2022).

3.11 Future challenges

Unsurprisingly, and like most other free ranging bison populations (Sanderson et al., 2008), managing herd growth and expansion of the Banff bison will be central issues in the management of this newly rewilded population in the near future (Parks Canada, 2022). Ironically, the technical mitigations that contributed to the success of the rewilding project in its initial years (e.g., collaring and monitoring many animals, constructing and maintaining drift fences in remote areas, herding animals on short notice when necessary) are now becoming logistically and financially challenging to maintain as the herd grows and expands. Policy changes that accommodate bison onto adjacent Alberta public lands would help ease these challenges, not only by reducing the need to contain them to a smaller area, but also for how it provides some road access to bison, which would facilitate

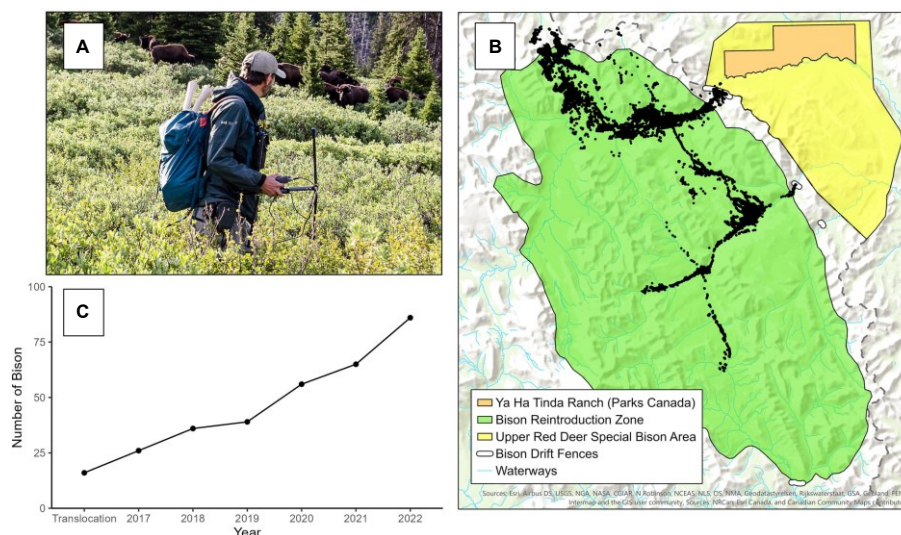


FIGURE 3
Ecological monitoring of bison following their 2017 reintroduction to Banff National Park integrates various forms of data collection including remote camera observations, radiotelemetry (A), and GPS collared bison (B) to assess body condition, behaviour, herd demographics, and population numbers (C).

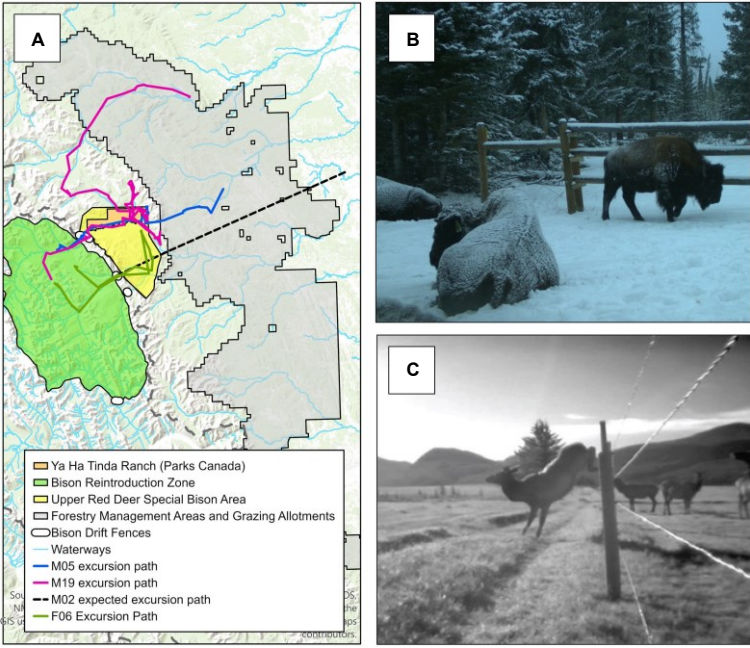


FIGURE 4
Bison excursions from the core reintroduction zone from 2017 to 2023 (A). Drift fences were largely effective at preventing excursions (B) while allowing other wildlife species like elk (*Cervus canadensis*) to pass through (C).

