BUFFALO
FIELD CAMPAIGN

February 28, 2022

Superintendent
Attn: Bison Management Plan
PO Box 168
Yellowstone National Park, WY 82190

Buffalo Field Campaign's Scoping Comments on Yellowstone National Park's Bison Management Plan

Dear Superintendent Cameron (Cam) Sholly,

Please consider Buffalo Field Campaign's scoping comments in developing a Bison Management Plan for Yellowstone National Park. As part of our scoping comments, an electronic copy of source material is provided for review and incorporation in your analysis.

Sincerely,

James L. Holt Sr.

Darrell Geist

James L. Holt, Sr.
Executive Director

Darrell Geist
habitat coordinator

> The Superintendent was informed that the Secretary of the Interior wanted (1) Yellowstone bison managed more actively like cattle on a ranch, and (2) the Bureau of Land Management to conduct an assessment of the number of bison the park could support using the animal unit month (AUM) concept. This approach is traditionally used to manage forage use by grazing livestock.

Yellowstone National Park, *USDI Guidance to Manage Bison and Grazing More Actively Like Livestock on a Ranch*, Briefing Statement FY 2018.

> The current management approach for Yellowstone bison is not serving the broader common good, but rather specific livestock interests based on perpetuated myths and misperceptions. The lack of tolerance for wild bison on more suitable public lands in the Greater Yellowstone Area is no longer justified based on the comparative risks of brucellosis transmission to cattle, human injury, and property damage; all of which are much higher for wild elk that are tolerated without substantive management.

P.J. White, Rick Wallen, & Chris Geremia, *Resolving Intractable Governance Issues to Recover Wild Bison While Maintaining Public and Tribal Trust*, (Yellowstone National Park, Mammoth, Wyoming) (unpublished manuscript, March 14, 2018).

Yellowstone National Park's preliminary alternatives do not avoid and minimize management actions directed against Yellowstone's bison herds.

Many of Yellowstone National Park's bison management actions are unreasonable and unjustified.

Many of Yellowstone National Park's bison management actions can be avoided and minimized by taking into account cattle are being managed in Designated Surveillance Areas.

Alternative 1: No-Action
The NPS would continue to manage bison pursuant to the 2000 IBMP as adaptively adjusted and implemented and would maintain a population range of bison similar to the last two decades (3,500 to 5,000 bison after calving). The NPS would continue hunt-trap coordination to balance population regulation in the park using culling at Stephens Creek with hunting opportunities outside the park, increase the number of brucellosis-free bison relocated to tribal lands, and work with the State of Montana to manage the already low risk of brucellosis spreading from bison to cattle.

- If action is needed because "new information obtained since the approval of the Interagency Bison Management Plan (IBMP) in 2000 indicates some of the premises regarding disease transmission in the initial plan were incorrect or changed over time" than the No Action alternative is not a viable alternative nor is it a suitable baseline to compare it with other alternatives.

- Please describe the new information and each premise that is incorrect or has changed. Yellowstone National Park should have included this information in your scoping documents for the public to consider.

- Consider evaluating a No Plan alternative as a suitable baseline to compare with other alternatives.

- Even under a No Plan alternative, any disease risk is minimal and rapidly reduced by natural and biological factors.

- What scientific evidence justifies "a boundary line beyond which bison will not be tolerated" on public lands, an action common to all alternatives?

- Managing cattle in Designated Surveillance Areas in the States is a significant change in circumstances. Yet there is no "adaptive management" change favoring wild buffalo in the same range and habitat permitted to wild elk.

- Subsistence hunters do not want to be used or classified as a "tool" in manager's toolbox. Management actions like trapping for slaughter also undermine subsistence hunting of bison naturally migrating to National Forest habitat.

- Managers continue to pound away against buffalo's natural migrations across public lands. In pounding buffalo through repeated and unjustified management actions, managers have imperiled the genetically distinct subpopulation of buffalo in the Central herd.

- Managers continue to ignore the adverse influence of management actions artificially selecting against "wild" buffalo.

- Yellowstone National Park does not appear to recognize the best available science of genetically distinct subpopulations or herds. Managing for a population range of 3,500 to 5,000 does not protect against loss of genetic diversity for each buffalo subpopulation or herd. Each buffalo subpopulation or herd requires a minimum size to avoid inbreeding and maintain genetic variation.

Alternative 2: Enhance Restoration and Tribal Engagement
Bison would be managed within a population range of about 4,500 to 6,000 bison after calving with an emphasis on using the Bison Conservation Transfer Program and tribal hunting outside the park to regulate bison numbers. The NPS may use proactive measures such as low stress hazing of bison toward the park boundary to increase tribal hunting opportunities outside the park. The NPS would reduce shipment to slaughter based on the needs and requests of tribes.

- Hazing buffalo from Yellowstone National Park for the purpose of being hunted on the National Forest is going to result in national condemnation.

- Subsistence hunters do not want to be used or classified as a "tool" in manager's toolbox. Management actions like trapping for slaughter also undermine subsistence hunting of bison naturally migrating to National Forest habitat.

- Yellowstone National Park needs to get out of the business of trapping buffalo for slaughter.

- Managing Yellowstone National Park for the benefit of the buffalo aligns with the Park's purposes. Stop managing Yellowstone National Park to the buffalo's detriment, a national disgrace.

- Over 8 million acres of National Forest habitat on the Custer-Gallatin, Shoshone, and Caribou-Targhee surrounds Yellowstone National Park. Please provide details on how Yellowstone National

Park hazing, quarantine, and trapping for slaughter contributes to self-sustaining buffalo herds on the National Forest, and how these management actions meet the "needs and requests of tribes."

- Yellowstone National Park does not appear to recognize the best available science of genetically distinct subpopulations or herds. Managing for a population range of 4,500 to 6,000 does not protect against loss of genetic diversity for each buffalo subpopulation or herd. Each buffalo subpopulation or herd requires a minimum size to avoid inbreeding and maintain genetic variation.

Alternative 3: Food-Limited Carrying Capacity
The NPS would rely on natural selection, bison dispersal, and public and tribal harvests in Montana as the primary tools to regulate bison numbers, which would likely range from 5,500 to 8,000 or more bison after calving. Trapping for shipments to slaughter would immediately cease. The NPS would continue captures to maintain the Bison Conservation Transfer Program as in Alternatives 1 and 2.

- Managing buffalo based on a "food-limited carrying capacity" assumes the range and habitat of the wild, migratory species is limited and restricted by enclosures, "tolerance" zones, and boundary management schemes.

- Subsistence hunters do not want to be used or classified as a "tool" in manager's toolbox.

- Managing Yellowstone National Park as an enclosure to limit buffalo's range and habitat undermines the potential for perpetuating evolutionary processes like natural selection.

- Managing Yellowstone National Park as an enclosure is an artificial selection process. Over the long-term it is domestication. Yellowstone National Park is not a zoo and should not be managed like a zoo.

- It is axiomatic that the less habitat available for wild buffalo to adapt and evolve, the greater the risk to native species and ecological processes.

- The buffalo should have freedom in defining their own biological presence on public lands for perpetuating natural variation and evolutionary adaptation in the Yellowstone ecosystem.

- Trapping for slaughter will not "immediately cease" if Yellowstone National Park continues to trap buffalo for quarantine.

- Yellowstone National Park is misleading people about quarantine's impacts and effects on buffalo.

- Slaughtering buffalo is a feature of quarantine. Buffalo testing positive for exposure to brucellosis are sent to slaughter.

- Yellowstone National Park does not appear to recognize the best available science of genetically distinct subpopulations or herds. Managing for a population range of 5,500 to 8,000 does not protect against loss of genetic diversity for each buffalo subpopulation or herd. Each buffalo subpopulation or herd requires a minimum size to avoid inbreeding and maintain genetic variation.

Buffalo Field Campaign is requesting Yellowstone National Park expand the range of alternatives, and actions common to all alternatives, for public consideration.

In developing a range of alternatives for people to consider, evaluate and disclose an alternative for:

- Managing wild buffalo like wild elk on public lands in Montana, i.e., subsistence hunting of sustainable populations.

- Making an expanse of habitat available for each genetically distinct subpopulation or buffalo herd to adapt and thrive over the long-term.

- Designating refuges to provide security from overhunting and permit dispersal across public lands.

In developing an environmentally preferred alternative, please review Buffalo Field Campaign's proposal detailing the four corners of a respectful wildlife management plan: https://www.buffalofieldcampaign.org/images/what-we-do/manage-wild-bison-like-wild-elk/Managing-wild-buffalo-like-wild-elk-in-Montana-Proposal.pdf.

In recognizing buffalo as a wild species and honoring their freedom to roam public lands, evaluate and disclose the benefits and costs of managing wild buffalo like wild elk in Montana, including:

- No trapping or capturing for slaughter.

- No commercial privatization or domestication via quarantine.

- No "hazing" unless there is an imminent threat to safety, e.g., buffalo on a blind-curve highway.

- No exclusionary management zones or boundary lines preventing natural migrations to range and habitat.

- No vaccinating.

- No permanent tagging, marking, or inserting microchips to identify individuals.

- No population control experiments, e.g., fertility or birth-control agents.

For actions common to all alternatives, and for each alternative, evaluate and disclose:

- Managing cattle in Designated Surveillance Areas in Montana, Idaho, and Wyoming as concurrent management actions.

- Costs and cost effectiveness of managing cattle in the States as concurrent management actions.

- How managing cattle, buffalo and elk biology, the biological role of predators and scavengers, and environmental conditions prevent disease risk and transfer.

- A fact-based quantitative risk management assessment for wild buffalo, elk, and cattle at local scales.

In managing wild elk in Designated Surveillance Areas in Montana, evaluate managing wild buffalo similarly by:

- Limiting actions to adjust buffalo distribution away from cattle ranches at local scales.

- Limiting actions to adjust buffalo distribution when a localized risk is greatest to cattle ranches.

For actions common to all alternatives, and for each alternative:

- Adapt a long-term minimum viable population size for each genetically distinct population or herd of Yellowstone buffalo.

Conservation biologists recommend a census of 2,000–3,000 for each individual herd to "avoid inbreeding depression and maintain genetic variation." (Hedrick 2009). "[B]oth the evolutionary and demographic constraints on populations require sizes to be at least 5000 adult individuals. . . minimum viable population size in many circumstances will be larger still." (Traill et al. 2010).

- Incorporate a safety-net halting lethal management actions if buffalo in the Northern or Central herds or both are below the conservation biology threshold.

- Incorporate a conservation biology action plan for increasing genetic diversity and protecting the integrity of each herd, and the Yellowstone buffalo population.

For actions common to all alternatives, and for each alternative, evaluate and disclose:

- Projected impacts of rapid climate change on buffalo and the ecosystem buffalo depend upon for survival. Include adaptability of buffalo (body mass or size, heat stress or thermoregulation, fitness, life history traits such as age of maturity, reproduction, and growth), availability and quality of forage, and access to water, across meaningful time scales, i.e., over the next century or longer.

For actions common to all alternatives, and for each alternative, evaluate and disclose how Yellowstone National Park will use the best available science for:

- Protecting the long-term viability and evolutionary potential of Yellowstone's wild buffalo.

- Protecting genetically distinct subpopulations or herds of buffalo in the wild.

- Retaining migratory behavior for each genetically distinct subpopulation or herd and the Yellowstone buffalo population.

- Making future "adaptive management" decisions.

For each alternative, evaluate and disclose:

- Impacts to genetically distinct subpopulations or herds, and the Yellowstone buffalo population.

- How management actions alter, adversely effect, or artificially select against wild traits and genetic diversity.

- How management actions alter, adversely effect, or artificially select against natural selection, natural disease resistance and immunity.

For actions common to all alternatives, and for each alternative, identify and evaluate:

- Measures for protecting and restoring migration corridors and connectivity to habitat for wild buffalo.

- Cattle grazing allotments suitable for closure, buy-out, or permanent retirement.

- Acquiring habitat to reduce local conflicts with cattle ranchers.

- Acquiring habitat to restore migration corridors and connectivity to habitat for wild buffalo.

For actions common to all alternatives, and for each alternative, evaluate and disclose:

- Ecological sustainability, the capacity of wild buffalo in providing for biological diversity, resilience of native species, and healthy grasslands in the Yellowstone ecosystem.

- Opportunities for developing wildlife safe passages and measures for increasing awareness of, and safety for, buffalo crossing highways in the region.

For actions common to all alternatives, and for each alternative, evaluate and disclose:

- Costs and cost effectiveness, and address accountability. The public should not have to guess where and how much public funds are being spent or what it costs for managing wild buffalo.

- Commit to annually disclosing total costs, and what, if any, outcomes were achieved or not, and why.

Does the actual incidence of brucellosis-induced abortion in the wild justify another Bison Management Plan?

Are the management actions Yellowstone National Park is proposing for bison necessary and justified by science and evidence?

- Address and answer both questions on the actual recorded incidence of a brucellosis infected abortion from a wild bison roaming the Yellowstone ecosystem, and the scientific basis for each management action.

Based on a review of the best available science, the evidence suggests any risk is local, temporal, and eliminated by biological and natural factors:

> Sixty-three samples (i.e., 14 fetuses, 21 tissues, and 28 swabs) from 47 different parturition events and one motor vehicle accident yielded only three positive cultures for *B. abortus*. Birthing females meticulously cleaned birth sites and typically left the site within two hours. The birth synchrony and cleaning behavior of bison females, combined with *Brucella* environmental persistence data from previous studies, indicates that the risk of brucellosis transmission from bison to cattle is minuscule after May.
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> . . .
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> The infrequency of observed abortions (*n* = 24), and the even rarer identification of *Brucella* from these abortions, supports claims that *Brucella*-induced abortions are rare events for Yellowstone bison (Meyer and Meagher, 1995; Dobson and Meagher, 1996). There have been seven documented, seropositive abortions in Yellowstone, including two from captive bison in 1917 (Mohler 1917), one in 1992 (Rhyan et al., 1994), and four during 1995-1999 (Rhyan et al., 2001). Only 2 of 25 samples collected from 15 termination events were culture positive for *B. abortus*. Ten stillborn calves have been submitted for culture testing and only one has been positive for *B. abortus*. Terminated pregnancies can occur for a multitude of reasons in bison (Williams et al., 1997), and *B. abortus* appears to play less of a role in inducing abortions than previously thought. Parturition events indicating a loss of pregnancy were typically observed prior to the onset of the bison calving season.
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> . . .
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> Based on field observations presented in this report, the potential for brucellosis transmission from bison to cattle is minimal by June 1 and essentially non-existent by June 15. Thus, the current haze back date of May 15 (i.e., the date after which bison are not tolerated outside the park) may be unnecessary from a disease transmission risk perspective.

Jones et al. 2009 at 3, 6, and 7.

Evaluate and disclose how Designated Surveillance Area management of cattle, bison biology, scavengers, and environmental conditions reduce and prevent disease transmission to cattle in the bison's range.

• In Montana, cattle are being managed under a U.S. Dept. of Agriculture Animal and Plant Health Inspection Service approved and taxpayer supported plan that is providing cattle ranchers a net benefit of $9.50 to $14 per head, and an annual net benefit to cattle ranchers statewide of $5.5 to $11.5 million. Montana Dept. of Livestock 2011 at 3, 6.

The rules affect approximately 78,500 head of livestock comprising 5.2% of Montana's domestic cattle and bison herds. Bonser 2019 at 7.

• The Designated Surveillance Area rules allow "a risk-based approach that protects producers in an entire State from unnecessary regulation for what is, in fact, a local problem." U.S. Dept. of Agriculture 2012 at 5.

Indeed, the new rules have resulted in net benefits of $66,000,000 to $138,000,000 for ranchers in Montana without any modification to the State of Montana's and Yellowstone National Park's Bison Management Plan taking these new circumstances into account.

Yellowstone National Park needs to take these new rules and conditions into account in selecting actions common to all alternatives, and a final alternative.

• Whatever risk of disease transmission from bison to cattle exists, the scientific evidence indicates *brucella abortus* behaves differently in the bison population from other species like wild elk while bison's biological behavior, the presence of scavengers, and environmental conditions conspire to reduce and prevent the risk of disease transmission to cattle in the bison's range.

> To our knowledge, the probability of bacterial survival and risk for indirect transmission of brucellosis from bison to other susceptible hosts had not been evaluated prior to our study. Our combined model predicts that *Brucella* organisms are unlikely to survive after 11 June provided bison have been removed from grazing pastures by 15 May. . . . bacterial decay and scavenging interacted to rapidly eliminate infectious material from the natural environment.
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> . . .
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> Furthermore, our results demonstrate that preserving a complete component of natural scavengers in this environment will benefit disease management by rapidly removing *B. abortus* infected materials from the landscape.

Aune et al. 2012 at 260.

The National Academy of Sciences concludes the "[p]redation and scavenging by carnivores likely biologically decontaminates the environment of infectious *B. abortus* with an efficiency unachievable in any other way." Cheville et al. 1998 at 51.

• State and federal managers continue to neglect evaluating changing or updating policies to reflect the role natural predators fulfill in disease management in cleaning the environment of *brucella abortus*.

The failure of the State of Montana and the U.S. Dept. of Agriculture to change its policies to accommodate the natural role of predators in reducing and preventing disease transmission to cattle is far removed from the best available science.

- For over two decades Montana has restricted bison's access to habitat and harmed their migrations claiming the rules required management actions to prevent brucellosis transmission to cattle. Whatever risk is present can be effectively addressed by managing cattle. Doing so would provide assurance to cattle producers while permitting migratory bison to roam and adapt as a wild species in the State.

- The systematic targeting of bison for disease management actions displaces bison and the ecological benefits bison provide to sustain native species in the ecosystem. At the same time, evidence of management action's adverse effects is not being systematically collected and evaluated for publication.

Evaluate and disclose managing cattle in Designated Surveillance Areas in conjunction with each alternative and action common to all alternatives.

Avoid, minimize, and mitigate harm to bison by considering cattle are being managed in Designated Surveillance Areas in a manner protecting the State's brucellosis free status.

- Montana's Designated Surveillance Area brucellosis action plan was designed in response to new rules by the U.S. Dept. of Agriculture Animal & Plant Health Inspection Service in classifying States as free of brucellosis. U.S. Dept. of Agriculture 2012 entire.

- A legislative audit found the Montana Dept. of Livestock is not enforcing and cattle ranchers are not complying with Designated Surveillance Area rules. Montana Legislative Audit Division 2017 entire.

"A risk assessment conducted by a MDOL or a USDA APHIS employee on all herds in Area 1 [where brucellosis positive elk have been harvested] is required." Montana Dept. of Livestock 2008 at 1.

The Montana Dept. of Livestock is not following up on rancher noncompliance, is "not documenting herd management plan risk assessments," is not annually reviewing the 160 herd management plans in place (no documented risk assessments for 50 audited samples), and is not documenting its basis for providing variances or exemptions for ranchers from brucellosis testing requirements. Montana Legislative Audit Division 2017 at 17, 20, 19, 21.

Cattle ranchers are not complying with brucellosis testing requirements (107 cattle ranchers were noncompliant in 2015). Any ranch testing 5 percent or more of its eligible cattle for brucellosis is "in compliance" with the regulations. Montana Legislative Audit Division 2017 at 17, 16.

- Montana's lackadaisical enforcement and interest in complying with disease management in cattle has not led to a loss in the State's brucellosis status or led to sanctions by other States and countries.

Despite the lack of enforcement and noncompliance with Designated Surveillance Area rules — and in spite of several infections in cattle from wild elk — the State of Montana still retains its' brucellosis free status.

Despite the new rules being in place for over a decade, the State of Montana has not proposed any adaptive management change for bison reflecting these new circumstances.

Instead, State and federal managers continue to use a sledgehammer on bison across large landscapes when and where cattle are not present.

The idea of managing for a localized risk, if any exists, is a serious defect in manager's actions and plans for bison roaming the wild.

In the Designated Surveillance Area, Montana manages wild elk populations to prevent commingling with cattle. Evaluate and disclose how wild bison could be similarly managed.

> Traditional methods of disease control, such as vaccination, culling, and test and slaughter, are unlikely to be effective, politically feasible, or logistically possible to implement on wide-ranging elk populations (Bienen and Tabor 2006, Kilpatrick et al. 2009). Thus, the primary strategy for managing brucellosis transmission risk between elk and livestock is to prevent commingling. This may be achieved by hiring herders to disperse or redistribute elk, by holding dispersal hunts during the transmission risk period, by fencing or removing haystacks and other attractants, or by improving available forage on public lands (Bienen and Tabor 2006).

Rayl et al. 2019 at 825.

- Wild elk number 141,785 with self-sustaining populations distributed across more than 38,116,527 acres of land in Montana. Montana Fish, Wildlife & Parks 2021.

- In contrast with how the State manages wild bison, management actions "are focused on hazing, hunting, and other actions to disperse or redistribute elk" from March through May where the risk is greatest on private ranchlands. Rayl et al. 2019 at 827.

Management actions "are designed to adjust local elk distribution away from cattle at small geographic scales." Montana Fish, Wildlife & Parks October 2020 at 1.

- Evaluate and disclose the environmental and cost benefits of managing wild bison similar to wild elk.

Evaluate and disclose how Yellowstone National Park's trapping and quarantine management actions remove recovered and disease resistant bison from the wild population.

Avoid management actions that remove naturally recovered and disease resistant bison.

• Because data is not being systematically gathered for publication, the extent and rate of loss of disease resistant bison from management actions is unknown.

> Removing brucellosis-infected bison is expected to reduce the level of population infection, but *test and slaughter practices may instead be removing mainly recovered bison. Recovered animals could provide protection to the overall population through the effect of population immunity (resistance), thereby reducing the spread of disease*. Identifying recovered bison is difficult because serologic tests (i.e., blood tests) detect the presence of antibodies, indicating exposure, but cannot distinguish active from inactive infection.

Yellowstone National Park 2014 at 236–237 (emphasis added).

• In addition to managers not systematically gathering data on the extent and rate of loss in disease resistance among bison removed in management actions, there has also been no recent study of or scientific investigation into bison's natural resistance to disease organisms such as brucellosis.

> Meyer (1992) noted greater resistance of wild bison to *Brucella abortus*, causative agent of brucellosis, compared to resistance in domestic cattle. Seabury et al. (2005) detected evidence of a genetic basis for this resistance in Yellowstone bison. Either the resistance of bison to *Brucella* is a case of "preadaptation" or some resistance and accommodation evolved during about 10 generations of bison since first exposure of the Yellowstone herd.

Bailey 2013 at 149 (endnote 12).

• "There is already evidence of Yellowstone bison having resistance to *Brucella* infection." Bailey 2010 at 2 (citing Derr et al. 2002, Yellowstone National Park's Draft Environmental Impact Statement 2010 at 155, and Seabury et al. 2005).

Evaluate and disclose how Yellowstone National Park practices "adaptive management."

- In theory adaptive management is based on science. In practice, it is not.

State and federal manager's decisions lack "accountability and transparency, more often resembling trial and error or crisis management, rather than adaptive management." In a three tiered-step plan, managers lack "linkages" to get to the next steps, and have "lost opportunities to collect data" to resolve "important uncertainties" in the absence of a scientific and systematic monitoring plan. "Park Service, APHIS, and Montana Department of Livestock officials also told us that they are not testing any hypotheses or the assumptions on which the plan is based." Furthermore, managers "have no process to collectively review new scientific information . . ." These flaws have impaired manager's decisions who do not share defined and measureable objectives. "Meanwhile, the federal government continues to spend millions of dollars on uncoordinated management and research efforts, with no means to ensure that these efforts are focused on a common outcome that could help resolve the controversies." U.S. GAO 2008 at 24, 28, 33.

The flaws in "adaptive management" continue a decade after the Government Accountability Office issued its' report to the U.S. Congress, as State and federal managers "no longer build their meetings, interactions, and decisions around their AM [Annual Management] Plan; no longer measure their performance against the metrics put forth in their AM Plan (including no longer building their Annual Report on measuring their performance against metrics set forth in the AM Plan); no longer rigorously follow the Partner responsibility matrix declared under each Management Action described in the AM Plan (and also in the Partner Protocols); and no longer use adaptive changes to their AM Plan to drive changes in their Winter Ops Plan." Bischke 2017 at 1.

- National Park Service management policies require Yellowstone National Park to "use scientifically valid resource information obtained through consultation with technical experts, literature review, inventory, monitoring, or research to evaluate the identified need for population management." National Park Service 2006 at 44.

Yellowstone National Park continues to compromise its' duty to not impair wild bison in deference to the unreasonable and arbitrary regulatory scheme put in place by the State of Montana.

Yellowstone National Park's intensive management actions including trapping bison for slaughter, and the resulting loss of range and adverse biological and ecological impacts in the ecosystem, contradicts its' public trust duty to caretake bison "for the benefit and inspiration of the people of the United States" and in "common benefit of all the people of the United States." Ross 2013 at 68 (citing the General Authorities Act of 1970) at 69 (citing the 1978 "Redwoods Amendment" of the General Authorities Act).

Time and again, State and federal managers have ignored briefings by scientists and biologists, and failed to incorporate vital and important information necessary for informed decision-making. For example, the State of Montana and Yellowstone National Park continue to impose "haze-back" deadlines and harass bison on spring calving grounds when no cattle are present and any risk is eliminated by scavengers and environmental conditions.

> Evidence from these studies indicates that after May 15 (bison haze-back date in the IBMP), natural environmental conditions and scavenging conspire to rapidly kill or remove brucella from the environment.

Aune et al. 2010 at 25.

> Brucellosis transmission risk from bison to cattle is extremely low after June 1 and negligible by June 15 because (1) parturition is essentially completed for the year, (2) parturition events rarely occur in areas that will later be occupied by cattle, (3) cattle are generally not released on summer ranges until after mid-June, (4) females meticulously consume birthing tissues, (5) ultraviolet light and heat degrade *Brucella* on tissues, vegetation, and soil, (6) scavengers remove fetuses and remaining birth tissues, and (7) management maintains separation between bison and cattle (Aune et al. 2007, Jones et al. 2009).
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> Allowing bison to remain on essential winter ranges outside Yellowstone National Park until late-May or early June, when they typically begin migrating back into the park to high-elevation summer ranges, is unlikely to significantly increase the risk of brucellosis transmission from bison to cattle.

Yellowstone National Park 2009.

> Allowing bison to occupy public lands outside the Park through their calving season will help conserve bison migratory behavior and reduce stress on pregnant females and their newborn calves, while still minimizing the risk of brucellosis transmission to cattle.

Jones et al. 2010 at 333.

- Whatever quantifiable risk exists is localized, "predominantly low," "zero under all scenarios," and can be addressed by managing cattle at a significantly reduced cost to the American people while recovering bison in the wild. Kilpatrick et al. 2009 at 1, 8.

- Published in 2012, a belated risk assessment of brucellosis transmission among bison, elk, and cattle in the northern range of the Yellowstone ecosystem found the exposure risk from bison to cattle was miniscule 0.0–0.3% compared to elk to cattle 99.7–100% of the total risk. Yellowstone Center for Resources 2012 at 40.

Clearly, adaptive management is a fig leaf to hide how "[t]he current power structure has led to cattle being protected at the expense of bison." Lancaster 2005 at 427.

Yellowstone National Park's range of alternatives and actions common to all alternatives are inadequate and fall far short of what is required for persistence of bison in the wild.

Evaluate and disclose how each alternative impacts bison's ability to function and persist as a wild population.

• American bison are "Near Threatened" with few populations functioning as wild in North America. Aune, Jørgensen & Gates 2018 at 1.

In the 48 conterminous States, bison in the wild are regionally extinct in 40 States including Idaho and Montana, and possibly extinct in Texas. Aune, Jørgensen & Gates 2018 at 2–3.

> Plains bison are currently not recognized at the subspecific level on any international or national list for species at risk. This survey reveals trends in plains bison status demonstrating that plains bison warrant consideration for a listing. . . . there are few plains bison populations within original range that exist under natural conditions, and none that are considered viable by the current benchmark. Conservation issues related to genetic diversity, hybridization with domestic cattle, and domestication also support consideration of plains bison for listing.

Boyd 2003 at 93.

• More than a century ago, one member of Congress concluded national legislation was required "because bison are migratory animals, moving from state to state and through the territories so that no one state could regulate for their protection." Peterson 1999 at 77 (footnote omitted).

More than a century later, in passing the National Bison Legacy Act in 2016 recognizing American bison as our country's National Mammal, the U.S. Congress specifically ruled out relying upon it to protect bison at all:

> Nothing in this Act or the adoption of the North American bison as the national mammal of the United States shall be construed or used as a reason to alter, change, modify, or otherwise affect any plan, policy, management decision, regulation, or other action by the Federal Government.

Public Law 114–152, 130 Stat. 373, (36 U.S.C. note prep. 301) Sec. 3(b) Rule of Construction.

Evaluate and disclose how each alternative and action common to all alternatives diminish or retain characteristics of "wild" bison.

• According to the free dictionary, the definition of wild means "occurring, growing, or living in a natural state; not domesticated, cultivated, or tamed." *The Free Dictionary* (Farlex, Inc. 2022).

• The International Union for Conservation of Nature's Red List Process key and criteria for classifying bison populations functioning as wild considers:

> • the physical environment in which bison exist, including the range area within which a wild population "roams and is sustained by range resources without human-imposed spatial limits on movements,"

- that can sustain a functioning wild population exceeding 1,000 bison "in the range area without nutritional supplementation," and
- has "unrestricted access to resources within the entire range area."

Aune, Jørgensen, & Gates 2018 Supplemental Material.

The range area includes a significant caveat and "excludes locations where population distributional limits are imposed for management purposes" outside the range area.

In addition to physical environment and range resources, the International Union for Conservation of Nature's criteria also consider "species patterns, (e.g. genetics, demography), reproductive and natural selections processes (e.g. mating system, resource competition, resource selection, predation), and social factors that may influence the persistence of a wild population (e.g. laws, policies, societal support)." Aune, Jørgensen, & Gates 2018 Supplemental Material Table 1.

The International Union for Conservation of Nature's definition of a wild bison population includes the "patterns of adaptation and geographic variation arising from species formational processes and occurs in locations where ecological and socio-ecological conditions support reproductive and natural selection and continued evolution of the species in the long term (centuries)." Aune, Jørgensen, & Gates 2018 Supplemental Material Definitions.

In the United States only four bison populations are classified as functioning as wild: Yellowstone, Jackson-Grand Teton, Crow Tribe, and UTE Tribal–Book Cliffs. Aune, Jørgensen, & Gates 2018 Supplemental Material Table 2.

Of those four, only two bison populations meet the large population criteria > 1,000 bison: Yellowstone and Crow Tribe.

As a result of few wild populations, the subspecies is Vulnerable and "considered to be facing a high risk of extinction in the wild." Aune, Jørgensen, & Gates 2018 at 1; International Union for Conservation of Nature 2012 at 15, 20–22.

Evaluate and disclose the regulatory framework and actors driving the bison management plan.

Explain to the public the interest each agency of government has in conserving or removing wild bison, and in providing or restricting habitat in the ecosystem they depend on for survival.

• State and federal managers continue to use their regulatory powers in prejudicial, arbitrary, and unreasonable management actions directed at removing bison in their habitat and range.

• State codes in Montana, Idaho, and Wyoming call for the removal and eradication of low numbers of migratory bison.

• The U.S. Dept. of Agriculture Animal & Plant Health Inspection Service maintains a cooperative funding agreement permitting and enabling the Montana Dept. of Livestock to enforce removing wild bison pursuant to Mont. Code Ann. § 81-2-120. Millions of dollars have flowed from American taxpayers to Montana Dept. of Livestock coffers to kill bison and remove them from the wild. The on-going grant appropriation is approximately $600,000 annually. Buffalo Field Campaign, *Funding Sources for Montana Dept. of Livestock Bison Operations* (2000-2016).

This self-serving relationship deserves scrutiny and disclosure in your analysis because the federal to State funding pipeline fuels the Dept. of Livestock's enforcement of Montana's code and cements the cattle industry's intolerant plans for removing migratory bison and preventing a wild, self-sustaining population in Montana.

Clearly, the Montana Dept. of Livestock "and allied veterinarians hold predominant power over bison management in the state of Montana." Cromley 2002 at 88.

• Wild bison are a "species of concern" in Montana primarily under the jurisdiction of the Dept. of Livestock. Under Montana law, wild bison are managed for removal.

In Montana, the migratory species is listed as a "species of concern" and "considered to be 'at risk' due to declining population trends, threats to their habitat, and/or restricted distribution" and "vulnerable to global extinction or extirpation in the state."

> [The Montana Department of Livestock] is granted broad and discretionary authority to regulate publicly-owned bison that enter Montana from a herd that is infected with a dangerous disease (YNP bison) or whenever those bison jeopardize Montana's compliance with state or federally administered livestock disease control programs including the authority to remove, destroy, take, capture, and hunt the bison (§ 81-2-120(1)-(4) MCA)).

Montana Fish, Wildlife & Parks and Montana Dept. of Livestock 2013 at 13.

> Montana could manage for *zero* genetic diversity of Yellowstone bison in the state.

Western Watersheds Project v. State of Montana, Case No. DV–10–317A, *Respondents' Reply Brief in Support of Motion for Summary Judgment* at 18 (Sept. 27, 2012) (emphasis in the original).

• Migratory bison are a critically imperiled species in the State of Idaho. Under Idaho law, migratory bison are eradicated.

"It is the purpose of the provisions of this section to provide for the management or eradication of bison . . ." Idaho Code § 25-618(1) (2021).

In migrating to Idaho, bison must traverse National Forest habitat in Region 4.

Acres of National Forest in Region 4: 31,885,607
Acres of National Forest on the Caribou-Targhee: 2,624,739

U.S. Forest Service 2015 Table 3.

Under Idaho law, state and federal officials shoot or eliminate any wild bison migrating from the Yellowstone population. Idaho Code § 25-618 (2021); Associated Press 2012; Montana Fish, Wildlife & Parks and Montana Dept. of Livestock 2013 at 39 ("the most recent occurrence being July 2012 when two bull bison made the 20 mile trek to Island Park" and were lethally removed).

• The State of Wyoming manages for the removal of low numbers of migratory bison in restricted areas. Wyoming law effectively reduces wild bison genetic diversity to zero.

Beyond Yellowstone National Park, bison migrating into Wyoming's jurisdiction are managed in restricted areas for removal. Wyoming Game & Fish Department 2008.

The State of Wyoming manages for the removal of migratory bison on National Forest habitat in Region 2.

Acres of National Forest in Region 2: 22,051,028
Acres of National Forest on the Shoshone: 2,439,093

U.S. Forest Service 2015 Table 3.

Regional Threatened and Endangered Sensitive Species Program Leader Nancy Warren recommended bison be listed as a sensitive species on the Shoshone National Forest. However, Shoshone National Forest, Forest Supervisor Joseph G. Alexander requested bison be removed from the proposed list, citing "[e]xisting state management plans may conflict with how the Shoshone would manage for species viability. Until further evaluation of this situation can occur, I respectfully ask for the species to be removed from the list."

State law calls for wild bison migrating onto the Shoshone National Forest in Wyoming to be shot by hunters or removed by state authorities. The low numbers Wyoming has set limit and reduce bison's exploratory movements and do not allow for female-led groups except in the Teton Wilderness.

Under State law, the migratory species falls under Wyoming Livestock Board authority who, by rule, can order Wyoming Game & Fish to remove bison. Wyo. Stat. Ann. § 23-1-302(a)(xxvii) (2020); Wyoming Game & Fish Department 2008 at 15.

- The Custer Gallatin has erected or permitted barriers to impede bison's natural migrations on the National Forest. These barriers disrupt habitat connectivity for bison the National Forest planning rule requires be maintained or restored.

- The Custer Gallatin permits more than 36,000 head of cattle to graze more than 1.1 million acres of the National Forest. Because managers do not tolerate bison where cattle graze the National Forest, the Custer Gallatin's grazing program is an ongoing detriment to migratory bison.

- In agreeing to the boundary line "beyond which bison will not be tolerated," the Custer Gallatin also enables the displacement and removal of migratory bison from substantial portions of National Forest range and habitat.

- Yellowstone National Park has trapped thousands of bison for slaughter at Stephens Creek since 1996, turning a protected area into an artificial population sink for our National Mammal.

Operating Yellowstone National Park as a slaughterhouse for bison is undermining the fundamental purposes of the park "to conserve the scenery and the natural and historic objects and the wild life therein." Ross 2013 at 68 (citing the 1916 Organic Act).

Compare and contrast the environmentally preferred alternative people overwhelmingly favored but managers rejected over two decades ago, with each alternative and action common to all alternatives.

Avoid harming wild bison by no longer managing them like cattle.

Avoid, minimize, and mitigate harming bison by permitting them freedom to roam public lands.

Avoid, minimize, and mitigate harming bison by acquiring habitat where a localized conflict exists.

- Management practices and actions managers choose to implement stand in contradiction to the broad public support locally, regionally, and nationally for protecting bison and their range and habitat in the wild.

Over two decades ago, people indicated "extremely strong support" for managing cattle and letting bison freely roam public lands in the ecosystem. Instead, managers chose a series of extreme and improper actions targeting bison when people overwhelming felt managing cattle was more appropriate.

Instead of getting behind people who supported bison using all public lands in the ecosystem, managers chose to turn Yellowstone National Park into a slaughterhouse and draw a boundary line on the National Forest "beyond which bison will not be tolerated."

> The environmentally preferred alternative is defined as the alternative(s) that best meets the criteria set out in Section 101 of the National Environmental Policy Act. The Council on Environmental Quality defines the environmentally preferred alternative as the alternative that ". . . causes the least damage to the biological and physical environment and best protects, preserves and enhances historic, cultural and natural resources."
>
> As a summary, the public was overwhelmingly in favor of more natural management of the bison herd, with minimal use of actions they felt more appropriate for livestock such as capture, test, slaughter, vaccinating, shooting, corralling, hazing, etc. They also indicated extremely strong support for the management and/or restriction of cattle rather than bison given a choice between the two. The public also supported the acquisition of additional land for bison winter range and/or the use of all public lands in the analysis area for a wild and free-roaming herd of bison. A large number of commenters also expressed opposition to lethal controls, and in particular the slaughter of bison.
>
> Alternative 2 would minimize human intervention, discontinue the use of capture, test and slaughter, focus on managing cattle rather than bison, and result in the largest area of acquired land for winter range. It also would offer the largest benefits to most environmental resources analyzed in the EIS [Environmental Impact Statement], with alternative 3 offering some benefits to many of these same resources as well. The management emphasis and environmental advantages of alternative 2 are most consistent with the overwhelming majority of public

> comment. In addition, the benefits to environmental resources as analyzed in the FEIS [Final Environmental Impact Statement] as well as those analysis of Section 101 criteria indicate alternative 2 as environmentally preferred. Based on this combination of public commentary, FEIS analysis, and adherence to the principles of Section 101 of the National Environmental Policy Act, alternative 2 is identified as the environmentally preferred alternative.

U.S. Dept. of the Interior & U.S. Dept. of Agriculture Record of Decision 2000 at 21.

The environmentally preferred alternative overwhelming favored by the public in 2000, "involves the purchase of large quantities of land outside the park to provide winter range for many bison, thus allowing the population to increase." Angliss 2003 at 44.

Acquiring winter range outside Yellowstone National Park for bison to roam would "conservatively" net "measurable benefits" of over $4 million dollars. U.S. Dept. of the Interior & U.S. Dept. of Agriculture FEIS Vol. 1 2000 at xxxix-xl.

It is far past time for Yellowstone National Park leadership to start heeding the will of the people in how bison are managed in Yellowstone.

Yellowstone National Park's alternatives must strive to fulfill the U.S. Congress's purpose to remedy man's profound impacts and influences on the natural environment and "to use all practicable means and measures . . . to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans." 42 U.S.C. § 4331(a).

Likewise, Yellowstone National Park's alternatives and actions common to all alternatives must "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;" and "attain the widest range of beneficial uses of the environment without degradation . . . or other undesirable and unintended consequences;" in order to "preserve important historic, cultural, and natural aspects of our national heritage" including wild, migratory bison. 42 U.S.C. § 4331(b)(1),(3),(4).