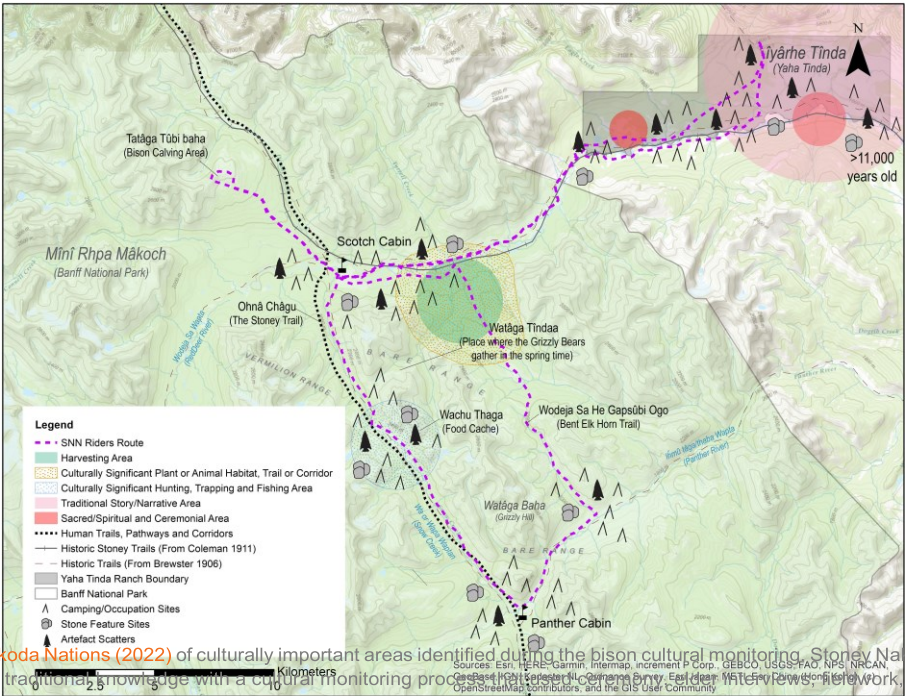


FIGURE 5
Map from [Stoney Nakoda Nations \(2022\)](#) of culturally important areas identified during the bison cultural monitoring. Stoney Nakoda wove together western science and traditional knowledge with a cultural monitoring procedure that included survey, elder interviews, network, and elder reconnection. The full cultural monitoring report is available online.

Indigenous and non-indigenous hunting as a means of regulating herd size. Such access issues are significant given the remoteness of the area and the size of a bison carcass (up to 1,000 kgs). Managing for a population of just 200 bison at today's growth rates, for example, would require removing 40–50 animals per year.

4 Discussion

The ecocultural rewilding of plains bison to Banff National Park has been an ecological and cultural success. Ecologically, we have reintroduced only the 5th free roaming population in the world of a red-listed species, and, after 5 years, the animals are healthy, growing rapidly and, except for a few wandering bulls, are anchored to the target reintroduction zone (Zier-Vogel and Heuer, 2022).

Culturally, the incorporation of Indigenous ceremony and traditional knowledge, and the establishment of an Indigenous Advisory Circle, have engaged Indigenous peoples in a project that has not only rewilded a species, but restored a cornerstone of endangered plains cultures. This has empowered and inspired many other bison restoration efforts, and has brought relevance to ancient Indigenous prayers, stories, and songs for a new generation of Indigenous people (Crosschild et al., 2021).

The strength of the ecocultural approach is only building for the Banff bison rewilding project. After ten years of working together, a trust has developed between Parks Canada and Indigenous nations that is about to deepen as the ultimate plains cultural practice – harvesting of bison by Indigenous people – becomes a fundamental ecological tool for managing the size and range of the growing herd. Discussions are underway to determine how and where this will unfold, and focusing new attention on the interjurisdictional inconsistencies in bison policies that hamper progress. Interestingly, the ecocultural approach is framing the rewilding of Banff bison as much more than an ecological issue of saving a red-listed species; with Indigenous harvest imminent, it has become an issue of human rights.