Yellowstone National Park's alternatives and actions common to all alternatives should follow the public's lead as expressed over two decades ago.

Please provide a meaningful analysis of the public's overwhelming support for wild bison freely roaming public lands by proposing an environmentally preferable alternative that matches the public's will, e.g., evaluating a No Plan alternative.

> *Environmentally preferable alternative* is the alternative required by 40 CFR 1505.2(b) to be identified in a record of decision (ROD), that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources. The environmentally preferable alternative is identified upon consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources.

43 CFR § 46.30, Definitions.

For each alternative and action common to all alternatives, evaluate, disclose, and adapt a conservation biology based threshold for each subpopulation or herd and the Yellowstone buffalo population.

Avoid harming bison by favoring actions that maximize bison genetic diversity.

- The best available science provides strong evidence of subpopulation structure and unique lineages in the Yellowstone bison population. However, managers do not recognize Halbert's findings — a finding that has not been refuted by peer-reviewed data — and management practices have not changed to consider subpopulation distinction in the decade following Halbert's publication.

State and federal managers are jeopardizing subpopulation distinction because they refuse to accept the best available science and adapt conservation biology based thresholds for protecting genetic diversity in each unique and distinct herd.

- "Individual herds or clusters should have an effective population size of 1,000 (census number of 2,000–3,000) to avoid inbreeding depression and maintain genetic variation." Hedrick 2009 at 419.

Based on Halbert's (2012) evidence of subpopulation division in Yellowstone bison, an effective population size of 1,000 for each cluster or herd would require a census of 2,000–3,000 for each genetically distinct subpopulation or herd.

- On genetic grounds alone, an effective population size of 5000 adults or more is needed for long-term viability of bison to adapt and persist in an environment subject to rapid climate change.

> [T]o maintain normal adaptive potential in quantitative characters under a balance between mutation and random genetic drift (or among mutation, drift, and stabilizing natural selection), the effective population size should be about 5000 rather than 500 (the Franklin-Soule number). Recent theoretical results suggest that the risk of extinction due to the fixation of mildly detrimental mutations may be comparable in importance to environmental stochasticity and could substantially decrease the long-term viability of populations with effective sizes as large as a few thousand. These findings suggest that current recovery goals for many threatened and endangered species are inadequate to ensure long-term population viability.
>
> . . .
>
> Excluding recessive lethal mutations, and whether or not we include stabilizing selection, it therefore appears that the effective population size necessary to maintain a high proportion of the potentially adaptive, additive genetic variance that would occur in a large population requires effective population sizes an order of magnitude larger than the original Franklin-Soule number, increasing the management goal from *Ne* = 500 to *Ne* = 5000.

Lande 1995 at 782, 786.

> Of course, *Ne* = 5000 should not be regarded as a magic number sufficient to ensure the viability of all species, because of differences among characters and among species in genetic mutability and differences in environmental fluctuations and

> selective pressures to which populations are exposed. Maintenance of potentially adaptive genetic variation in single-locus traits (such as major disease resistance factors), which have mutation rates on the order of 10^{-6} per allele per generation, may require much larger effective population sizes, on the order of 10^4 or 10^5 (Lande & Barrowclough 1987; Lande 1988).
>
> . . .
>
> The above results cast doubt on whether populations of many threatened and endangered species will maintain adequate evolutionary potential and long-term genetic viability unless they recover to much large sizes. Effective population sizes generally are substantially lower than actual population sizes because of fluctuations in population size, high variance in reproductive success, and unequal sex ratios (Wright 1969; Crow & Kimura 1970; Lande & Barrowclough 1987); maintaining effective population sizes of several thousand in the wild therefore will usually require average actual population sizes on the order of 10^4 or more. Synergistic interactions among different genetic and demographic factors contributing to the risk of population extinction (Gilpin & Soule 1986) are likely to cause the minimum population sizes for long-term viability of many wild species to be much larger than 10^4.

Lande 1995 at 789.

- Lande's results and Hedrick's recommendations are consistent with Traill's study of population viability who found "both the evolutionary and demographic constraints on populations require sizes to be at least 5000 adult individuals." Traill et al. 2010 at 30 (comparing minimum viable populations rates of hundreds of species while noting "similarities are not strictly equivalent, and are a result of evaluation of some non-overlapping factors, meaning minimum viable population size in many circumstances will be larger still.").

"Conservation biologists routinely underestimate or ignore the number of animals or plants required to prevent extinction," according to Dr. Lochran Traill, from the University of Adelaide's Environment Institute. "Often, they aim to maintain tens or hundreds of individuals, when thousands are actually needed. Our review found that populations smaller than about 5000 had unacceptably high extinction rates. This suggests that many targets for conservation recovery are simply too small to do much good in the long run." University of Adelaide 2009.

For each alternative, evaluate and disclose the risk of extinction for bison roaming the wild over the next 100, 200, or 500 years.

Avoid choosing management actions that increase the risk of extinction for bison freely roaming the wild.

Avoid long-term risk by securing provisions for large expanses of habitat on public lands for bison to freely roam year-round, and designating refuges secure from human stressors and for recovering from environmental stressors such as chronic drought, fire, severe winters, and ice crusting events.

- In assessing the factors that threaten bison in the wild with extinction, the historical factors of population bottleneck (from millions to < 1,000), few founders (< 100), and present population isolation (> 120 years) must be evaluated in relationship to proposed management actions.

Evaluate the consequences of management actions selecting against brucellosis (bison's natural or acquired immunity and disease resistance), nonrandom, differential government slaughter of subpopulations, skewing sex ratios, altering age structures, and removing entire lineages in disease management actions that have been ongoing for decades.

- Avoiding inbreeding, preventing the erosion of fitness, and preserving bison's evolutionary adaptive potential and genetic variance are at risk under management practices.

Evaluate the consequences of management actions confining and restricting bison's natural migrations, disrupting connectivity to habitat and reducing bison's ability to respond to stresses (natural and human made), and driving the "target" population down without regard for genetically distinct subpopulations and unique lineages.

> Many scientists have cautioned that low genetic variability, to the extent that it appears, would limit the potential of bison for future evolutionary change (Lacy 1987; Lewin et al. 1993).
>
> . . .
>
> Isolating bison on small landscapes, where gene flow between isolated groups can occur only through artificial migration and human intervention, further erodes genetic diversity (Berger and Cunningham 1994). Bottlenecks and chance events not only lower genetic variability but also limit the evolutionary potential of bison to adapt to changing conditions because natural selection is inhibited by the loss of rare alleles (Berger and Cunningham 1994).

McDonald 2001 at 108, 109.

> Extinction is fundamentally a demographic process, influenced by genetic and environmental factors. If a population becomes extinct for demographic reasons, such as habitat destruction, the amount of genetic variation it has is irrelevant. . . . For wild populations in natural or semi-natural environments, demography is likely to be of more immediate importance than genetics in determining population viability.

Lande 1988 at 1457 (endnotes omitted).

> *Edge effects*. Of course, if an area with fixed boundaries has been established as a natural preserve containing suitable habitat for some species, long-term climatic trends may induce major evolutionary changes in the population, or render the entire preserve unsuitable. This problem is compounded for species that undergo long-distance seasonal migrations and require two or more widely separated patches of suitable habitat.
>
> *Local extinction and colonization*. Many species exist in subdivided populations for social reasons or because suitable habitat has a patchy spatial distribution. Fluctuating environments may make some habitat patches temporarily unsuitable, so that a widely distributed population persists through a balance between local extinction and colonization. . . Critical factors affecting the persistence of a subdivided population include the number, size, and spatial distribution of patches of suitable habitat and dispersal rates between them.
>
> . . .
>
> Increasing either the number of territories a dispersing individual can search, or the expected number of off-spring produced, increases both the demographic potential of the population and the equilibrium occupancy of suitable habitat.
>
> . . .
>
> This model demonstrates two important features of populations maintained by local extinction and colonization. First, as the amount of suitable habitat (randomly or evenly distributed) in a region decreases, so does the proportion of the suitable habitat that is occupied. Second, there is an extinction threshold, or minimum proportion of suitable habitat in a region necessary for a population to persist. If the proportion of suitable habitat falls below 1 — *k*, the population will become extinct. Extensions of this model show that an Allee effect caused by difficulty in finding a mate, an edge effect due to the finite extent of the region containing suitable habitat, or a fluctuating environment all increase the extinction threshold.

Lande 1988 at 1458 (endnotes omitted).

> Of course, Ne = 5000 should not be regarded as a magic number sufficient to ensure the viability of all species, because of differences among characters and among species in genetic mutability and differences in environmental fluctuations and selective pressures to which populations are exposed. Maintenance of potentially adaptive genetic variation in single-locus traits (such as major disease resistance factors), which have mutation rates on the order of 10^{-6} per allele per generation, may require much larger effective population sizes, on the order of 10^4 or 10^5 (Lande & Barrowclough 1987; Lande 1988).

Lande 1995 at 789.

The No Action alternative is not viable because the underlying analysis is flawed, outdated, and not supported by the best available science.

Consider evaluating a No Plan alternative as an environmentally preferred baseline to compare and contrast the impacts and effects of each alternative and action common to all alternatives.

• The State of Montana's and Yellowstone National Park's Bison Management Plan is a flawed plan operating on an outdated Environmental Impact Statement: the 15-year life of the plan analysis ran its' course in 2015. The 15-year life of the plan analysis could not and did not foresee impacts to the bison population and the ecosystem beyond this timeframe. *See* e.g., U.S. Dept. of the Interior & U.S. Dept. of Agriculture FEIS Vol. 1 2000 (enter "life of the plan" into Adobe Reader's find feature).

• Furthermore, State and federal managers have avoided undertaking an independent science-based review of the assumptions driving its' outdated regulatory plan.

• In the vast Yellowstone ecosystem, managing cattle remains the most effective and least costly disease management approach. In managing cattle, numerous proposed management actions and the resulting adverse effects and impacts to wild bison can be avoided.

> [E]stablishing a local brucellosis infection status zone for cattle in the greater Yellowstone area of Montana and testing all cattle within this area for brucellosis (with a 'split status' for the rest of Montana), has been discussed earlier (USDOI & USDA 2000a). Our results highlight the benefits of this strategy and suggest that transmission of brucellosis from bison to cattle even under a 'no plan' (no management of bison) strategy is likely to be a relatively rare event, and the costs of yearly testing of cattle ($2500 to $5000 a year per test for the cattle in areas shown in Fig. 1) are a thousand-fold lower than the current management plan.

Kilpatrick et al. 2009 at 8, *see also* Table 1 at 4.

• State and federal managers continue to operate under faulty assumptions and outdated information, in contravention of the National Park Service's mandate to "use the best available scientific and technical information and scholarly analysis" and "actively seekout and consult" the public and Indigenous tribes in all decisions made. National Park Service 2006 at 22, 24–25.

• The premise bison are a disease risk to managed cattle in the Yellowstone region — the entire basis for a decades-long series of extensive and harmful management actions — was never quantified by any regulatory agency or addressed in three volumes of government analysis over two decades ago.

A belated quantitative risk assessment published in 2012 found the exposure risk from wild bison to cattle was miniscule 0.0–0.3% compared to wild elk to cattle 99.7–100% of the total risk. Yellowstone Center for Resources 2012 at 40.

• Clearly, evaluating a No Plan alternative for bison is merited, with widespread and long lasting environmental benefits, reduced costs, and advantages in cost effectiveness without the adverse consequences and harmful actions managers have inflicted on bison for decades.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects to bison's long-distance migrations, corridor use, connectivity to habitats, diversity, and resiliency.

- Migration is an essential life-history strategy for wild bison allowing for adaptation in a rapidly changing environment and evolutionary resilience in a climate that is being disrupted on a global scale.

- Genetic diversity has always been significant in Yellowstone bison. What is unknown is the extent and rate of loss in bison genetic diversity under current and proposed management practices. "Genetic connectivity" between herds may or may not be increasing as a result of management practices. Nonetheless, there needs to be an evaluation of impacts to bison's distinct subpopulation structure and loss of genetic diversity as a result of management actions.

- The Central bison herd was decimated under the current management plan (Yellowstone National Park's "No Action" alternative), and their numbers continue to be far below what is needed (census of 2000–3000) to prevent inbreeding and maintain genetic diversity.

The Park's census counted 3,533 bison in the Central herd in 2005, 847 bison in 2017, and 1,299–1,564 bison in 2021. Geremia 2021 at 7–8.

- While National Forest habitat could support additional bison, it is not "readily available" because the Forest Service has precluded availability by continuing to permit cattle grazing in the bison's range, and fencing schemes that thwart bison's natural migrations and connectivity to National Forest habitat.

Unless the Custer Gallatin withdraws the agency's special use permits, these barriers to landscape connectivity in wildlife corridors will have long-term and adverse impacts on bison viability, access to their range and habitat on the National Forest, and associated loss of biological diversity bison provide the ecosystem.

- Through its' voluntary participation in the State of Montana's and Yellowstone National Park's Bison Management Plan, the Custer Gallatin has also signed onto arbitrarily defined State "tolerance" zones that do not tolerate bison naturally migrating into Zone 3 on the National Forest.

> *[T]he presence, abundance and distribution of wild bison on the Custer Gallatin National Forest is coordinated with the state of Montana through the identification of, and management emphasis on, bison tolerance zones. The plan calls for deference to bison management within these zones (FW-GDL-WLBI 01).*

Custer Gallatin July 2020 at 41 (emphasis added).

The Forest Service and Yellowstone National Park must "stop the practice of reflexively acquiescing to state claims of wildlife authority" (Nie et al. 2017 at 905) and follow your duty to provide for diversity and viability of native species including bison.

- It is unknown how much National Forest habitat bison are excluded from in Zone 3. The ecological impact of Zone 3 on bison migration corridors and habitat connectivity is also unknown because evidence is not being systematically gathered or evaluated for publication. The effects and impacts of excluding bison from National Forest habitat need to be publicly evaluated and disclosed.

• The lack of enforceable mechanisms to ensure bison persist is preventing the native species from occupying four out of five landscapes on the Custer Gallatin. At the same time, the National Forest's cattle grazing program and permitting activities are degrading habitat and depleting bison in the remaining landscape on the Custer Gallatin.

There is no stability or self-sustaining population if migratory bison are reduced to one landscape and managed for removal within that landscape on the Custer Gallatin.

• There are no standards for bison in the Custer Gallatin National Forest's Land Management Plan. Custer Gallatin 2022 at 57–58. In Region 1, the Regional Forester also rejected evidence bison met the substantial concern criteria for listing as a Species of Conservation Concern. Custer Gallatin Nov. 2020 at 1–6.

> Defendants deny that the Forest Service is required by applicable law to provide or maintain a viable population of bison on the GNF [Gallatin National Forest] or determine what a minimum viable population would be.

Western Watersheds Project v. Salazar, Case No. 9:09–cv–00159–DWM, Defendants' Answer to Complaint at 30–31 (Feb. 18, 2010) (similar statements of regulatory commitment are made at 29, 33, and 34).

> Neither NFMA [National Forest Management Act] nor the Forest Plan require the Forest Service to ensure a viable population of bison on the Gallatin.

Western Watersheds Project v. Salazar, Case No. 11–35135, Federal Defendants–Appellees' Response Brief at 15 (Feb. 3, 2012).

• The Custer Gallatin's desired conditions, goals, and objective for bison is undermined by the agency's guidelines which acquiescence to stopping bison's natural migrations on the National Forest in exclusionary boundary and zone management schemes.

> 01 To promote bison expansion *within management zones*, management actions taken to resolve bison-livestock conflicts should favor bison within these zones.
>
> 02 To facilitate progressive expansion of bison management zones over time, bison habitat improvement projects should be strategically placed within and near *existing management zone boundaries*.
>
> 03 To facilitate bison expansion into unoccupied, suitable habitat in the area that coincides with the grizzly bear primary conservation area, *management actions should not create a barrier to bison movement unless needed to achieve interagency targets for bison population size and distribution.*

Custer Gallatin 2022 at 57, 58 (emphasis added).

It is unclear how the Custer Gallatin would resolve bison-cattle conflicts within the zone management scheme in favor of bison, when the agency knows managers impose spacial and temporal requirements removing bison if cattle are present on the National Forest.

The only de facto standard in the Custer Gallatin's land management plan incorporates the State's intolerant zone management scheme excluding migratory bison from substantial portions of their National Forest range and habitat.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects of managers confining bison's migratory range and limiting access to habitat.

Evaluate and disclose the additive, synergistic, and cumulative impacts of management actions confining bison's range and limiting access to habitat, and the long-term consequences for the migratory species.

Avoid management actions that restrict bison's range and habitat, and exclude bison from public lands.

- Bison should have freedom to roam public lands.

- There is no valid justification for State and federal managers restricting the range and habitat for bison to naturally evolve and adapt.

- Intensive management actions, human intolerance and developments are adversely impacting bison's natural migrations to range and habitat.

- Bison migration is imperiled due to "land use change contributing to range restriction and depopulation." Aune, Jørgensen, & Gates 2018 at 6.

- A continuing decline in area, extent and/or quality of habitat is one factor contributing to bison's Near Threatened status. Aune, Jørgensen, & Gates 2018 at 15.

Reducing bison migrants through over-killing or removing range contributes to habitat loss, population declines, shortens the distances migrants can travel, can destroy mass migration, and drive migratory species to extinction.

> Mass migrations usually extend beyond protected areas, which are simply too small to contain them. Hence, agriculture and development outside of parks often threaten migrations (Campbell & Borner 1995, Kahurananga & Silkiluwasha 1997, Homewood et al. 2001). Lack of adequate protection within parks also poses problems (Newmark 1987).
>
> . . .
>
> Migrants' abilities to adapt to changing environmental conditions are likely exacerbated by other anthropogenic threats, such as habitat loss and fragmentation (Jetz et al. 2007).

Harris et al 2009 at 68.

- Wild bison are "entirely dependent upon conservation interventions," and without the anchor provided by large protected landscapes in National Parks, Refuges, and Sanctuaries, bison "would not likely survive and the future survival of American bison would be in serious jeopardy." Aune, Jørgensen, & Gates 2018 at 3.

- In Montana, the migratory species is listed as a "species of concern" and "considered to be 'at risk' due to declining population trends, threats to their habitat, and/or restricted distribution" and "at risk because of very limited and/or potentially declining population numbers, range, and/or habitat, making it vulnerable to global extinction or extirpation in the state." Adams & Dood 2011 at 32 (citations omitted).

Furthermore, Montana's Comprehensive Fish and Wildlife Conservation Strategy lists bison as Tier 1, a native species in "greatest conservation need. Montana Fish, Wildlife & Parks has a clear obligation to use its resources to implement conservation actions that provide direct benefit to these species, communities, and focus areas" (FWP, 2005, pp. 32)." Adams & Dood 2011 at 32.

According to the Montana Natural Heritage Program, only 1% of bison's breeding range in Montana remains to perpetuate self-sustaining populations of the migratory species in the wild. Montana Natural Heritage Program 2020 at 6.

- The Custer Gallatin National Forest has erected or permitted barriers impeding bison's natural migrations to National Forest habitat. These barriers disrupt habitat connectivity the National Forest System Land Management planning rule requires be maintained or restored. 77 Fed. Reg. 21162, 21265 (Apr. 9, 2012).

Connectivity is defined under the 2012 National Forest planning rule as the "ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the . . . daily and seasonal movements of animals within home ranges, the dispersal and genetic interchange between populations, and the long distance range shifts of species, such as in response to climate change" 36 C.F.R. § 219.19 (2012).

There are two primary requirements for habitat connectivity. The first is that suitable habitats are present for species of interest, and the second is that there are no barriers to movement (USDA 2006). Custer Gallatin Draft Terrestrial Wildlife Report 2016 at 11 (emphasis added).

> The fence installation will be more or less perpendicular to the river with the goal of preventing bison from moving further downstream.

Gallatin National Forest Decision Memo 2011 at 1 (approving 900 feet of jackleg fencing uphill from both sides of the Yellowstone River and associated gates and "cattle guards" on HWY 89 near Yankee Jim Canyon in Gardiner basin).

> The only identified effect to wildlife is to prevent bison from migrating further west, toward the Madison Valley, which is exactly the purpose of the fence.

Custer Gallatin National Forest Decision Memo 2016 at 3 (approving 30 feet of jackleg fencing, gate, and associated "Bison Cattle Guard" on HWY 287 in Hebgen basin).

> [T]he Holder is authorized to construct and maintain a bison corridor fence.

Gallatin National Forest Special Use Permit 2009 at 1 (approving 695 feet of electrified fencing, associated cattle guards, and gates in Gardiner Basin).

The Custer Gallatin's fencing schemes disrupt landscape linkages and habitat connectivity that is essential for maintaining bison diversity and viability as a self-sustaining population in the wild.

While not insurmountable — bison do climb mountains — the barriers are placed in corridors the migratory species favors to access habitat within their range.

• In contrast to how managers exclude migratory bison from their range and habitat, cattle are permitted to range far more National Forest habitat on the Custer Gallatin than native bison.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects of the continuing loss and fragmentation of bison range, habitat, and migration corridors.

• Bison should have freedom to roam public lands because the best available science points to continuing loss and fragmentation of bison range and habitat from expanding human developments, with bison migration corridors among the most heavily impacted habitats.

• Berger studied the imperiled, biological phenomena of long-distance migration and conservatively found all 14 migration routes or corridors have been lost for bison in the Greater Yellowstone ecosystem. Berger 2004 at 322 (Table 1) (estimating lost routes based "on point counts of discrete winter and summer ranges.").

Among the causes that stand out for loss of major migration routes include "little tolerance for bison outside protected areas," and an increase in human population and "associated loss of habitat, especially areas crucial" to wintering ungulates. Berger 2004 at 324.

• "Habitat destruction in GYE [Greater Yellowstone Ecosystem] has occurred primarily in valley bottoms with more fertile soils as a consequence of agricultural and urban development (Gude 2006)." Hansen 2009 at 29.

• "Low elevation and non-forest habitats are at highest risk of human-induced habitat loss and fragmentation" across 30.2 million hectares of habitat in Montana and northern Idaho. Cushman et al. 2012 at 873.

• "[F]ragmentation due to land use reduces connectivity of habitats that is essential to species shifting range under change climate." Hansen 2009 at 34.

> We found that the measured biodiversity responses, including riparian habitat, elk winter range, migration corridors, and eight other land cover, habitat, and biodiversity indices, are likely to undergo substantial conversion (between 5% and 40%) to exurban development by 2020. Future habitat conversion to exurban development outside the region's nature reserves is likely to impact wildlife populations within the reserves. Existing growth management policies will provide minimal protection to biodiversity in this region.

Gude et al. 2007 at 1004.

• In the Greater Yellowstone ecosystem, human population is expected to double from 425,000 in 2010 to 725,000 in 2040 with the expansion of human homes in riparian habitat, valley bottoms, and migration corridors having "longer distance effects" and "fairly strong impacts on migration and spatial distribution of ungulates, including the time they spend in the park, in ways that strongly influence policy." Hansen 2010 at 39, 40, 41, 42. "It's an example of where land-use intensification, in this case 40–60 miles away from the park, could be affecting population viability within the park." Hansen 2010 at 42.

Evaluate the effects of these rapid and profound changes in the Yellowstone ecosystem which are likely to be additive (further reductions in habitat from management actions and intensification of human land use), synergistic ("greater than their additive effects due to interactions between them," e.g., loss of biodiversity from habitat fragmentation exacerbated by climate-change induced drought), and cumulative (past, present, and future effects). Hansen et al. 2014 at 498.

- It is unknown how sensitive or susceptible bison will be to these adverse effects and stressors, and the ecological processes bison are a part of, what the adaptive capacity for bison is, and the degree and scope of vulnerability the migratory species faces from changes in intensifying land use and corresponding fragmentation of habitats, rapid climate change, and the effects on the availability and nutritional quality of forage, and the role and expansion of invasive plants and nonnative species in the ecological degradation of the Yellowstone ecosystem, the life support system for bison.

Bison should have freedom to roam public lands because it advances ecological sustainability, native diversity, and persistence of the migratory species consistent with National Park Service policies and directives.

- According to the Committee of Scientists, the core elements of ecological sustainability depend on the diversity of plant and animal communities and the productive capacity of ecological systems. "Biological diversity and ecological productivity, in turn, depend on the viability of individual species. Diversity is sustained only when species persist." Committee of Scientists 1999 at 176.

"The Service recognizes that natural processes and species are evolving, and the Service will allow this evolution to continue—minimally influenced by human actions." National Park Service 2006 at 36.

The agency's policies and directives require "natural resources, processes, systems, and values" be preserved. National Park Service 2006 at 36**.**

General management concepts require the National Park Service "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems." National Park Service 2006 at 36.

- "Key principles for conserving migrants, exemplified by the SME [Serengeti-Mara Ecosystem] and Greater Yellowstone Ecosystem include . . . securing seasonal ranges, resource protection, government support and minimizing fences. This review forms a baseline for initiating conservation action for many ungulate migrations needing attention." Harris et al 2009 at 55.

> Conservationists worry about the persistence of migrations (Wilcove & Wikelski 2008). Some issues are ecological, as mass migrants have positive feedback effects on grassland forage and indirect effects on ecosystem processes (e.g. increasing grassland production and raising nitrogen mineralization) (Caughley 1976, McNaughton et al. 1988, Frank 1998), and therefore losing migrations may result in ecosystem collapse.

Harris et al 2009 at 56.

> Across the western United States, many ungulate herds must migrate seasonally to access resources and avoid harsh winter conditions. Because these migration paths cover vast landscapes (in other words migration distances up to 150 miles [241 kilometers]), they are increasingly threatened by roads, fencing, subdivisions, and other development.
>
> . . .
>
> Across the American West, many ungulate herds migrate to exploit key resources that shift seasonally across topographically diverse landscapes (Kauffman and others, 2018). Migration promotes abundant populations by enhancing foraging opportunities and reducing risk of exposure to adverse conditions (Bolger and others, 2008). Evidence of the importance of migration can be found throughout western landscapes as well as more broadly across the globe.

Kauffman et al. 2020 at 1.

Evaluate and disclose how management actions conserve or deplete migratory bison and transfer of migratory knowledge, contribute to or undermine ecological diversity and persistence of bison in the wild.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects of managing bison in enclosures.

Why are cattle permitted to range far more National Forest habitat than native migratory bison?

Evaluate and disclose how introducing cattle into bison range limits and reduces the native species' range due to exclusionary boundaries, delineated "tolerance" zones, and disease management actions.

- Empirical evidence demonstrates ungulates including bison "must learn where and when to migrate" from other bison, and seasonal migration is maintained "by passing cultural knowledge across generations." University of Wyoming 2018.

"These results indicate that ungulates accumulate knowledge of their landscapes over time, and cultural transmission of this knowledge is necessary for migrations to arise and persist," according to Brett R. Jesmer. Jesmer 2018 entire.

- "Over the last century, individuals in this population have learned to migrate up to 80 mi (97 km) (Geremia and others, 2019) and can now be considered the last truly migratory herd. The migratory movements of Yellowstone bison are also truncated, however. They are not allowed to move freely outside the park for concerns about human safety, disease transmission, conflicts with domestic livestock, and protection of property (National Park Service, 2020)." Kauffman et al. 2020 at 106.

- On the Custer Gallatin National Forest, cattle are permitted to graze 1,117,456 acres while managers confine the range of bison to 293,151 acres through a zone boundary or enclosure "beyond which bison will not be tolerated." Interagency Bison Management Plan 2022 at 2.

Most of the habitat managers limit and confine bison to is outside their current migration paths or high-elevation habitat, and not suitable for winter range or spring calving habitat.

- Private livestock graze over 103 million acres of National Forest habitat and 168 million acres of Bureau of Land Management habitat in the western United States. Over 50% of livestock grazed public lands are in "poor or fair condition." Carter et al. 2020 at 46 (endnotes omitted).

- "[N]o self-sustaining herds of wild plains bison exist on National Forest System lands." U.S. Forest Service Warren 2011.

Acres of National Forest: 192,922,127
Acres of National Forest in the Western Region: 145,184,376
Acres of National Forest in Region 1: 25,550,270
Acres of National Forest in Region 2: 22,051,028
Acres of National Forest in Region 4: 31,885,607
Acres of National Forest on the Custer Gallatin: 3,039,325
Acres of National Forest on the Shoshone: 2,439,093

Acres of National Forest on the Caribou-Targhee: 2,624,739
Acres of suitable bison habitat on the Custer Gallatin in Montana-defined "tolerance" zones: 293,151
Acres of suitable habitat bison are predicted to use on the Custer Gallatin in Montana-defined "tolerance" zones: 83,751

U.S. Forest Service 2015 Tables 1 & 3; Custer Gallatin Final Terrestrial Wildlife Report 2017 at 1, 134; Wallen 2012 (acres of habitat bison are predicted to use on the Custer Gallatin includes some private lands).

- One representative National Forest within the bison's range, the Custer Gallatin, is speckled with 36,000 head of cattle, with one-third of the forest's habitat allocated for grazing livestock, primarily cattle.

Acres of National Forest in Region 1: 25,550,270
Acres of National Forest on the Custer Gallatin: 3,039,325
Acres of primary range for grazing livestock: 666,233
Acres allotted for grazing livestock: 1,117,456
Percent of the Custer Gallatin allocated for grazing livestock: 36.7
Percent of the Pine Savanna forest allocated for grazing livestock: 93
Percent of the Montane forest allocated for grazing livestock: 22
Number of permitted grazing allotments: 216/199 active
Number of permitted cattle: 36,259
Number of permitted horses: 548
Number of permitted domestic bison: 400
Number of permitted Animal Unit Months: 202,187
An Animal Unit Month: 780 pounds dry weight forage for a 1,000-pound cow for one month
Cost per Animal Unit Month: $1.41
Miles of fencing on active livestock grazing allotments: 2,775
Number of dugouts, guzzlers, ponds, reservoirs, storage tanks, and troughs on active livestock grazing allotments: 1,849
Number of proper functioning riparian habitats within grazing allotments: 184
Number of functional-at-risk riparian habitats within grazing allotments: 70
Number of nonfunctional riparian habitats within grazing allotments: 7

U.S. Forest Service 2015 Table 3; Custer Gallatin Final Permitted Livestock Grazing Report 2017 at 42, 7, 1, 49, 15, 18, 20, 19; Custer Gallatin Grazing Allotments (Pine Savanna) Map (Feb. 16, 2017); Custer Gallatin Grazing Allotments (Montane) Map (Feb. 16, 2017); U.S. Dept. of the Interior, Bureau of Land Management 2018.

Managing bison for disease control is domesticating the wild species.

For each alternative and action common to all alternatives, evaluate and disclose how management actions domesticate bison.

Avoid adopting management actions that undermine wild bison and lead to domestication.

> With disease control, we are interfering with evolved and evolving mechanisms of resistance and accommodation between bison and their pathogens. We do not fully understand the implications of wildlife disease control; and we will not learn what they are unless we retain at least a few wild populations without disease control, as a basis for comparison.

Bailey 2013 at 145.

• The best available evidence indicates that for over a century, bison in the wild have not transmitted *Brucella abortus* to cattle introduced into the bison's range in the Yellowstone ecosystem. This century old fact has held true with or without a bison management plan and its' prior reincarnations covering various management regimes across several decades.

While managers claim their plan and actions have successfully prevented such an occurrence, bison in the wild have not transmitted any disease to cattle under various management practices — reintroduction of a captive herd, herding and roundups, ranching and hay-baiting, husbandry, preservation in a natural state, natural regulation, intensive culling, intrusive management, government hazing operations, trapping for slaughter, confinement in fenced paddocks — for over a century. Meagher 1973 at 29–32, 12; Geremia et al. Feb. 2011 at 1; White et al. 2011 at 1326 (Table 1), 1327 (Table 2), 1328 (Table 3).

• European cattle, the original source of the disease, passed brucellosis to wild elk and bison populations at least 5 times in the Yellowstone ecosystem. Kamath et al. 2016 at 1.

• As practiced, managing bison for disease control depletes bison diversity, and limits and restricts the natural range of the wild species in the ecosystem they depend upon for survival.

• Despite harmful and intrusive State and federal disease management activities directed against bison, brucellosis does not pose a threat to bison in the wild.

A recent study "found no relationship between pregnancy rates and serological status for brucellosis across a range of ages." Gogan et al. 2013 at 1276.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects of using veterinary and livestock management practices on wild bison.

Avoid using veterinary and livestock practices in managing wild bison.

• The evidence demonstrates State and federal disease management actions have "differentially affected breeding herds," altered sex and age structures, disproportionately removed female and calf cohorts, and increased seroprevalence in bison. Halbert et al. 2012 at 368; Halbert 2003 at 131, 146, 148–149, 151–152, and 156; White et al. 2011 at 1322, 1326 (proportion of adult females testing positive increased; calves were vaccinated), 1328 (large-scale disproportionate culls of females significantly reduced the Central herd; disproportionate culling of calf-mother pairs; perturbed male: female ratios with fewer males in the Northern herd and more males in the Central herd, 1330 (skewing sex ratios to more males than females reduces bull over-winter survival rates and increases aggression and mortality during the rut), 1331 (differential culling significantly reduced the Central herd's numbers and growth; nonrandom, large-scale culling "could have consequences that persist for multiple generations" in long-lived, age-structured bison subpopulations).

Adverse effects and impacts from disease management actions targeting bison and occurring over long time periods "may not be detectable for decades (e.g. genetic diversity) and, as a result, unintended consequences may occur." White et al. 2011 at 1331.

Now is the time to publicly evaluate and disclose what the unintended consequences of management actions portend for bison roaming the wild.

- Despite the increased risk of loss in natural variation, genetic diversity, and family lineages, managers carried out large-scale slaughters of bison (>1,000 bison from the total population) during the winters of 1997 (21%), 2006 (32%), and 2008 with >1,700 bison (37%) of the population taken from the wild. Geremia et al. Feb. 2011 at 7.

> *In 2008, IBMP managers decided to implement moderated culls in an attempt to avoid large annual fluctuations in the bison population, which occurred during the early IBMP period and could threaten long-term preservation of Yellowstone bison, cause societal conflict, and reduce hunting opportunities outside the park.*

Geremia et al. 2014 at 1 (emphasis in the original).

"Removing less than 25% of the population reduces the chances of altering population age and sex composition and reducing genetic diversity." Geremia 2020 at 3.

Despite the biologist's cautionary recommendation, recurrent, large-scale slaughters occurred again with >1,200 bison killed in 2016-2017 (23% of the total population) and >1,100 bison killed in 2017-2018 (24% of the total population). Geremia et al. Sept. 2018 at 1, 17.

- Despite warnings by park scientists and biologists, managers continue to undertake disease management actions that are significantly altering the demographic composition of Yellowstone's bison herds.

> Frequent large-scale, non-random culls could have unintended effects on the long-term conservation of bison, similar to demographic side effects detected in other ungulate populations around the world (Ginsberg and Milner-Gulland, 1994; Schaefer et al., 2001; Coulson et al., 2001; Raedeke et al., 2002; Nussey et al., 2006). For example, bison sent to slaughter from the west (n = 556) and north (n = 2650) boundaries during 2003–2008 were female-biased (1.8 females per male in 2003, 3.0 in 2004, 2.3 in 2005, 5.3 in 2006, and 1.2 in 2008) and likely contributed to changes in the gender ratio of bison greater than 1 year-old in the central herd from 1.7 ± 0.2 (standard deviation) females per male in 2003 to 0.9 ± 0.2 female per male in 2009 (Fig. 3).

White et al. 2011 at 1330.

"Males were overrepresented more so in the central herd with 149 males per 100 females (5-year average of 153:100) compared to 114 males per 100 females in the northern herd (5-year average 97:100)." Geremia 2020 at 4.

Large-scale government slaughters also "contributed to a substantial reduction in juvenile cohorts when captured bison were not tested for brucellosis exposure before being removed from the population." White et al. 2011 at 1330.

In addition, large-scale government slaughter of females "apparently reduced the productivity of the central herd, which decreased from between 0.71 and 0.75 ± 0.01 juvenile (calves and yearlings) per female greater than 2 years-old during 2004–2007 to 0.49 ± 0.10 in 2008 and 0.63 ± 0.01 in 2009." White et al. 2011 at 1331.

- The State of Montana's and Yellowstone National Park's intensive disease control actions threaten bison with domestication because the primary mechanisms for evolutionary adaptation and natural selection are eclipsed by a preponderance of human selection processes that continue to be exerted on the migratory species.

Intensive human selection for disease control has whip-sawed the size of bison subpopulations with the Northern herd fluctuating from 590 to 3,628 (2000–2015), while the Central herd was severely reduced to nearly one-third from 3,531 to 1,282 (2005–2015). Geremia et al. 2019 at 2.

- 2000 census of 2,060 bison in the Central herd, 553 bison in the Northern herd.
- 2005 census of 3,553 bison in the Central herd, 1,266 bison in the Northern herd
- 2010 census of 1,652 bison in the Central herd, 2,246 bison in the Northern herd.
- 2015 census of 1,323 bison in the Central herd, 3,628 bison in the Northern herd.
- 2020 census of 1,251 bison in the Central herd, 3,437 bison in the Northern herd.

Geremia 2020 at 7–8, Appendix B (highest census count is used).

The common factor accounting for the dramatic shifts in bison subpopulation size is Yellowstone National Park's and the State of Montana's disease management and population control actions.

- Intensive management practices and a preponderance of human selection pressures are in conflict with National Park Service management policies allowing for natural selection and evolutionary processes using the best available science.

"The Service recognizes that natural processes and species are evolving, and the Service will allow this evolution to continue—minimally influenced by human actions." National Park Service 2006 at 36.

The agency's policies and directives require "natural resources, processes, systems, and values" be preserved. National Park Service 2006 at 36.

General management concepts require the National Park Service "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems." National Park Service 2006 at 36.

Far less intrusive cattle management practices are available to the U.S. Dept. of Agriculture Animal and Plant Health Inspection Service and the States to manage specific and identifiable risks in the Designated Surveillance Areas of Montana, Idaho, and Wyoming.

- In 2012, Halbert and scientists discovered strong evidence of two genetically distinct and clearly defined subpopulations based on both genotypic diversity and allelic distributions (STRUCTURE analysis using 46 nuclear microsatellites).

In addition, scientists have found and noted other distinctions in the bison herds including different tooth wear patterns (Christianson et al. 2005 at 674), parturition timing and synchrony (Gogan et al. 2005 at 1716), longitudinal differences in migration patterns (Halbert 2012 et al. at 368), differential migration at the herd scale (Geremia et al. 2011 at 6), spatial separation (Olexa & Gogan 2007 at 1536) differences in plant communities, diet, and environmental conditions (Fuller et al. 2007 at 1925), fidelity to breeding territories and female philopatry to natal ranges (Gardipee 2007 at 10, 31–32), and strong substructure detected in mitochondrial DNA (Gardipee et al. 2008).

Halbert's finding corroborates earlier findings by Olexa and Gogan who identified 2 subpopulations: the Northern and Central bison herds, and Meagher's earlier findings of 3 subpopulations.

> We identified 2 groups, the northern and central herds, during winter. Minimal exchange of individuals occurred between these groups. The spatial distribution of cross-classified relocations showed that exchange during this period continued to occur almost entirely in the upper Pelican Creek and Mirror Plateau areas of YNP [Yellowstone National Park].
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> . . .
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> We found consistent agreement among fusion strategies in classifying radiomarked bison into 2 subpopulations with no cross-classification during the rut. Exchange was greatest during the winter management period, and was intermediate during the extended rut. These patterns indicate that bison exhibit high fidelity to a specific range during the rut and lower fidelity in winter. In addition to the spatial separation exhibited by Yellowstone bison, limited exchange of individuals may result in genetic or demographic disjunction. When we assume the rut occurs between 15 July and 15 September, distinct northern and central herds with no exchange are most pronounced. *Thus, these 2 groups may function as separate populations.*
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> . . .
>
> An analysis of the genetics of Yellowstone bison slaughtered as they left the park in the vicinity of Gardiner, Montana, or West Yellowstone, Montana, between the winters of 1996–1997 and 2001–2002 (P. J. P. Gogan, unpublished data) revealed a genotypic differentiation >75% between bison at the 2 locations (Halbert 2003). Such differences imply long-term separation during the rut.