The additional pressure this focusses on resolving policy differences between jurisdictions would not have happened had the project been framed as only an ecological rewilding effort. Plains bison have been hunted by humans for millennia and the restoration of this relationship is as important as restoring the animal itself (Farr and White, 2022; Shamon et al., 2022) and helped us overcome the oversight of not including people in our rewilding effort (Jørgensen, 2015). Doing so not only broadened our initial success beyond ecological to cultural restoration, but also created a more resilient and diverse foundation from which we have more tools and voices to meet future challenges. The ecocultural approach has become our collective strength.

References

Allen, J. A. (1876). *The American Bisons, Living and Extinct* (Welch, Bigelow: University Press).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The animal study was approved by Parks Canada Animal Care Task Force. The study was conducted in accordance with the local legislation and institutional requirements. Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

Author contributions

KH: Methodology, Project administration, Writing – original draft, Conceptualization. JF: Conceptualization, Visualization, Writing – review & editing. LL: Writing – review & editing. MH: Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Aune, K., Jørgensen, D., and Gates, C. (2017). *The IUCN Red List of Threatened Species* (Switzerland: IUCN).

- Bakker, E. S., and Svenning, J.-C. (2018). Trophic rewilding: impact on ecosystems under global change. *Phil. Trans. R. Soc. B* 373, 20170432. doi: 10.1098/rstb.2017.0432
- Binnema, T., and Niemi, M. (2006). "Let the line be drawn now": Wilderness, conservation, and the exclusion of Aboriginal people from Banff National Park in Canada. *Environ. History* 11, 724–750. doi: 10.1093/envhis/11.4.724
- Brink, J. (2009). *Imagining Head-Smashed-In: Aboriginal Buffalo Hunting on the Northern Plains* (Alberta: Athabasca University Press).
- Canada National Parks Act (2000) *Canada National Parks Act*. Available at: <https://lawslois.justice.gc.ca/eng/acts/n-14.01/>.
- Clark, D., Workman, L., and Jung, T. (2016). Impacts of reintroduced bison on first nations people in Yukon, Canada: Finding common ground through participatory research and social learning. *Conserv. Soc.* 14, 1. doi: 10.4103/0972-4923.182798
- COSEWIC (2013). *COSEWIC assessment and status report on the Plains Bison and the Wood Bison in Canada* (Ottawa: Committee on the Status of Endangered Wildlife in Canada). Available at: http://www.registrelep-sararegistry.gc.ca/default_e.cfm.
- Crosschild, R., Starblanket, G., Voth, D., Hubbard, T., and Bear, L. L. (2021). Awakening buffalo consciousness: lessons, theory, and practice from the buffalo treaty. *Wicazo Sa Rev.* 36, 5–29. doi: 10.1353/wic.2021.a903665
- Farr, J. J., and White, C. A. (2022). Buffalo on the edge: Factors affecting historical distribution and restoration of Bison bison in the Western Cordillera, North America. *Diversity* 14, 937. doi: 10.3390/d14110937
- Freese, C. H., Aune, K. E., Boyd, D. P., Derr, J. N., Forrest, S. C., Cormack Gates, C., et al. (2007). Second chance for the plains bison. *Biol. Conserv.* 136, 175–184. doi: 10.1016/j.biocon.2006.11.019
- Fuhlendorf, S. D., Engle, D. M., Kerby, J., and Hamilton, R. (2009). Pyric herbivory: Rewilding landscapes through the recoupling of fire and grazing. *Conserv. Biol.* 23, 588–598. doi: 10.1111/j.1523-1739.2008.01139.x
- Hebblewhite, M. (2016). *Potential Bison habitat modelling: Extending beyond Banff* (Missoula, Montana: University of Montana).
- Hebblewhite, M., Merrill, E., and McDermid, G. (2008). A multi-scale test of the forage maturation hypothesis in a partially migratory ungulate population. *Ecol. Monogr.* 78, 140–166. doi: 10.1890/06-1708.1
- Hebblewhite, M., White, C., and Musiani, M. (2010). Revisiting extinction in national parks: Mountain Caribou in Banff. *Conserv. Biol.* 24, 341–344. doi: 10.1111/j.1523-1739.2009.01343.x