Olexa & Gogan 2007 at 1536 (emphasis added).

"It is not clear at this point how the subpopulations may be changing over time or how the current bison management plan (US Department of Interior and US Department of Agriculture 2000) might influence the genetic integrity of the subpopulations." Halbert et al. 2012 at 368.

"[T]he identification of genetic subpopulations in this study raises serious concerns for the management and long-term conservation of Yellowstone bison." Halbert et al. 2012 at 368.

> In conclusion, we have presented strong evidence for the existence of 2 genetically distinct subpopulations of bison . . . Our study has also revealed longitudinal differences in migration patterns among Yellowstone bison, as it appears that bison moving to the park boundary in the vicinity of West Yellowstone are consistently from the Central subpopulation, whereas those moving to the park boundary in the vicinity of Gardiner may originate from either the Central or Northern subpopulation. *These observations warrant serious reconsideration of current management practices. The continued practice of culling bison without regard to possible subpopulation structure has the potentially negative long-term consequences of reducing genetic diversity and permanently changing the genetic constitution within subpopulations and across the Yellowstone metapopulation. Population subdivision is a critically important force for maintaining genetic diversity and yet has been assessed in only a handful of species to date. The identification of cryptic population subdivision of the magnitude identified in this study exemplifies the importance of genetic studies in the management of wildlife species*.

Halbert et al. 2012 at 368 (emphasis added).

White and Wallen's rebuttal contained no new data to refute Halbert's findings of distinct subpopulation structure in Yellowstone bison. Instead, Yellowstone National Park scientists say any distinction is a result "likely created or exacerbated by human actions." White & Wallen 2012 at 753.

In 2016, Forgacs and scientists assessed mitochondrial haplotypes and "did not detect geographic population subdivision. . . However, we identified two independent and historically important lineages in Yellowstone bison . . ." representing the descendants of the indigenous bison remaining in the Central herd, and the reintroduced bison in the Northern herd. Forgacs et al. 2016 at 1.

The objective of Forgacs's research was to determine if Yellowstone bison carried an hypothesized, detrimental mitochondrial DNA. Significantly, Forgacs's analysis found ten unique haplotypes from 25 Yellowstone bison sampled representing "nearly half—10 of 22 modern plains bison haplotypes—of all the known haplotypes in plains bison . . ." Forgacs et al. 2016 at 6.

"Before new management standards and policies are defined for the Yellowstone bison population, additional studies involving population structure and genetic diversity based on both mtDNA and nuclear genetic diversity assessments need to be conducted." Forgacs 2016 et al. at 7.

No such studies have appeared in publication.

Based on the limited information Yellowstone National Park provided the public for developing scoping comments, managers still do not recognize Halbert's findings and we are unaware of any studies that would shed light on the population structure and genetic diversity of Yellowstone bison.

- Managing bison for disease control and domestication is a decades old threat that continues to operate as a threat because strict application of the rules driving the bison management plan destroys the migrants, depletes bison range and habitat, and nutritionally restricts the native species' access to food and water.

An attempt to trap bison for slaughter in Yellowstone National Park was initiated by "veterinarians and allied interests" in 1962 and abandoned in 1964 due, in part, to concern over changes in "the wild behavior of bison," reducing the herds to "dangerously low numbers," and eliminating "the genes of dominant females who teach historical habitat use patterns (Meagher 1972, Meagher 1974)" that could "threaten the wild bison herd." Cromley 2002 at 65.

"A border control policy and other attempts to deter the migrations, including cattle guards and fences, failed to end the migrations in the 1970s and early 1980s." Cromley 2002 at 66.

Livestock groups, veterinarian associations, and 17 Western state veterinarians also pressured the U.S. Dept. of Agriculture Animal and Plant Health Inspection Service "to downgrade the status of states that allowed wild bison exposed to brucellosis to roam (Alley 1995)" and "threatened to revoke Montana's status without a scientific or legal basis." Cromley 2002 at 70.

Livestock and veterinarian control of policy culminated in 1995 with the Montana Legislature transferring authority for wild bison to the Montana Dept. of Livestock (Mont. Code Ann. § 81-2-120) which then Governor Marc Racicot used to sue Yellowstone National Park "because the Park failed to prevent bison migrations into Montana and because APHIS threatened to downgrade Montana's brucellosis-free status based only on the presence of diseased wild bison in the state." Cromley 2002 at 72.

In 2000, the State of Montana and Yellowstone National Park voluntarily reached an agreement and released Records of Decisions codifying a plan that rigidly set in place the use of livestock and veterinary practices on bison for the foreseeable future. Montana Dept. of Livestock and Montana Fish, Wildlife & Parks 2000; U.S. Dept of the Interior and U.S. Dept. of Agriculture 2000.

The use of livestock and veterinary practices on bison is widely reflected in many of the actions common to all alternatives and the preliminary alternatives.

Each of the alternatives managers considered in 2000 involved removing bison migrants and restricting bison's natural range (and so it is two decades later despite the public's overwhelming support for managing cattle rather than bison given a choice between the two):

> Each alternative management plan included the removal of bison migrants from the population by managers in order to achieve at least one of the following: reduce the seroprevalence, reduce the probability of bison coming into contact with cattle, or reduce the size of the population.

Angliss 2003 at 51.

Many of the intensive management techniques employed on bison historically and currently, "were adapted from ranch and range management techniques developed for cattle." Cromley 2002 at 64.

Clearly, managing bison in Yellowstone National Park like cattle on a ranch as former Sec. of the Interior Ryan Zinke ordered is being dutifully carried out by management in the face of overwhelming public support for protecting wild bison and their freedom to roam public lands in the Yellowstone ecosystem.

The ecological role of Yellowstone bison in the ecosystem remains largely unknown due to managers fixation on disease management.

Evaluate and disclose how bison provide for biological diversity, resilience of native species, and grassland health.

- Disease management actions depleting and eliminating bison from their range in the wild also adversely affects the ecosystem bison engineer to benefit native species diversity.

- A review of scientific research identified in the State of Montana's and Yellowstone National Park's Bison Management Plan analysis finds over fifty disease-related study needs and not one study on the keystone contributions of bison in sustaining the ecosystem. U.S. Dept. of the Interior & U.S. Dept. of Agriculture 2000 FEIS Vol. 1 Appendix D at 728–732.

- Managers have yet to study and evaluate the loss of bison and resulting adverse effects on the ecosystem from disease management actions eliminating a keystone species and ecological engineer from the Yellowstone ecosystem.

> Bison . . . act as "ecosystem engineers" by creating and responding to heterogeneity across the landscape (Gates et al. 2010). They create greater plant diversity by preferentially feeding on grasses and avoiding some flowering plants, while preventing plant community succession through hoof action and horning or rubbing on trees and shrubs (Meagher 1973; Coppedge and Shaw 1998; Knapp et al. 1999). Their heavy bodies and sharp hooves combine to till the soil and disturb roots of grasses and grass-like plants (Frisina and Mariani 1995). This prevents grassland succession to shrubs or trees and provides grasses with greater access to sunlight, which is important for growth (Knapp et al. 1999). Large groups of bison contribute to natural disturbances that influence plant species composition and distribution across large portions of grasslands and shrub steppe, similar to fire, windthrow, and mass soil erosion events (Augustine and McNaughton 1998; Turner et al. 2003; Collins and Smith 2006; McWethy et al. 2013).

Auttelet et al. 2015 at 108.

> Notably, during mid and late summer (i.e., Julian days 200–289), grazing improved forage quality by 50–90% in plots with high bison use (Fig. 3B). In plots where bison grazed intensely, they maintained forage in a high-quality state beyond the spring green-up period.
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> . . .
>
> Yellowstone's bison (*Bison bison*) do not choreograph their migratory movements to the wave of spring green-up. Instead, bison modify the green wave as they migrate and graze. While most bison surfed during early spring, they eventually slowed and let the green wave pass them by. However, small-scale experiments indicated that feedback from grazing sustained forage quality. Most importantly, a 6-fold decadal shift in bison density revealed that intense grazing caused grasslands to green up faster, more intensely, and for a longer duration. Our finding broadens our

> understanding of the ways in which animal movements underpin the foraging benefit of migration. The widely accepted Green Wave Hypothesis needs to be revised to include large aggregate grazers that not only move to find forage, but also engineer plant phenology through grazing, thereby shaping their own migratory movements.

Geremia et al. 2019 at 1, 2.

> The migrations of large herbivores are dwindling across the globe, and their absence has likely caused significant alterations to ecosystems. A century and a half ago, the American West was occupied by tens of millions of bison moving seasonally across its big landscapes. With their aggregated grazing across vast areas, phenological patterns would have been radically different from what they are today. Currently, only 20,000 bison remain protected in conservation herds, and only 8,000 of those are allowed to freely move across large landscapes. Moreover, today's model of bison conservation involves maintaining small bison populations within fenced areas and actively managing their abundance for light to moderate grazing. The massive bison migrations that existed before European settlement are gone. Conserving North American ecosystems as a semblance of what they were prior to the loss of bison will involve the restoration and protection of large herds. Restoring lost bison migrations will require that these animals be allowed to freely aggregate, intensely graze, and move in sync with landscape-level patterns of plant phenology.

Geremia et al. 2019 at 3–4 (endnotes omitted).

> When the buffalo disappeared, the old wild Indian disappeared too. There are places set aside for a few surviving buffalo herds in the Dakotas, Wyoming and Montana. There they are watched over by Government rangers and stared at by tourists. If brother buffalo could talk he would say, 'They put me on a reservation like the Indians.' In life and death we and the buffalo have always shared the same fate.

John Fire Lame Deer (Tahca Ushte), *Lame Deer, Seeker of Visions* (Washington Square Press 1976).

> Like the colonized, bison share the low status of an uprooted population in a state of exile. Within the GYE [Greater Yellowstone Ecosystem], a multiplicity of borders segment the landscape, defining "safe and unsafe" zones. The park boundary and property lines present a gauntlet which park bison must navigate successfully in order to persist within the borderlands. These borders, physical and metaphysical, demarcate regions in which park bison are the "forbidden." Clearly bison exist in a state of deprivation, as available resources are denied for the purpose of stability.

Lulka 1998 at 77.

> Domestication is the predominant threat to persistence of wild plains bison. If wild plains bison are to persist, we must retain the wild genome in a wild environment. In an "artificial" environment with abundant human controls, the wild genome will deteriorate into something else.

Bailey 2013 at xv.

> Short-term economic and political interests often dominate scientific considerations in the development and implementation of management plans for threatened or endangered species. Whether economics and politics continue to produce scientifically deficient conservation plans will be decided in many cases only by extended litigation.

Lande 1988 at 1459.

For each alternative and action common to all alternatives, evaluate and disclose the impacts and effects of domestication and artificial selection processes on Yellowstone bison.

Avoid using artificial selection processes that domesticate wild bison.

- Systematically subjecting Yellowstone bison to management practices that "replace or weaken natural selection" is domestication.

For bison in Yellowstone, domestication is self-evident in managers restricting the range and natural migrations of bison, limiting herd sizes below conservation biology thresholds to prevent inbreeding and maintain genetic diversity, conducting annual trapping operations with disproportionate impacts on genetically distinct subpopulations or herds, unnaturally skewing breeding male to female ratios, depleting older aged bulls and females, harassing bison from habitat including calving grounds, permitting fencing and cattle guard schemes to prevent migrations and dispersal within their home ranges, among them.

Weakening patterns of natural selection in Yellowstone bison also breeds complacency among managers who then perpetuate the practices as a matter of course or as part of your plan.

“Furthermore, the notion of domesticity is strengthened by the changing jurisdiction of state agencies. In the past 5 years, the Montana Department of Livestock and the Idaho Department of Agriculture have taken over the responsibility of managing Yellowstone's migrant bison from their state's respective Game and Fish Departments (Keiter, 1997).” Lulka 1998 at 121.

- Manager’s use of livestock husbandry and veterinary practices act as artificial selection pressures, replacing and weakening natural selection, natural variation, and evolutionary adaptation of Yellowstone bison in the wild.

The preponderance of artificial selection and domestication pressures is evident in many of the actions common to all alternatives, and the preliminary alternatives, including:

1) managing the Yellowstone bison population without regard for population subdivision, genetic distinction, and variation;
2) confining, limiting and reducing Yellowstone bison’s natural migrations and dispersal to range for forage, water, and shelter;
3) confining and limiting Yellowstone bison’s access to migratory range and obstructing connectivity to habitats on public lands;
4) trapping Yellowstone bison for slaughter year after year and differentially impacting subpopulations in the Central and Northern herds;
5) altering sex ratios, skewing age structures, and removing lineages in large-scale, nonrandom government trapping for slaughter operations;
6) brucellosis management actions selecting against brucellosis (natural or acquired immunity and disease resistance) in Yellowstone bison; and
7) domesticating Yellowstone bison by removing them from the wild for quarantine.

Evaluate and disclose how artificial selection processes embodied in each alternative and action common to all alternatives, undermine the persistence of wild bison in the Yellowstone ecosystem.

Avoid using artificial selection processes that undermine natural selection in wild bison.

- Yellowstone National Park’s trapping for slaughter program in conjunction with trapping for quarantine is depleting and exacerbating the loss of bison genetic diversity.

- In the absence of a program to monitor retention and loss of genetic diversity, the public does not know the extent of genetic diversity lost in each herd and in the Yellowstone bison population as a result of intensive management practices, principally trapping bison for slaughter and quarantine.

- Furthermore, taking Yellowstone bison from the wild for quarantine is domestication. Domestication via quarantine does not preserve natural selection of the bison genome in the wild.

“The benchmark of domestication is the degree of replacement of natural selection by artificial selection.” Bailey 2013 at 136.

“Domestication may . . . be irreversibly altering the bison gene pool and its morphology, physiology and behavior . . .” Freese et al. 2007 at 177 (citations omitted).

“Bison domestication is like hide hunting, except that instead of stripping off the hide and discarding the meat, bison domestication will strip out the genes that make for good domestic bison and discard the genes that make wild bison wild.” Lott et al. 2002 at 197.

> The essence of domestication is selective breeding: humans deciding which individuals will produce the next generation, and choosing them to produce a next generation that will better serve human goals.
>
> . . .
>
> Natural selection works and artificial selection works even faster. That’s why wild bison behave the way they do, and why domestic bison will behave differently.

Lott et al. 2002 at 198–199.

Managing bison in enclosures—"tolerance" zones, boundaries, traps, quarantine pens—should be eliminated from each alternative and action common to all alternatives, because domesticating wild bison is in conflict with the purposes of Yellowstone National Park.

Managing bison in enclosures is not supported by the best available science or information.

> Based on their body mass, bison should have the largest spatial requirements of any North American mammal (Ofstad et al. 2016), yet they are among the most geographically restricted due to current management regimes (Gates et al. 2010). More than half of bison herds managed for conservation are confined to fenced pastures encompassing areas less than 16 km^2, which is ~80 times smaller than the expected minimum space use of free-range bison (Bailey 2013). Anthropogenic restrictions like this render bison incapable of responding to seasonal changes in landscape characteristics, including shifts in forage productivity (Merkle et al. 2016), resulting in increasingly intensive use of existing patches (Frank et al. 2016).

Ritson 2019 at 16.

• Domestication of Yellowstone bison is multifold: in Yellowstone National Park using livestock and veterinary management practices on wild bison (and proposing them again in a new plan lasting decades), and encroaching livestock and veterinary agency authority over wild bison populations migrating in the States of Montana, Idaho, and Wyoming.

• Wild bison surviving quarantine for removal elsewhere are subject to managers selecting a pre-defined space, confining bison to the limited habitat available, i.e., stocking rates based on "carrying capacity" as determined by the extent of fencing or electrified fencing to contain movements.

• In enclosing bison's range in Yellowstone, managers also artificially limit population size to the "carrying capacity" of the reduced or enclosed range, which then necessitates further management intervention to control and artificially select bison to maintain the "target" population in the wild.

• Confining bison to small scale landscapes is incompatible with the large spatial need bison require for adapting and evolving as a migratory wildlife species with complex biological relationships in the ecosystem upon which they depend for survival.

• While bison as a species may continue to persist, the influence of domestication is a predominant influence, undermining natural selection and adaptation, and weakening bison's natural ecological role and function in complex ecosystems.

> Managers of captive populations only recently became aware of the importance of avoiding inbreeding depression in propagating small populations.
>
> . . .
>
> In small populations, random fluctuation in gene frequencies (random genetic drift) tends to reduce genetic variation, leading eventually to homozygosity and the loss of evolutionary adaptability to environmental changes.
>
> . . .

> Of course, if an area with fixed boundaries has been established as a natural preserve containing suitable habitat for some species, long-term climatic trends may induce major evolutionary changes in the population, or render the entire preserve unsuitable. This problem is compounded for species that undergo long-distance seasonal migrations and require two or more widely separated patches of suitable habitat.

Lande 1988 at 1456, 1458 (endnotes omitted).

"We detected seasonal variation in the size of free-range bison home ranges, but not in captive bison, which suggests that management limitations may affect the ability of bison to respond to landscape changes and has possible consequences on their fitness. . . . In the context of bison conservation, decreased access to foraging patches may discourage their natural feeding patterns and result in individuals less similar to their wild ancestors." Ritson 2019 at 79, 80.

> Restricting the natural space use tendencies of bison could have cascading effects on their long-term conservation. While the physiological needs of captive bison are likely being fulfilled by the pastures they occur in (Kohl et al. 2013, Schoenecker et al. 2015), it may not be adequate for the large-scale biological interactions bison have as a keystone species (Knapp et al. 1999; Freese et al. 2007; Fuhlendorf et al. 2010).
>
> . . .
>
> The unencumbered movement ability of free-range bison could enable their response to anthropogenic disturbance (Fortin and Andruskiw 2003) while captive individuals may be restrained from such responses. Continued restriction of natural responses to disturbance may lead to captive bison becoming desensitized to humans, a characteristic selected in commercially raised herds but maladaptive for bison conservation (Freese et al. 2007; Sanderson et al. 2008).
>
> . . .
>
> [S]patial isolation is a greater issue for bison conservation than suitability of habitat . . . indicating differences in spatial patterns which could have negative impacts on adaptive behaviors in bison. . . . These findings suggest the possibility that limitations on bison movement might result in behaviors unsuitable for long-term evolutionary fitness, as well as capacity for ecological interactions, working against the conservation goals of these herds.

Ritson 2019 at 80, 81, 82.

Managing bison in enclosures should be eliminated from each alternative and action common to all alternatives, because these management actions undermine bison's adaptability, natural evolution, and fitness in the wild.

Managing bison in enclosures is a conspicuous feature of domestication.

"Confinement has been imposed upon bison in order to render the species docile, impotent, and incapable of disrupting the established order." Lulka 1998 at 77.

An acutely accurate observation reflecting how Yellowstone National Park has institutionalized limiting the range, migratory movements, abundance and distribution of bison regardless of its designation as a protected place to serve dominant political and economic orders.

• Protected areas do not migrate. Rapid climate change is already undermining the capacity of migratory species to persist in protected areas. Confining bison's migrations and limiting their range and habitat reinforces the ongoing influence of managing bison for domestication in Yellowstone.

A drought in western South Dakota (2002–2007) reduced "the reproductive capacity of bison and elk, which was attributed to reduced forage quality and quantity," prompting Wind Cave National Park staff to make "unprecedented inquiries about water rights and delivery in the bison enclosure." Beeton et al. 2019 at 56.

• Enclosure is a continuous factor in domesticating bison in Yellowstone, because barriers (or demarcating boundaries and zones) limit and reduce the migratory species long range foraging, adaptability to rapid climate change and climate variation.

Enclosure also reinforces "stocking" rates based on "carrying capacity" which drives the "surplus" of bison removed in Yellowstone National Park in trapping for slaughter and quarantine actions.

"Natural selection, with no or minimal influence by humans, is the benchmark of wildness." Bailey 2013 at 78.

"[T]here is something "unnatural" about ranges that do not change and populations that do not substantially vary." Lulka 1998 at 126.

> Biologists are concerned about the genetic health of bison (*Bison bison*) herds because all North American herds were founded by few individuals and they have generally been maintained at small population sizes (Boyd 2003). National Park Service (NPS) bison herds were established from groups of about 20 to 50 bison (Halbert 2003:16) and NPS herds have largely been managed to maintain a size of fewer than 1000 animals. The small size and isolation of bison herds has led to concerns about their long-term genetic health.

Gross & Wang 2005 at 3.

"One consequence of intensive management is that populations are often managed in small, isolated populations, due to factors such as limited availability of habitat or resources. This, in turn, makes them more susceptible to evolutionary processes, such as genetic drift, that erode genetic variation over time (Wright 1931, Allendorf and Luikart 2007)." Toldness 2014 at 1.

"Herds with fewer than 2000–3000 bison have compromised evolutionary potentials." Bailey 2013 at 179.

• Intensive, widespread State and federal management actions are contributing to the loss of variance and increasing the risk of extinction for Yellowstone bison, a population that has been isolated for over century.

- Natural migration between bison populations is a rare occurrence in Yellowstone, with a few observed movements south to the Jackson bison herd.

> In winter 1995/96, 3 bulls from the Hayden Valley and wintered in the vicinity of Polecat Creek . . . were captured and radio collared. For several years after they returned each year to Hayden Valley during the rut then back to the Jackson Lake area to spend the winter. During the harsh winter of 1996-1997 a mixed group of 3 cows and 3 juveniles followed the road from YNP [Yellowstone National Park] through the south gate and spent winter in the same area as the 3 bulls. Then they moved south and joined the Jackson herd; this mixed group did not return to YNP.

Gates et al. 2005 at 93 (n. 34).

Dispersal of bison among populations has been lost to human developments that continue to encroach upon protected areas. Allocating bison range and habitat to cattle on National Forests contributes to management actions directed against bison. Loss of migration corridors threatens the biological phenomena of long distance bison migrations. Furthermore, there is no source population of intact bison in the wild of large enough size that is itself not subject to inbreeding that could be reintroduced to Yellowstone.

- Management actions driving the decline and loss of ecological diversity wild bison provide the Yellowstone ecosystem need to be eliminated from consideration.

“Management of particular species should incorporate details of the species ecology, especially its life history and demography, which may require larger populations than has been suggested on genetic grounds alone.” Lande 1988 at 1459.

Bison are more than their genes; without habitat to evolve and adapt, genetic diversity alone will not save bison from extinction in the wild.

Evaluate and disclose how Yellowstone National Park's trapping for slaughter and quarantine programs impact genetic diversity and retention of genetic variation in the Central and Northern herds, and in the Yellowstone bison population.

- Regulatory quarantine has not led to the re-establishment of bison in the wild (elsewhere, outside Yellowstone). To our knowledge, managers have not investigated the extent or rate of loss in Yellowstone bison genetic diversity as a result of regulatory quarantine and trapping for slaughter.

- Managers are operating on the assumption bison genetics are being conserved elsewhere while neglecting to systematically gather data and publish the results investigating consequences on genetic variation and diversity in Yellowstone bison remaining in the wild.

In other species, translocated populations "often harbour reduced genetic diversity compared to source populations and initiating translocated populations can decrease the genetic diversity of source populations, placing them at an increased risk of extinction." Furlan et al. 2020 at 831.

Mangers are overlooking adverse consequences of removing founders from the remnant source population of Yellowstone bison, a factor that could harm the wild population but remains unstudied despite the 50-year quarantine program put in place by Yellowstone National Park.

- Yellowstone National Park must conduct an impartial, open-eyed evaluation of conditions bison endure in quarantine and thereafter.

- After suffering the great loss of bison for over 140 years, the spiritual, cultural, and ecological significance of returning bison most directly related to the ancestral herds that populated aboriginal territories is to be celebrated and commended. Haggerty et al. 2018 entire.

The prospect that bison surviving quarantine will remain in fenced, limited ranges is likely to continue for the foreseeable future. Fort Peck Assiniboine & Sioux Tribes 2014 entire (confining bison to a 320-acre holding pen, and electrified fenced ranges initially totaling 10,778 acres, which has expanded to 25,000 acres according to Chris Geremia, Yellowstone National Park).

> [A] shock resulting from a bison coming into contact with the electric fence is very uncomfortable and bison quickly learn to respect this fence.
>
> The Fort Peck Tribes have observed uncharacteristic behaviors among the first QFS [Quarantine Feasibility bison] . . . and were again required to break up the family structure . . . when 33 bison were removed and sent to the Fort Belknap Tribes. The bison have a tendency to follow the biggest bull in the herd, despite the fact that they would typically follow one of the lead females.

Fort Peck Assiniboine & Sioux Tribes 2014.

Confining bison to limited ranges may also be a factor in reports of health and nutritional concerns. *See* Rhodes et al. 2018, 2019, 2020 ("With the limited grazing opportunities, it has been discovered that many of these bison have serious health problems related to malnutrition which can cause lower birth rates.").

Our comment is not a criticism of the Assiniboine & Sioux Tribes. Prior Acts by Congress, including the Dawes Act and homesteading Acts, fragmented reservation land held in common into private parcels. Hubbard 2016 at 92–93 (imposed on over 100 reservations, land once commonly held was parceled out to enrolled individuals in a tribe, with the remainder deemed “surplus” and sold to settlers).

Even with a large reservation like Fort Peck, the Sioux and Assiniboine who hold 378,000 acres scattered across 2,093,318 acres, could only allocate – after the Bureau of Indian Affairs approved – a few, electrified ranges for Yellowstone bison surviving quarantine.

Buffalo Field Campaign is in agreement with the values of cooperation, renewal, and restoration embodied in the collective wisdom of the Buffalo Treaty.

We are also in agreement with the Buffalo Treaty signatories recognizing buffalo as a wild free-roaming animal whose presence on their ancestral land is an important part of nurturing the ecological systems that sustain us all.

Our foremost concern guiding the founding and mission of Buffalo Field Campaign is on restoring and renewing the wellspring of buffalo roaming wild in Yellowstone for future generations.

For all of the reasons stated in our scoping comments, the future of wild buffalo persisting in Yellowstone is not secure and in doubt. Much and more needs to be done to secure a future for the wild buffalo in Yellowstone.

Reciprocity also means giving back to the buffalo so they may persist in the wild in the one place they have occupied for thousands of years: their stronghold in Yellowstone.

Buffalo Field Campaign objects to Yellowstone National Park's interpretation and determination of "surplus" bison, and taking bison from the wild for any commercial purpose.

Evaluate and disclose the U.S. Congress's original intent and Yellowstone National Park's justification for taking a contrary course of action in determining "surplus" bison.

- The U.S. Congress never intended for wild bison in Yellowstone to be declared "surplus" and did not authorize the Secretary of the Interior to remove wild bison as "surplus" for quarantine.

> The "tame" herd of buffalo in Yellowstone National Park was established under authority contained in the act of July 1, 1902 (32 Stat. 574), with an appropriation of $15,000 for the purpose. Twenty-one animals were purchased in the fall of that year, and these have multiplied until now the herd contains 578. *It is estimated that the "wild" herd, a remnant of the vast hordes that once roamed this region, numbers from 125 to 150, but it has no place in the present discussion*.

U.S. Congress 1923 at 46 (distinguishing the "wild" herd from "surplus" captive bison reintroduced on the Lamar Buffalo Ranch) (emphasis added).

> The quarantine program would entail testing bison captured to reduce abundance and segregating some bison testing negative for brucellosis exposure from other bison. These test-negative bison would be tested repeatedly over time using established protocols to evaluate if they remain free of brucellosis (USDA, APHIS 2003; Clarke et al. 2014). Animals that remain test-negative for brucellosis through these protocols would be sent alive to other public, tribal, or private lands for conservation, cultural, or commercial purposes. Animals not selected for quarantine would be released or sent to terminal pastures, meat processing facilities, or research facilities.

Yellowstone National Park 2016 at 22 (Programmatic Actions Common to All Action Alternatives) (footnote omitted).

Contrary to misleading claims made by Yellowstone National Park and others, in Montana, bison in the wild that are reduced to captivity for quarantine are <u>not</u> wild according to the Montana Supreme Court.

> A "wild buffalo or bison" is defined as a bison "that has not been reduced to captivity and is not owned by a person." Sections 81-1-101(6) and 87-2-101(1), MCA. The brucellosis quarantine bison involved in this case have been reduced to captivity for a number of years and therefore arguably are not "wild buffalo or bison" as defined in Montana law . . .

Citizens for Balanced Use v. Montana, (Case No. DA 12–0306) 2013 MT 166 at ¶ 15.

> **Concern Statement:** Commenters suggested Yellowstone bison are wildlife, but quarantine will result in commercializing and domesticating bison.
>
> Response: Quarantine will not lead to commercialization. Judicial evaluations have concluded that Yellowstone bison completing quarantine are wild animals under

> Montana law (*Citizens for Balanced Use et al. v. Director Maurier, Montana Department of Fish, Wildlife & Parks et al*.; Montana Seventeenth Judicial District, Blaine County; Cause No. DV–2012-1 [2012, 2014], overturned No. DA 12-0306 [Montana Supreme Court 2012]).

Yellowstone National Park 2018 at 18.

In misleading people in your official responses, Yellowstone National Park's credibility is undermined.

For each alternative, evaluate and disclose the retention or loss of natural selection and diversity in each genetically distinct subpopulation or herd and for the Yellowstone bison population.

Avoid adopting management actions that undermine natural selection and lead to loss of bison diversity.

> Genetic variation is the basis for evaluating biodiversity within and between populations; without genetic variation, populations could not evolve or adapt to changing environmental conditions.

Forgacs et al. 2019 at 1 (endnote omitted).

- Management actions driving the loss of bison genetic diversity remains largely unknown because managers are not systematically collecting and evaluating data and evidence for publication.

- The failure to evaluate and disclose actual effects of frequent, recurrent, large-scale, non-random slaughter of bison is a serious defect in management.

Furthermore, disease management is disproportionately impacting genetically distinct subpopulations in the Northern and Central bison herds, and removing entire family groups or lineages.

Evidence of the extent and rate of loss in bison lineages is not being systematically gathered for publication.

- Management actions driving the loss of bison lineages is an additional concern in retaining genetic variation and diversity in Yellowstone bison's distinct population structure.

Managers assumptions about Yellowstone's bison population need to be re-evaluated in light of the best available information and science.

"The IBMP-2000 [Interagency Bison Management Plan adopted in 2000] generally assumes that any culling as a result of this plan will be genetically random and therefore have no real impact on the genetic constitution of the YNP [Yellowstone National Park] bison population. These assumptions, however, are largely untested." Halbert 2003 at 131.

Halbert's study demonstrated results indicating "some level of population subdivision" in the Yellowstone bison population. Halbert 2003 at 146.

"Although a disconcerting number of parent-offspring pairs and family groups were found in this study, providing evidence of nonrandom culling within the YNP [Yellowstone National Park] bison population, the magnitude and long-term genetic and demographic effects of this type of nonrandom culling are unknown." Halbert 2003 at 151–152.

"Even random culling of bison will weaken natural selection. Random removal of animals treats the most fit and least fit bison equally, whereas natural selection would favor survival and reproduction of bison most suited for wild conditions." Bailey 2013 at 142.

"Since bison are known to naturally assemble in matriarchal groups including several generations of related females and the most recent calf crop (Seton 1937; Haines 1995), it is possible that the culling of bison at the YNP [Yellowstone National Park] boundaries is non-random with respect to family groups, a practice that over sufficient time may lead to systematic loss of genetic variation." Halbert 2003 at 133.

> Bison calves generally remain with their mothers throughout the first year of life (Berger and Cunningham 1994), so it is not very surprising to find cow-calf pairs within the sampled groups. *The long-term genetic and ecological effects of killing off cow-calf pairs in this manner are unknown*.
>
> . . .
>
> *The parent-offspring matches were not limited to calf-cow pairs. Both male and female 1, 2, and 3 year-old offspring were matched to dams. Several cases of dams with multiple offspring of different ages were found, indicating the presence of family units within the groups analyzed*. In one case, a multigenerational matriarchal group was found which spanned 4 generations ranging from a 7 year-old female to a male calf. All of the animals from this group were killed within 8 days of each other from the same location. These analyses indicate [it] is much more likely for sisters or mother-daughter pairs to be sampled from the same location within days of each other, providing evidence of matriarchal groups and corroborating observational data (Seton 1937; Haines 1995).

Halbert 2003 at 150 (emphasis added).

Halbert's dissertation is the only known study to assign parentage and estimate the loss of family groups or lineages in Yellowstone bison. In not gathering and evaluating crucial data, the extent and rate of loss of bison lineages under current and proposed management practices is unknown.

> *Because populations in zoological parks and nature reserves often are derived from only a few individuals, conservationists have attempted to minimize founder effects by equalizing family group sizes and increasing the reproductive contributions of all individuals. Although such programs reduce potential losses of genetic diversity, information is rarely available about the actual persistence of family groups or genetic lineages in natural populations. In the absence of such data, it can be difficult to weigh the importance of human intervention in the conservation of small populations. Separate long-term studies of two mammals, the North American bison (*Bison bison*) and the white-nosed coati (*Nasua narica*), and a bird, the Acorn Woodpecker (*Melanerpes formicivorus*), demonstrate differential extinction of genetic lineages. Irrespective of the mechanisms affecting population structure, which may range from stochastic environmental events to such behavioral phenomena as poor intrasexual competitive abilities, our results show that lineages can be lost at rapid rates from natural populations. A survey of comparable studies from the literature indicates that the loss of matrilines over the course of the study varies from 3% to 87% in wild mammals and from 30% to 80% in birds, with several small mammals losing approximately 20% of matrilines per year of study. These lineage extinctions were not an artifact of the length of the study or the generation time of the species. Such rapid losses of lineages in less than 20-year periods in natural populations suggest that efforts to maintain maximal genetic diversity within populations may not always*

> *reflect processes that occur in the wild. Conservation biologists need to give further thought to the extent to which parity among genetic lines should be a primary goal of management of captive and small wild populations.*

Gompper et al. 1997 at 857.

> Lineage loss necessarily decreases the genetic effective size of the population (*Ne*) through time. Lande (1995) has shown that for quantitative characters to maintain adaptive potential in the face of environmental and demographic stochasticity, *Ne* should be about 5,000. Unlike some processes that effect *Ne* (Crow & Kimura 1970; Harris & Allendorf 1989; Hartl & Clark 1989), however, lineage loss may not be a random process but can result from specific ecological or behavioral processes such as mating ability in bison . . . To the extent that these processes result in directional selection in free-living populations, the *Ne* needed to maintain adaptive potential will be even greater than that estimated by Lande (1995). The practicality of attaining these *Ne* sizes are interesting problems for which few data on vertebrates are yet available.
>
> . . .
>
> [G]iven the frequent loss of lineages among even the established breeders as indicated by these results, it is unclear whether or not most immigrants will actually have an impact on the genetic population structure. And, as the habitats of most species become increasingly fragmented and immigration between populations more difficult, such genetic rescue may become even less common.

Gompper et al. 1997 at 865.

Evaluate and disclose the retention or loss of bison genetic variation and diversity for each alternative and action common to all alternatives.

Inform the public of the assumptions and limitations of each model relied upon in your analysis.

Choose actions that maximize retention of bison genetic variation and diversity.

- All of the developed models to retain genetic variation for wild bison have drawbacks and deficiencies, namely they do not mirror real management actions year-to-year, decade-to-decade, or generation-to-generation for long periods of time, and vary in the degree to which management interventions undermine natural selection or fitness of bison in the wild.

The assumptions incorporated into models may or may not mirror actual demographic and population structures of Yellowstone's bison herds. Each model must therefore be critically examined.

Without accurate and valid data on bison, researchers' simulations and models may not reflect how management actions retain or diminish genetic diversity and natural variation year to year, decade to decade, or even over the next century.

Valid evidence must also be comprehensively, systematically, and non-intrusively gathered over time, and acted upon by managers to be relevant for bison.

Models and simulations are subject to the assumptions used to make predictions and the actual state or condition of the population, monitoring data error and incompleteness, and the inability to distinguish unique individuals from similar groups in the population. Hobbs et al. 2009 at 1.

In addition, instruments used to gather data on bison such as GPS collars, are also subject to collection error and biases. Jung et al. 2018 at 1.

Even the most superbly accurate data, model, and range of actions presented to prevent undesirable outcomes for bison can be undermined by unforeseen variables, managers not making informed decisions or disregarding the evidence in making decisions, not properly observing and recording undesirable outcomes through monitoring to inform managers, who may or may not adapt the new information into management decisions and actions. Hobbs et al. 2009 at 30.

Furthermore, the validity of selecting for a set of values to retain (or not) in bison may or may not miss the mark. *See* for example, Gross & Wang 2005, Toldness 2014, and Giglio et al. 2016 & 2018, on the various models used to estimate retention of a selected set of values in bison.

Therefore, actions common to all alternatives, and the final alternative chosen, must maximize retention of bison genetic diversity and natural variation.

- Gross & Wang developed an individual-based model "of bison herds inhabiting National Park Service (NPS) units to evaluate the consequences of management actions on retention of genetic diversity." Gross & Wang 2005 at 3. (Gross & Wang's 2005 report is used as the 2006 revised final report with several new authors is a carbon copy save the deleted Figures 1–10 found at 19–25).

The near extermination of bison from millions of individuals to less than 1,000 "represents a genetic bottleneck of epic proportions." Gross & Wang 2005 at 4.

> We examined the effects of removal of bison that were young, old, or a random selection of ages, and removals that contained a high proportion of cow-calf groups (24% or 50% of animals removed). We also evaluated the effects of using contraceptives applied to young, old, or a random selection of breeding-age cows. Over the 200-year period of the simulations, herd size accounted for more variation in retention of H_0 [heterozygosity] and loss of alleles than any other factor. Based on Monte Carlo analysis of 500 replicate simulations, bison herds with more than 400 animals generally met the objective of achieving a 90% probability of retaining 90% of the herd's H_0 for 200 years. Differences in generation time accounted for about 75% of the variation in retention of H_0 in herds of 200–800 bison. When allelic diversity was used as the key criterion for evaluating management alternatives, a population size of about 1000 animals was needed to achieve a 90% probability of retaining 90% of alleles. . . . Population control strategies had huge effects on the age and sex composition of bison herds.

Gross & Wang 2005 at 3.

"Data on breeding rates by bulls are extremely limited and we thus developed parameter estimates from available literature and interviews with bison herd managers. . . . Data on other factors that may influence lifetime breeding success of bison bulls, such as size, social status, mating group size, etc., are poorly documented and were not included in the model." Gross & Wang 2005 at 5.

"Because there was considerable uncertainty in estimates of bison vital rates, we conducted a sensitivity analysis to evaluate the potential influence of variation in vital rates on simulation results." Gross & Wang 2005 at 6.

> Of all National Park bison herds (Halbert 2003: 40), the YELL herd had the highest proportion of all alleles, the second highest H_0 [heterozygosity], and the most severe environmental conditions.

Gross & Wang 2005 at 7, 8.

> [A] much larger population objective – on the order of 1000 bison (Figure 8) – is required to achieve a reasonable assurance of retaining 90% of currently existing alleles.
>
> . . .
>
> [W]e did not explicitly model non-random removal of extended matrilineal groups.
>
> Bison have been reported to naturally assemble into matriarchal groups including several generations of related females and calves (Seton 1937; Haines 1995). In YELL, where culling is primarily through opportunistic selection of bison groups as they exit park boundaries, Halbert (2003) estimated that 24% of the removals were cow-calf pairs, about 50% more cow-calf pairs than we estimated would be removed through a random selection of bison ($p < 0.05$). The extent of matrilineal group removal from YELL cannot be accurately determined given current limitations in bison sampling as they exit the park. The genetic consequences of non-random removal of matrilineal groups (3 or more generations) was not explicitly considered in this study and it merits further study, although results from simulations with very high levels of cow-calf removals suggest that the effects of matrilineal removals in YELL may be small. While the effect of removal of matrilineal groups from YELL has been most actively discussed, this may be a more important issue in parks where a significant proportion of the herd was traditionally harvested at the same location year after year.