- Hessami, M. A., Bowles, E., Popp, J. N., and Ford, A. T. (2021). Indigenizing the north american model of wildlife conservation. *FACETS* 6, 1285–1306. doi: 10.1139/facets-2020-0088
- Heuer, K., and Zier-Vogel, A. (2016). *BNP Bison excursion prevention and response plan* (Parks Canada: Banff National Park).
- Hobbs, N. T. (1996). Modification of ecosystems by ungulates. *J. Wildlife Manage.* 60, 695. doi: 10.2307/3802368
- Hoffman, K. M., Davis, E. L., Wickham, S. B., Schang, K., Johnson, A., Larking, T., et al. (2021). Conservation of Earth's biodiversity is embedded in Indigenous fire stewardship. *Proc. Natl. Acad. Sci. U.S.A.* 118, e2105073118. doi: 10.1073/pnas.2105073118
- Isenberg, A. C. (2000). *The Destruction of the Bison: an Environmental History 1750–1920* (United Kingdom: Cambridge University Press).
- IUCN (2020) *IUCN World Heritage Outlook: Canadian Rocky Mountain Parks - 2020 Conservation Outlook Assessment*. Available at: <https://worldheritageoutlookiucn.org/>.
- Jørgensen, D. (2015). Rethinking rewilding. *Geoforum* 65, 482–488. doi: 10.1016/j.geoforum.2014.11.016
- Jung, T. S. (2020). Investigating local concerns regarding large mammal restoration: group size in a growing population of reintroduced bison (Bison bison). *Global Ecol. Conserv.* 24, e01303. doi: 10.1016/j.gecco.2020.e01303
- Jung, T. S., Czetwertynski, S. M., and Schmiegelow, F. K. A. (2018). Boreal forest titans do not clash: low overlap in winter habitat selection by moose (Alces americanus) and reintroduced bison (Bison bison). *Eur. J. Wildl. Res.* 64, 25. doi: 10.1007/s10344-018-1184-z
- Kamath, P., Foster, J., Drees, K., Luikart, G., Quance, C., Anderson, N. J., et al. (2016). Genomics reveals historic and contemporary transmission dynamics of a bacterial disease among wildlife and livestock. *Nat. Commun.* 7, 11448. doi: 10.1038/ncomms11448
- Keery, L. (2019). *Evaluating the potential impacts of reintroduced plains bison (Bison bison) contained in a soft-release pasture in Banff National Park* (Victoria, Canada: Royal Roads University).
- Kimmerer, R. (2013). *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (Minneapolis USA: Milkweed Editions).
- Knapp, A. K., Blair, J. M., Briggs, J. M., Collins, S. L., Hartnett, D. C., Johnson, L. C., et al. (1999). The keystone role of Bison in North American tallgrass prairie. *BioScience* 49, 39. doi: 10.2307/1313492
- Kopjar, N. R. (1989). Alternatives for bison management in Banff National Park. doi: 10.7939/R35H7BZ79
- Kremeniuk, T. (2016). Canadian bison association AGM.
- Laliberte, A. S., and Ripple, W. J. (2003). Wildlife encounters by Lewis and Clark: a spatial analysis of interactions between Native Americans and wildlife. *BioScience* 53, 994–1003. doi: 10.1641/0006-3568(2003)053[0994:WEBLAC]2.0.CO;2
- Langeman, E. G. (2004). "Zooarchaeological research in support of a reintroduction of Bison to Banff National Park," in *The Future from the Past: Archaeozoology in Wildlife Conservation and Heritage Management* (Calgary Alberta: Oxbow Books), 79–89.
- Laskin, D. N., Watt, D., Whittington, J., and Heuer, K. (2020). Designing a fence that enables free passage of wildlife while containing reintroduced bison: a multispecies evaluation. *Wbio* 2020, wlb.00751. doi: 10.2981/wlb.00751
- Lewis, J. L., and Sheppard, S. R. J. (2005). Ancient values, new challenges: Indigenous spiritual perceptions of landscapes and forest management. *Soc. Natural Resour.* 18, 907–920. doi: 10.1080/08941920500205533
- Locke, H. (2016). *The Last of the Buffalo Return to the Wild* (Banff Alberta: Summerthought Publishing).
- Macbeth, B. (2016). *BNP Bison reintroduction health monitoring strategy* (Parks Canada: Banff National Park).
- Markewicz, L. (2017). *Like distant thunder: Canada's Bison conservation story* (Ottawa, Canada: Parks Canada).
- Marris, E. (2011). *Rambunctious Garden: Saving Nature in a Post-Wild World* (New York: Bloomsbury Publishing USA).