Gross & Wang 2005 at 11–12.

> The genetic subpopulation structure of the YELL bison population complicates accurate simulation modeling and the interpretation of the existing simulations. Meagher (1973) reported geographically distinct bison herds within YELL, but as the number of bison in YELL increased some of the herds merged (Taper et al. 2000). Recent radiotelemetry data indicated little interchange of bison between the northern and central herds (Edward Olexa, personal communication) and historical sightings indicated high densities of bison in several distinct areas of activity (Taper et al. 2000). Recent work revealed genetically distinguishable subpopulations in YELL (Halbert 2003) and cluster analysis of this data (Pritchard et al. 2000) revealed at least 2, and most likely 3, genetically distinguishable subpopulations among those YELL bison sampled (Halbert 2003). Furthermore, statistically significant genetic differentiation between bison collected in different locals (West

> Yellowstone vs. Gardiner) were observed for between 65 and 78% of the markers analyzed, a result also indicative of subpopulation structure (Halbert 2003). Subpopulation structure serves to reduce *Ne* from that estimated by the overall population size, and the rate of interchange will need to be considered in the long-term genetic management of YELL bison.
>
> At present, data from YELL are inadequate to accurately estimate rates of genetic interchange between herds, particularly as the total number of bison in YELL varies from 2500 to more than 4000. *However, it appears that animal movements between herds are relatively rare (E. Olexa, personal communication), and thus model results should be interpreted as representing a single herd unit (e.g., the northern range herd unit or West Yellowstone). A more complex simulation analysis will be necessary to fully assess the long-term genetic consequences of subpopulation structure and interchange, and non-random removal of matrilineal groups*.

Gross & Wang 2005 at 12 (emphasis added).

> Any interpretation of simulation model results must consider the quality of the data used to drive the model, the assumptions on which the model is founded, and the sensitivity of model results to uncertainty in model inputs and assumptions. Sensitivity analyses showed that our model results were relatively insensitive to realistic variation in vital rates, initial population structure, and initial genetic composition of herds. In this model, sensitivity analysis showed that a potentially realistic variation in male breeding success could significantly affect results, primarily in populations with fewer than about 600 animals. We identified complicated interactions between variation in male breeding success, population control strategy, and target population size. In general, greater levels of variation in male breeding success affected treatments that removed old animals to a greater extent than those that removed young. There are extremely few reliable data available to estimate variation in lifetime breeding success of bison, or for that matter, any other large ungulate (Wilson et al. 2002; McEligott and Hayden 2000; Roed et al. 2002; Coltman et al. 1999). The reliability of simulation model predictions for some treatments could be significantly increased by incorporating data on paternity analysis based on genetic samples from herds of interest. *At present, there are no data from bison herds that can be used to estimate how herd size, sex ratio, habitat characteristics (e.g., open vs closed), age structure, or other factors influence variation in male success. The absence of this information constrains our ability to realistically forecast the effect of population control measures on retention of genetic diversity*.
>
> . . .
>
> Because there are inherent uncertainties in model assumptions, input data, and our ability to properly interpret model results, the most appropriate use of these results is to support general recommendations on management of NPS bison units. Management actions can be simulated with a much higher degree of precision than they can be implemented under field conditions.

Gross & Wang 2005 at 14 (emphasis added).

Only a single population or herd of 2,000 bison retained 95% or more of genetic diversity as measured in alleles and heterozygosity over a period of 200 years.

• Toldness developed an "individual-based model to compare" management strategies using mean allele frequency (MAF) by removing bison with more common alleles and retaining bison with more rare alleles, random removal of young based on sex and age classes, and the zoo-biology developed strategy of removing bison based on kinship or pedigree with highly related bison removed and bison with low relatedness retained. Toldness 2014 at ii, 7–11.

> Of the three culling strategies, the random removal of young strategy preserved the fewest alleles, as measured by allelic richness (Table 2). This difference was already evident after the 100-year time step. This strategy also ended with the lowest heterozygosity, lowest gene diversity, and highest inbreeding coefficient across all time steps (Table 2). After 500 years, the random removal of young culling strategy resulted in an average decrease of 34.3% in allelic richness, 7.4% in heterozygosity, 18.7% in gene diversity, and an increase of inbreeding to 0.184 (Table 4, Figure 5).
>
> The MAF culling strategy retained more genetic variation than the random removal of young strategy at all genetic variation measures. Allelic richness decreased by 4.5% and gene diversity decreased by 16.3% over 500 years (Table 4, Figure 5). The MAF strategy resulted in an increase in heterozygosity relative to the founding population; over 500 years heterozygosity increased by 32.3% (Table 4, Figure 5). Inbreeding increased over time in the MAF strategy, rising to 0.160 over 500 years (Table 4, Figure 5).
>
> The pedigree-based strategy retained the most genetic variation in terms of gene diversity retention (10.2% decrease) and accumulated the least inbreeding (0.099) over 500 years (Table 2). It performed second to the MAF strategy in retention of allelic richness (decrease of 22.5%) and heterozygosity (increase of 2.5%) (Table 4, Figure 5).

Toldness 2014 at 18–19.

Furthermore, "a reduction in allelic richness and gene diversity was observed for all culling strategies from the founding population" and "an increase in inbreeding from the founding population from each time step with varying rates of accumulation . . ." Toldness 2014 at 17–18.

In addition, selection for variation only reflects retention of a subset of genes, the fate of the other genes "across the genome is unknown." Toldness 2014 at 24.

• Giglio developed a pedigree based management model that would have to overcome the logistical difficulties of non-intrusively acquiring genetic data from all individuals regularly, and consistently removing each individual based on kinship, making it an unlikely strategy for a wild population of bison. Nonetheless, Giglio's model is informative in comparison to other management strategies attempting to retain genetic variation in bison herds.

Because of the historical loss of variation, few founders, evidence of inbreeding (and to avoid inbreeding), further loss or erosion of bison genetic diversity resulting from management actions must be evaluated in time frames of 100, 200, and 500 years.

“Differences among herds and among culling strategies in the amount of genetic variation retained and extent of inbreeding became more pronounced over time and were most evident at the 500-year mark.” Giglio et al. 2018 at 769.

> First, conservation herds were established with small numbers of individuals that remained after the severe bottleneck (Halbert, 2003; Halbert & Derr, 2008). Surplus animals from these conservation herds were often used to establish new herds, potentially exacerbating the loss of genetic variation. Second, gene flow between herds has been sporadic during the past century, often limited by concerns about disease introduction (Williams & Barker, 2001). Third, conservation herds are typically maintained at small population sizes to avoid permanent habitat damage and accommodate multiple-use goals on small, isolated reserves (Boyd, 2003; Boyd *et al*., 2010). To maintain consistent population sizes, individuals are typically removed from populations each year. These obstacles make it critical that management of conservation herds focuses on retaining as much existing variation as possible. The annual removal of individuals is a key stage at which management actions could be designed to maximize the retention of genetic variation over time.

Giglio et al. 2016 at 381.

> Small, isolated populations are not only less demographically stable than large populations, but they are also more susceptible to erosion of genetic variation by genetic drift (Wright, 1931). In the absence of gene flow, the loss of genetic variation through drift is not mitigated. A lack of genetic variation not only makes a population more susceptible to inbreeding depression (Ralls, Brugger & Ballou, 1979; Crnokrak & Roff, 1999; Keller & Waller, 2002), but also less able to adapt to changing environmental conditions (Falconer, 1981; Keller *et al*., 1994; Willi, Van Buskirk & Hoffmann, 2006; Markert *et al*., 2010). Preserving genetic variation has become a priority for management, particularly for small and isolated populations, in order to maintain long term viability (McNeely *et al*., 1990; Lacy, 1997).

Giglio et al. 2016 at 380–381.

> *As predicted for any population of finite size, we observed a reduction in allelic richness and GD [gene diversity], and an increase in inbreeding, for all strategies.* Heterozygosity increased or decreased depending on the strategy employed. All strategies succeeded in maintaining the target population size and a balanced sex ratio. Differences among strategies in the amount of genetic variation retained and the extent of inbreeding were evident at the 100-year time step and became more pronounced over time. Differences in the pattern of genetic variation loss were also detected between the target and non-target microsatellite loci for some culling strategies.

Giglio et al. 2016 at 384 (emphasis added).

> Loss of alleles and a reduction in genome-wide heterozygosity in small populations result in loss of overall genetic variation. Since loss of genetic variation can be partially mitigated by increasing population size (e.g. Supporting Information Table S1a), wildlife managers often attempt to maximize the population size to minimize the effects of genetic drift (Epps *et al*., 2005; Dixo *et al*., 2009) and the related

> accumulation of inbreeding (Soulé & Mills, 1998). As population size decreases, maintaining stable demography and retaining genetic variation become increasingly important to prevent local extinction (Lande, 1988). In our study, the differences in genetic variation became more profound as population size decreased, demonstrating that the choice of management strategy becomes increasingly important as population size decreases (Supporting Information Table S1a). For range-restricted species such as bison, where habitat is limited and populations must be maintained at particular target sizes, management has historically focused on removal strategies based on demographic parameters to select individuals for cull. The advantage of such strategies is that they require only limited data and resources to implement. Our RANDOM culling strategy relied solely on demographic data (an individual's age and sex) to inform culls. At the end of 500 years, the RANDOM strategy yielded the lowest allelic richness, observed heterozygosity and *GD* [gene diversity], as well as the highest average inbreeding of the three tested culling strategies (Table 2). Further, the RANDOM, as well as the MAF [Mean Allele Frequency], culling strategies exhibited high variance in measures of genetic variation across iterations, indicating less predictability in the outcome of these strategies and potentially important impacts on population persistence. These results indicate that although demographically based removal strategies can be easy to implement and effective at maintaining sex and age ratios, incorporating genetic data into culling decisions improves a population's long-term retention of genetic variation and thus, its adaptive potential.

Giglio et al. 2016 at 386.

> Our results suggest wildlife management strategies that incorporate goals for retaining genetic variation are better suited to preserving the evolutionary potential of wildlife populations than those that focus solely on a target size and demographic stability. Declines in genetic variation not only limit the evolutionary potential of a population, but can also have direct and immediate effects on factors such as the response to diseases and new pathogens (O'Brien & Evermann, 1988). For these reasons, bison are an exemplary example of a species in need of genetic management. Bison, as a species, underwent a severe bottleneck in the late 1800s, and were further bottlenecked as conservation herds were founded with few individuals. Thus, *all contemporary bison populations can be assumed to have accumulated some level of inbreeding*, with Hedrick (2009) estimating 0.367 inbreeding (equal to two generations of full sibling matings) in the Texas State Bison Herd. Although the direct effects of inbreeding in bison are unclear, even small amounts of inbreeding have been correlated with the susceptibility to bacterial disease in other wildlife populations (Acevedo-Whitehouse *et al*., 2003). Historical erosion of genetic variation due to severe bottlenecks, serial founding events, and current levels of inbreeding make the preservation of remaining genetic variation through effective management strategies even more imperative to the persistence of bison.

Giglio et al. 2016 at 387–388 (emphasis added).

The random "culling strategy yielded the greatest reduction in allelic richness and heterozygosity at target loci (decrease of 44% and 35%, respectively) and allelic richness at non-target loci (decrease of 45%; Fig. 1). Gene diversity was reduced by 36% and inbreeding increased to 0.360 under the

Random strategy (Table S1, Fig. 1).” Giglio et al. 2018 at 770.

“The Random strategy resulted in the lowest retention of allelic richness and heterozygosity at the target (decrease of 56% and 32%, respectively) and non-target loci (decrease of 58% and 35%, respectively; Fig. 2).” Giglio et al. 2018 at 771.

- Finally, it is worth noting a study by Angliss who recognized management actions have different consequences for each unique and distinct herd as opposed to managing for only a single Yellowstone bison population.

Funded in part by Yellowstone National Park, the objectives of Angliss’s study were to determine “the relative outcomes of the bison management plans,” identifying “any implications of having two discrete bison populations within” the Yellowstone bison population, and predicting “likely outcomes of different management alternatives” for the State of Montana’s and Yellowstone National Park’s plan managing bison for disease control. Angliss 2003 at i, 2.

> Recent information from tagged bison (Gogan pers comm 2002) indicates that little or no migration of animals occurs between Central and Northern Range herds. Thus, management actions in one area may have a disproportional affect on one bison group. To investigate the impacts of removing this movement, I eliminated the migration between areas in the model for the new preferred alternative, and looked at the change in the average minimum number of bison in the population in any one year. When migration was included in the new preferred alternative, the average population in the Central and Northern Range wintering areas was 2356 and 968, respectively (averaged over 18 years for 10 model runs). When the low net migration rate from Central to Northern was eliminated, the average estimated population size was 2588 and 883, respectively, which indicates a slight increase for the Central group and a slight decrease for the Northern Range group relative to the results when the model included migration between areas. Clearly, whether there are two separate herds of bison in YNP [Yellowstone National Park] should be investigated further, as the impacts of management actions on separate, smaller bison groups, will likely be different than the impacts of management on a population of 3500.

Angliss 2003 at 60.

For each alternative, evaluate and disclose how management actions impact the extent and rate of loss in natural variation in Yellowstone's bison herds. Include factors such as artificial selection processes, population and genetic isolation, few founders, limited ranges, removal for slaughter and quarantine, etc.

For actions common to all alternatives, commit to systematically gathering data for publication any evidence of the loss or retention in natural variation and diversity for each genetically distinct subpopulation or herd and for Yellowstone's bison population.

- In managing Yellowstone bison for a limited size in a restricted and isolated range, management is adversely impacting maintenance of adaptive genetic variance, and undermining natural selection.

- Bison need to be managed as a conservation species because of the potential adverse effects from "low initial numbers of founders, past bottlenecks in various herds, cattle hybridization in a number of conservation herds, artificial selection for non-adaptive traits, isolation of most conservation herds, and the observation of severe inbreeding depression in 1 conservation herd." Hedrick 2009 at 412.

The near extinction of bison by man created a bottleneck that resulted in the present-day plains bison population being descended from less than 100 founders. Hedrick 2009 at 411 (*see also* Table 5 at 418).

"Shaw (1993) estimates that there were only 74 to 79 animals that provided the genetic foundation for all future tribal, federal and private herds in North America." Ecoffey 2009 at 9.

A 2019 study by Davies of bison's evolutionary responses to environmental change spanning the megafaunal extinctions of the Late Pleistocene to the present, records the first of two population bottlenecks for North American bison.

- Bison's "long-term viability as a species remains threatened due to restricted rangelands, artificial selection within confined herds, and a lack of gene flow between herds. Questions remain about the genetic diversity currently found in conservation herds and how the species will respond to environmental change within restricted areas." Davies et al. 2019 at 1.

A significant and relevant finding from Davies's study is the admission that it is unclear what is causing an observance of low variability in the diet of modern bison, including Yellowstone bison "despite their ability to cover much larger areas and complete substantial elevational migrations." The factors could be related to restricted or limited ranges, management practices, or a "narrowing in plasticity" from the more recent 19th century genetic bottleneck. Davies et al. 2019 at 7 (endnotes omitted).

The low variability in diet is concerning because bison's ability in the past to survive "changing composition of habitat" relied on "their ability to adapt and exploit a variety of resources" attributed to the species' long-term survival when other megafauna species were driven to extinction. Davies et al. 2019 at 6. ("Shifts from C3 to C4 grass dominance would have a substantial influence of altering critical features associated with forage quality and quantity." Fuhlendorf et al. 2018 at 5).

> The North American landscape has been transformed dramatically during the last 250 years, and with few exceptions, bison are no longer allowed to migrate or range widely in localities where they currently exist. Further, the extreme population bottleneck experienced by bison at the end of the 19th century has left the species with only a microcosm of the genetic toolkit that it once wielded for adaptation. Thus, both the resiliency of the species and the landscape it once inhabited have been altered in a manner unprecedented since the last ice age. We may expect that genetically isolated and spatially confined herds will be the most challenged by environmental fluctuations. Range expansion efforts . . . are already underway . . . but only at incrementally small amounts in comparison to the native range of the species.

Davies et al. 2019 at 7 (endnote omitted).

Evaluate and disclose how management actions are increasing the risk of inbreeding by confining and limiting bison's migratory range, managing Yellowstone's bison herds below conservation biology thresholds in a population that has been isolated for 120 years.

For actions common to all alternatives, commit to systematically gathering data for publication any evidence of inbreeding and other adverse effects observed in Yellowstone's bison herds.

- Under current management practices, inbreeding in the bison population may not be evident for a century. *See* Gross & Wang 2005, Toldness 2014, and Giglio et al. 2016 & 2018.

> Genetic diversity within a species provides the mechanism for evolutionary change and adaptation (Mitton and Grant 1984; Allendorf and Leary 1986; Meffe and Carroll 1994; Chambers 1998). Reduction in genetic diversity can result in reduced fitness, diminished growth, increased mortality, and reduced evolutionary flexibility of individuals within a population (Ballou and Ralls 1982; Mitton and Grant 1984; Allendorf and Leary 1986; Berger and Cunningham 1994). *There are four interrelated mechanisms that can reduce genetic diversity: demographic bottlenecks, founder effects, genetic drift, and inbreeding (Meffe and Carroll 1994). Over the last two centuries, bison in North America have to some degree experienced all of these mechanisms.*
>
> . . .
>
> *[T]here is no existing technology for recovering genetic material lost as a result of the bottleneck in the form of living animals. Therefore, it is imperative to maintain the existing genome, and minimize future losses in genetic diversity*.

Boyd 2003 at 60, 62 (emphasis added).

Evaluate and disclose how each alternative and action common to all alternatives, impacts and effects bison's resilience and adaptability to rapid climate change.

> The North American Bison may be sentinels of global climate change impacts on the Great Plains and prairies.

Martin & Barboza 2020 at 347.

> Body size of bison (*Bison bison*) has shrunk by 31% (Martin et al. 2018) with rising mean global temperature since the last Ice Age, and over the last 5 decades, body size of Bison has declined by 11–23% . . .

Martin & Barboza 2020 at 1 (citation omitted).

• Human exploitation of fossil fuels and the resulting pollution poses a threat to the biosphere. Fossil fuel pollution is driving rapid changes in climate across the Earth with catastrophic consequences for ecosystems and species survival.

• The collective global science on climate change predicts "increasingly drier conditions," "precipitation variability and associated drought risk will increase in many areas . . .[d]rought-affected areas will increase over low latitudes and mid-latitude continental interiors in summers" with "substantial increases in drought severity and coverage" in the western United States, and reduction in mountain glacier and snow cover, among the high confidence projections. Kallis 2008 at 95.

"It is the speed of change relative to adaptation and the magnitude of drought extremes in relation to evolved baseline conditions that are of paramount importance." Kallis 2008 at 96.

> Climate is an important driver of ungulate life-history characteristics, population dynamics, and migratory behaviors and changes in climate can directly or indirectly affect the growth, development, fecundity, dispersal, demographic trends, and long-term viability of populations as well as the timing and locations of migratory movements.
>
> . . .
>
> Direct impacts can include changes in the costs of thermoregulation or locomotion, while indirect impacts can include shifts in forage quality and quantity. Studies have documented, for example, that winter temperatures can directly affect juvenile survival and have population-level effects. . . Precipitation and temperature, through their effects on plant production and nutritional quality, can also directly and indirectly affect ungulate life-history characteristics.
>
> . . .
>
> The effects of changes in the timing of spring green-up and winter severity, two key drivers of ungulate migration in North America, have also been documented.

Malpeli et al. 2020 at 2 (endnotes omitted).

Between 1895–2012, "the annual mean monthly minimum temperature increased" by 2.9 degrees Fahrenheit, "while the annual mean monthly maximum temperature increased" by 1.2 degrees Fahrenheit in the Greater Yellowstone ecosystem. By 2100, the annual mean monthly minimum temperature is projected to increase 5 to 10 degrees Fahrenheit, and the annual mean monthly maximum temperature to increase 7 to 12 degrees Fahrenheit. Halofsky et al. 2018 at 41.