- Martin, A., Fischer, A., McMorran, R., and Smith, M. (2021). Taming rewilding - from the ecological to the social: How rewilding discourse in Scotland has come to include people. *Land Use Policy* 111, 105677. doi: 10.1016/j.landusepol.2021.105677
- Martin, H., and Hebblewhite, M. (2022). Elk (Cervus canadensis) and Bison (Bison bison) share space and resources without evidence of competitive exclusion following Bison reintroduction to Banff National Park.
- Massenberg, J. R., Schiller, J., and Schröter-Schlaack, C. (2023). Towards a holistic approach to rewilding in cultural landscapes. *People Nat.* 5, 45–56. doi: 10.1002/pan3.10426
- National Centre for Truth and Reconciliation (2020). *Truth and Reconciliation Calls to Action* (Government of Canada, Ottawa Canada).
- Olson, W., and Janelle, J. (2022). *The Ecological Buffalo: On the Trail of a Keystone Species* (Regina, Canada: University of Regina Press).
- Page, R., Bayley, S., Cook, J. D., Green, J. E., and Ritchie, J. B. (1996). "Banff-Bow Valley: at the crossroads," in *Summary report of the Banff-Bow Valley Task Force* (Ottawa, Ontario, Canada: Department of Canadian Heritage).
- Parks Canada (2014). *What we heard: Summary of public comment, reintroduction for Plains Bison in Banff National Park* (Banff National Park: Parks Canada).
- Parks Canada (2015a). *Basic impact assessment for Banff Field Unit meadow burning prescribed fire plan* (Banff National Park: Parks Canada).
- Parks Canada (2015b). *Reintroduction plan: Plains Bison in Banff National Park* (Banff National Park: Parks Canada).
- Parks Canada (2016). *Basic impact assessment for Bison pasture at Panther River soft-release site* (Banff National Park: Parks Canada).
- Parks Canada (2017). *Detailed environmental impact analysis, Plains Bison reintroduction in Banff National Park: Pilot project 2017-2022* (Banff National Park: Parks Canada).
- Parks Canada (2019). *Banff National Park Indigenous advisory circle, terms of reference* (Banff National Park: Parks Canada).
- Parks Canada (2022). *Report on the Plains Bison reintroduction pilot 2017-2022* (Banff National Park: Parks Canada).
- Perino, A., Pereira, H. M., Navarro, L. M., Fernández, N., Bullock, J. M., Ceausy, S., et al. (2019). Rewilding complex ecosystems. *Science* 364, eaav5570. doi: 10.1126/science.aav5570
- Pettersson, H. L., and Carvalho, S. H. C. (2021). Rewilding and gazetting the Iberá National Park: Using an asset approach to evaluate project success. *Conserv. Sci. Prac.* 3, 1-14. doi: 10.1111/csp2.258
- Pohlin, F., Hofmeyr, M., Hooijberg, E. H., Blackhurst, D., Reuben, M., Cooper, D., et al. (2019). Challenges to animal welfare associated with capture and long road transport in boma-adapted Black (Dicerus bicornis) and semi-captive White (Ceratotherium simum) Rhinoceroses. *J. Wildlife Dis.* 56, 294–305. doi: 10.7589/2019-02-045
- Redford, K. H., Aune, K., and Plumb, G. (2016). Hope is a bison: editorial. *Conserv. Biol.* 30, 689–691. doi: 10.1111/cobi.12717
- Roe, F. G. (1970). *The North American Buffalo: A Critical Study of the Species in its Wild State*. 2nd ed (Toronto, Ontario, Canada: University of Toronto Press).
- Rogean, M.-P., Flannigan, M. D., Hawkes, B. C., Parisien, M.-A., Arthur, R., Rogean, M.-P., et al. (2016). Spatial and temporal variations of fire regimes in the Canadian Rocky Mountains and Foothills of southern Alberta. *Int. J. Wildland Fire* 25, 1117–1130. doi: 10.1071/WF15120
- Rothenburger, J., and Leighton, F. A. (2012). *Disease risk assessment for the reintroduction of Plains bison into Banff National Park*. Canadian Cooperative Wildlife Health Centre (Saskatoon, Canada: CCWC).
- Sanderson, E. W., Redford, K. H., Weber, B., Aune, K., Baldes, D., Berger, J., et al. (2008). The ecological future of the North American Bison: Conceiving long-term, large-scale conservation of wildlife. *Conserv. Biol.* 22, 252–266. doi: 10.1111/j.1523-1739.2008.00899.x
- Schmitz, O. J., Sylven, M., Atwood, T. B., Bakker, E. S., Berzaghi, F., Brodie, J. F., et al. (2023). Trophic rewilding can expand natural climate solutions. *Nat. Climate Change* 13, 324–333. doi: 10.1038/s41558-023-01631-6

- Shamon, H., Cosby, O. G., Andersen, C. L., Augare, H., BearCub Stiffarm, J., Bresnan, C. E., et al. (2022). The potential of Bison restoration as an ecological approach to future Tribal food sovereignty on the Northern Great Plains. *Front. Ecol. Evol.* 10, 826282. doi: 10.3389/fevo.2022.826282
- Shaw, J. H. (1995). How many bison originally populated western rangelands? *Rangelands* 17, 148–150.
- Slater, O., Backwell, A., Cook, R., and Cook, J. (2021). The use of a long-acting tranquilizer (zuclopenthixol acetate) and live video monitoring for successful long-distance transport of caribou (*Rangifer tarandus*). *Rangifer* 41, 13–26. doi: 10.7557/2.41.1.5605
- Steenweg, R., Hebblewhite, M., Gummer, D., Low, B., and Hunt, B. (2016). Assessing potential habitat and carrying capacity for reintroduction of Plains Bison (*Bison bison bison*) in Banff National Park. *PLoS One* 11, e0150065. doi: 10.1371/journal.pone.0150065
- Stoney Nakoda Nations (2022). *Enhancing the reintroduction of Plains bison in Banff National Park through cultural monitoring and traditional knowledge* (Morley, Alberta: Stoney Nakoda Nations).
- Stroupe, S., Forgacs, D., Harris, A., Derr, J. N., and Davis, B. W. (2022). Genomic evaluation of hybridization in historic and modern North American Bison (*Bison bison*). *Sci. Rep.* 12, 6397. doi: 10.1038/s41598-022-09828-z
- Svenning, J.-C. (2020). Rewilding should be central to global restoration efforts. *One Earth* 3, 657–660. doi: 10.1016/j.oneear.2020.11.014
- Verzuh, T., and Merkle, J. (2022). *Exploration, diet, and habitat selection of reintroduced Bison (Bison bison) in Banff National Park: The first three years* (Laramie, Wyoming (USA: University of Wyoming).
- Watt, D., and Heuer, K. (2021). Low-stress stockmanship as a tool in the reintroduction of wild plains bison to Banff National Park. *Stockmanship J.* 7, 68–79.
- White, P. J. (2022). Bison and Bighorns: Assessing the potential impacts of reintroducing a large herbivore to a mountainous landscape.
- White, C. A., Langeman, E. G., Gates, C. C., Kay, C. E., Shury, T., and Hurd, T. E. (2001). "Plains Bison restoration in the Canadian Rocky Mountains: Ecological and management considerations," in *Proceedings of the George Wright Biannual Conference on Research and Resource Management in National Parks and on Public Lands 11*, Hancock, MI, USA (Michigan USA: George Wright Society), 152–160.
- White, C. A., Perrakis, D. D. B., Kafka, V. G., and Ennis, T. (2011a). Burning at the edge: Integrating biophysical and eco-cultural fire processes in Canada's parks and protected areas. *Fire Ecol.* 7, 74–106. doi: 10.4996/fireecology.0701074
- White, P. J., Wallen, R. L., Geremia, C., Treanor, J. J., and Blanton, D. W. (2011b). Management of Yellowstone bison and brucellosis transmission risk – Implications for conservation and restoration. *Biol. Conserv.* 144, 1322–1334. doi: 10.1016/j.biocon.2011.01.003
- Wilson, G., Fulton, T., and Heuer, K. (2023). When theory meets practice: Balancing genetic diversity and behaviour when choosing founders for a recently reintroduced Bison (*Bison bison*) herd in Banff National Park, Canada. *Diversity* 15, 366. doi: 10.3390/d15030366
- Woodley, S. (2010). Ecological integrity and Canada's national parks. *George Wright Forum* 27, 151–160.
- Zamboni, T., Di Martino, S., and Jiménez-Pérez, I. (2017). A review of a multispecies reintroduction to restore a large ecosystem: The IberáRewilding Program (Argentina). *Perspect. Ecol. Conserv.* 15, 248–256. doi: 10.1016/j.pecon.2017.10.001
- Zier-Vogel, A., and Heuer, K. (2022). The first 3 years: Movements of reintroduced Plains Bison (*Bison bison bison*) in Banff National Park. *Diversity* 14, 883. doi: 10.3390/d14100883