Between 1950–2018, the Greater Yellowstone ecosystem experienced an increased warming of 2.3 degrees Fahrenheit, a 25% loss in snowfall (23 inches less), with peak stream flow occurring 8 days earlier. Hostetler et al. 2021 at III. Additionally, the "average temperature of the last two decades (2001-2020) is probably as high or higher than any period in the last 20,000 yr, and likely higher than previous glacial and interglacial periods in the last 800,000 yr. Research suggests that the current level of carbon dioxide in the atmosphere is the highest in the last 3.3 million years." Hostetler et al. 2021 at VI.

Even with "significant intervention . . . beginning in the next few years" to mitigate greenhouse gases, mean annual temperature in the Greater Yellowstone ecosystem is projected to increase 5 degrees Fahrenheit by the period 2061–2080; with "little to no mitigation" mean annual temperature is projected to increase by more than 10 degrees Fahrenheit by the end of the 21st century. Hostetler et al. 2021 at VIII.

Since 1900, the Yellowstone region experienced an increased warming of 2 degrees Fahrenheit with climate scientists projecting a far more rapid warming wave from 6 to 11 degrees Fahrenheit by 2100. Human demand for resources is increasing while habitats for wildlife to adapt to a rapidly changing environment are decreasing in the Yellowstone ecosystem. Hansen 2016 entire.

The cumulative and synergistic effects of changes in land use (740% average increase in housing density since 1940, an additional 255% increase projected by 2100), spread of invasive species and displacement of native species (noxious nonnative plants account for 13% presently), and rapid climate change "are expected to dramatically impact ecosystem function and biodiversity in national parks." Hansen et al. 2014 at 484.

Fourteen protected-area centered ecosystems "*in the mountain and southwestern United States are projected to experience unsuitable climates for their present biome types across 50–86% of their areas by 2030 and up to 96% by 2090*. It is places with high projected climate change and places with topographic complexity where climate-driven biome shifts are projected to be most prevalent (e.g., Glacier, Greater Yellowstone, and Rocky Mountain in the Rocky Mountain region and Petrified Forest in the southwestern deserts)." Hansen et al. 2014 at 492–493 (emphasis added).

A vulnerability assessment for the Custer Gallatin National Forest "projected rapid changes in climate will impact the vegetation of the GYE in myriad ways both directly by shifts in growth, mortality, and regeneration, and indirectly by changes in disturbance regimes, hydrology, snow dynamics, and exotic invasions." Hansen et al. 2018 at 2.

> Climate projections indicate average temperature and precipitation will both likely increase across the GYE (Gross et al. 2016) (Figure 5A). However, increases in precipitation will not be sufficient to offset increases in drying caused by warming (Figure 5B). On an annual basis snow water equivalent and soil moisture will decline, while deficit will increase over time (Melton et al. 2016). The changing seasonality will affect vegetation primarily by initiating earlier start of growing season and imposing late season moisture deficits at lower elevations and

> lengthening growing seasons at higher elevations. An important consequence of warm temperatures in the future results from increased evapotranspiration causing "hotter drought" that increases relative seasonal water deficit regardless of precipitation amount.

Hansen et al. 2018 at 11.

> Climate change is anticipated to increase the frequency of large wildfires and increased smoke impacts.
>
> . . .
>
> [T]he majority of published science suggests that warming trends may strongly influence the frequency, intensity, and size of disturbances (such as fire and extensive insect outbreaks) in coming decades on areas of the Custer Gallatin National Forest. Changes in disturbance prompted by climate change are likely as important as incremental changes in temperature and precipitation for affecting ecosystem productivity and species composition. Recent research indicates that these risks may be particularly acute for forests of the northern Rocky Mountains.
>
> . . .
>
> All habitat guilds for regional forester sensitive or at-risk species are expected to be impacted by warming trends.
>
> . . .
>
> Increases in the severity of disturbances, combined with projected warming trends, may limit habitat for at-risk species over time.
>
> . . .
>
> Because of the uncertainty in scale, direction, and rate of climate change, management of sensitive or at-risk plant species on the Custer Gallatin National Forest focuses on maintaining persistent populations throughout the species known range on the national forest.
>
> . . .
>
> [T]here is sufficient indication from past climate records and future projections to prioritize development of effective strategies for coping with the consequences of more frequent, more severe, and longer drought (Halofsky et al. 2018a;b).
>
> . . .
>
> [E]xtreme precipitation events (such as, lapses in precipitation and more intense storms) will increase in frequency, and warmer temperatures will exacerbate the impacts of drought on forests and rangelands in the future (Vose et al. 2016).

. . .

> [D]rought in rangelands could reduce forage and water available for livestock grazing and wildlife use. Reduced vegetative cover can lead to wind and water erosion. Drought often affects wildfire-related disturbance. In addition, droughts are predicted to accelerate the pace of invasion by some nonnative plant species into rangelands.
>
> [In Montane ecosystems:]
> • By 2100, annual mean monthly minimum temperatures are projected to increase 5 to 10 degrees Fahrenheit while the annual mean monthly maximum temperatures are projected to increase 7 to 12 degrees Fahrenheit.
>
> • Winter maximum temperature is projected to increase above freezing in the mid-21st century. Summer temperatures are projected to increase 5 degrees Fahrenheit by 2060 and 10 degrees by 2100.

. . .

> • Assume the forest will burn more, that snowpack will decline, and the river flows will be reduced and manage accordingly. Temperature changes will overwhelm precipitation increases, particularly at lower tree line.
>
> • Successful management of vegetation and ecosystems during this period of rapid environmental change will require “anticipatory” planning and management.

. . .

> [M]anagers and the public should expect climate change to drive profound and often surprising changes on ecosystem structure, function, and composition in the coming decades.

Custer Gallatin July 2020 Final EIS at 63, 140, 169, 170, 173.

Evaluate and disclose how each alternative and action common to all alternatives, avoids, minimizes, or mitigates harm to bison’s resiliency and adaptability to rapid climate change.

- Rapid climate change is a threat to bison in the wild because adverse effects from multiple factors currently operating on the species and their habitat will be additive, synergistic, and cumulative across the ecosystem they depend upon for survival.

- The best available science indicates rising temperature and drought negatively affect bison body mass and predicted climate change will likely drive further declines in body size in the coming decades.

- As a result of rapid climate changes, bison’s life history traits and physiological processes will likely be adversely affected through decreases in age of maturity, declining reproduction, and growth rates, among them.

> Our data indicate that increasing temperature and drought negatively affect ABM [asymptotic body mass] of *Bison*. Additionally, our temporal and spatial mixed models contextualized variation of ABM of *Bison* explained by climatic changes in MDT [mean decadal temperature] and dPDSI [decadal Palmer Drought Severity Index]. Specifically, MDT has a greater effect on *Bison* ABM (−114.7 ± 26.7 kg/ 1°C MDT, $p < .001$) temporally at one location—WICA [Wind Cave National Park]—than spatially (−1.1 ± 0.0 kg/ 1°C MDT, $p < .001$) across multiple study sites along the Great Plains. However, dPDSI decreased *Bison* ABM (~16 ± 6 kg/ 1 dPDSI, $p \leq .007$) both temporally and spatially likely due to declines in plant productivity (i.e., eNPP) [ecological/evolutionary net primary production] and water availability (i.e., evapotranspiration) across both space and time. On a finer resolution, interannual variation in primary productivity, water availability, and heat stress may be direct causes for declines of *Bison* ABM at each site. Given climatic predications for the Great Plains for the next five decades, our models suggest *Bison* body size and ABM are likely to decline due to increases in local mean annual (and thus decadal) temperature and the worsening conditions of drought (i.e., increasing frequency and intensity). As a consequence, some life history traits that are dependent on ABM will likely shift in response to decreasing ABM, including decreases in age of maturity, declining reproduction rates, and growth rate reduction (Peters, 1983). Preliminary data suggest female *Bison* at WICA are reducing life span, potentially reducing age of maturity and thus reducing growth duration. Because ABM is an outcome of environmental conditions for this large herbivore, it is reasonable to expect that trends of increasing warming and drought may also apply to other large herbivores. Although sex explained the largest variance in both temporal and spatial models, sexual dimorphism was less pronounced in the spatial dataset than in the temporal data from WICA.

Martin & Barboza 2020 at 344.

> Changes in climate and land use/land cover are a growing concern for conservation of grasslands in *Bison* ecosystems.

Martin & Barboza 2020 at 346.

> Cooler summers are more optimal for *Bison* growth because of reduced heat loads during the growing season. Rising temperatures constrain body size and productivity of *Bison*.

. . .

> Body size of bison (*Bison bison*) has shrunk by 31% (Martin et al. 2018) with rising mean global temperature since the last Ice Age, and over the last 5 decades, body size of *Bison* has declined by 11–23% (Martin and Barboza 2020) with rising mean annual temperature along the Great Plains of North America, but what are the mechanisms driving temperature response?
>
> Body size depends on growth, which depends on maximizing net energy and nutrient flows for the production of tissues at seasonal scales across the range of the species.

. . .

> Maximum body size of endotherms depends on optimal growth of individuals and thus populations. Optimal growth depends on low costs of maintenance for the efficient production of tissues, especially in seasonal environments when food availability and environmental demands constrain the annual window for growth. High thermal loads increase costs of body maintenance to balance internal and external heat loads through thermoregulation, which ultimately reduces the energy available for growth.

Martin & Barboza 2020 at 11, 1.

The scientist's findings on bison confirm the theories of Kooijman, Schmidt-Nielsen, Speakman and Król, and Bergmann, on the role of "heat flux as a common currency" in driving and selecting for body size with corresponding influences on annual growth, reproduction, and life history traits.

> *Bison* are resilient to short duration extreme weather events such as blizzards, dry spells, heat waves, or wildfires; however, chronic droughts and warming may affect long-term life-history traits (Martin and Barboza 2020). Moreover, anticipated warming and drying along the Great Plains will shift the distribution of vegetation types by mid- and late-century to alter the supply of digestible energy and digestible nitrogen available to *Bison*, native wildlife, and domestic livestock (Tieszen et al. 1998, Craine et al. 2015, Briske 2017).

Martin & Barboza 2020 at 2.

The majority of variation in bison body size is driven by temperature and drought, which are projected to increase and become more severe across seasons in the Yellowstone region. Hansen et al. 2014 at 492 (projecting a rise in temperatures of 3.89 degrees Celsius by 2100); Hansen 2016 entire (projecting rapid warming of 6 to 11 degrees Fahrenheit by 2100).

"Unseasonably warm winter days appear to raise surface temperatures of *Bison* (Fig. 4). The frequency of these warmer winter scenarios is expected to increase in the coming decades (Wuebbles et al. 2017), which may be stressful for large animals that are well insulated with a woolly underfur and a layer of subcutaneous fat." Martin & Barboza 2020 at 9.

"Our data support Kooijman's dynamic energy budget theory (Figs. 4 and 5) because body surface temperatures were directly related to radiative loads and convective losses of energy. Schmidt-Nielsen's rule predicts that surface-area-to-volume ratio decrease with increasing body size to slow heat transfer from large animals. We found that increasing body mass increased total surface heat transfer in both an isometric and an allometric fashion (Fig. 6)." Martin & Barboza 2020 at 9–10.

"Understanding the causes driving changes in body size has important implications for reconstructing size-related relationships in ancient faunal communities, size selection, and modeling extinction probabilities in contemporary settings (Peters 1983; Tomiya 2013: E196)." Dalmas 2020 at 3.

> It appears that male and female bison are in fact decreasing in body size over time, as is evident from size plots over time and the meta-regression results (Figure 3.7).

. . .

> Considering the changes in bison body size through time . . . it appears that body size trends towards smaller bison but not linearly . . . size changes variably with the climate (Figure 3.6). . . . Bison body size may be responding to the same millennial scale variability in the climate or more likely to the corresponding environmental shifts.

Dalmas 2020 at 48, 49.

"Not only does the archaeological data support climate driven diminution but so does the ecological theory." Dalmas 2020 at 62.

> This hypothesis beckons the question; if the environment is so unfavorable for numerous megafauna presiding in North America, then why is it that bison did not go extinct while many similar species did? It may be supposed that environmental effects and selection for shorter gestation time and earlier age at maturity were great enough in North American bison to respond to changes in the climate. It is evident that body size changed rapidly during the Early Holocene, suggesting that selection for body size was strong and an effective response to climate variability. It may also be posited that bison mobility allowed for more effective movement between resource patches in a resource-limited environment.

Dalmas 2020 at 50–51.

> The relationship between body size and temperature of mammals is poorly resolved, especially for large keystone species such as bison (*Bison bison*). Bison are well represented in the fossil record across North America, which provides an opportunity to relate body size to climate within a species. We measured the length of a leg bone (calcaneal tuber, DstL) in 849 specimens from 60 localities that were dated by stratigraphy and ^{14}C decay. We estimated body mass (M) as $M = (\text{DstL}/11.49)^3$. Average annual temperature was estimated from δ^{18}O values in the ice cores from Greenland. Calcaneal tuber length of *Bison* declined over the last 40,000 years, that is, average body mass was 37% larger (910 ± 50 kg) than today (665 ± 21 kg). Average annual temperature has warmed by 6°C since the Last Glacial Maximum (~24–18 kya) and is predicted to further increase by 4°C by the end of the 21st century. If body size continues to linearly respond to global temperature, *Bison* body mass will likely decline by an additional 46%, to 357 ± 54 kg, with an increase of 4°C globally. The rate of mass loss is 41 ± 10 kg per °C increase in global temperature. Changes in body size of *Bison* may be a result of migration, disease, or human harvest but those effects are likely to be local and short-term and not likely to persist over the long time scale of the fossil record. The strong correspondence between body size of bison and air temperature is more likely the result of persistent effects on the ability to grow and the consequences of sustaining a large body mass in a warming environment. Continuing rises in global temperature will likely depress body sizes of bison, and perhaps other large grazers, without human intervention.

Martin et al. 2018 at 4564.

> Our data supported our hypothesis that global climate change drives body size of *Bison* spp., that is, as temperatures warmed, *Bison* became smaller. Generally, described as Bergmann's Rule (Bergmann, 1847), endotherms increase in body size with increasing latitude (Huston & Wolverton, 2011). It is likely that negative correlation between temperature and latitude is driving Bergmann's rule (i.e., body size) because even though we found that bison are larger at cooler temperatures, we were unable to correlate a significant effect of latitude over the geologic record ($p >$ .94). The negative relationship between body mass and global temperature may reflect underlying relationships between body size and net primary production as well as heat loads (Speakman & Król, 2010; Huston & Wolverton, 2011; Figure 1).

Martin et al. 2018 at 4569–4570.

Evaluate and disclose the natural generation times of bison and their ability to adapt body size in response to rapid climate change.

"It is unclear whether *Bison* can adapt body size to a 4°C warming within 10 generations by year 2100." Martin et al. 2018 at 4570.

> The IPCC Working Group 1 (2014) predicts 4°C rise in global temperatures by year 2100. While the absolute increase in 4°C is not unprecedented in the evolutionary history of *Bison*, the rate of temperature change is 30 times faster than the Bølling–Allerød period, the transition from the Last Glacial Maximum to Holocene climate conditions. The Last Glacial Maximum corresponds with a global temperature 6°C cooler than the 20th century, when *Bison* mass was 910 kg. If global temperature warms to +4°C as predicted for the 21st century, *Bison* body mass will likely decline from 665 kg to 357 kg (Figure 6), if body size declines at the long-term average. The greatest decline in body size of *Bison* apparently occurred between 12,500 and 9,250 years ago, when mass declined by 26% (906 kg to 670 kg) in approximately 3,000 years. If generation time of *Bison* is 3–10 years (Evans et al., 2012; Gingerich, 1993), the change in body size occurred in 325–1,080 generations producing an average rate of change of 0.2–0.7 kg per generation. It is unclear whether *Bison* can adapt body size to a 4°C warming within 10 generations by year 2100.

Martin et al. 2018 at 4570–4571.

Evaluate and disclose the impacts and effects of management actions reducing bison's range combined with climate-driven changes in the range of bison outside delineated enclosures and "tolerance" zones.

- While rapid climate change will result in more grassland and less forest there is no unexploited grassland for bison to roam because human developments, State-delineated "tolerance" zones, and State and federal disease management actions severely restrict the migratory species range and intentionally disrupt connectivity to habitat.

> Parks and preserves with geographically fixed administrative boundaries face the problem of not being able to "migrate" with the species they presently protect. As a result, cooperative management across administrative boundaries will be necessary to address the effects of climate change.

> Conservation reserve theory advocates the creation and preservation of habitat corridors to connect reserves and provide pathways for migration and dispersal (Hunter et al. 1988; Shafer 1990; Noss & Cooperrider 1994). As climate changes and the areas of potentially suitable habitat for individual taxa move across the landscape, however, corridors designed to facilitate the movement of organisms across the present landscape may no longer be optimal.

Bartlein et al. 1997 at 789.

Evaluate and disclose the impacts and effects of mangers confining bison migrations to a small portion of the Yellowstone ecosystem, and how climate change impacts the nutritional value and availability of forage in the restricted range managers delineate.

Craine sampled diets in 50 bison herds finding forbs and legumes contributed over half the protein across their range.

> Comparing the relationships between climate and dietary quality between 2018 and 2019 reveals that cooler, wetter sites generally have higher forage quality for bison than warmer, drier sites. . . . bison from cool, wet climates have the highest weight gain.
>
> . . .
>
> In all, the research presented here illuminates one of the reasons that bison might have migrated long distances in the Great Plains, similar to the Green Wave Hypothesis. Bison that began the spring in southern ranges would have experienced higher protein concentrations than those in northern ranges. Assuming they could have migrated fast enough to follow phenological development, this would have provided them with higher total protein intake than those that did not migrate. A migration rate of ~ 20 km d^{-1}, which is similar to the migration rate of caribou and saiga, would be sufficient to cover the distance between central Texas and southern Nebraska over a 2-month period. Given the interannual variation in dietary quality observed between 2018 and 2019 in June and September, it is likely that this benefit to migration would have varied among years, although more years of monitoring with data covering the entire growing season is required to more fully evaluate this question.

Craine 2021 at 8, 9 (endnotes omitted).

"Climatic warming is likely to exacerbate nutritional stress and reduce weight gain in large mammalian herbivores by reducing plant nutritional quality. Yet accurate predictions of the effects of climatic warming on herbivores are limited by a poor understanding of how herbivore diet varies along climate gradients." Craine et al. 2015 at 1.

> There was a 19% reduction in ANPP [net aboveground primary production] from 1988 to 1989, likely caused by death or injury to plants during the 1988 drought. Drought also appeared to be partially responsible for reductions in elk and bison from 1988 to 1989, which were coincident with declines in *C* [large herbivore consumption] and *D* [dung deposition]. Results indicate direct effects and suggest

> indirect effects of a single-season drought on grassland function that will persist for several years after the event.
>
> . . .
>
> Grasslands supporting abundant herds of large mammalian herbivores sustain the highest chronic rates of herbivory of any terrestrial ecosystem (Detling 1988, McNaughton et al. 1989). The effects of grazers on grasslands are profound and cascade through all trophic levels (McNaughton 1985, Detling 1988, McNaughton et al. 1988). When herbivores are migratory, their effects include additional spatial and temporal components (Senft et al. 1987, McNaughton 1989, 1990). A variety of large herbivores have been shown to exhibit habitat preferences with landscapes, including bison, *Bison bison* (Coppock et al. 1983, Norland et al. 1985), feral horses, *Equus caballus* (Turner and Bratton 1987), eastern gray kangaroos (*Macropus giganteus*), wallaroos (*M. robustus robustus*) (Taylor 1984), and both resident (McNaughton 1988) and migratory (McNaughton 1990) African ungulates. As a result, large herbivores can play an important role in determining landscape patterns of energy and nutrient fluxes. Furthermore, since the composite effects of herbivores are partially dependent on other trophic processes (McNaughton 1985) that vary temporally (e.g., soil processes; Birch 1958, Burke 1989, Burke et al. 1989), the timing of herbivore use is an important determinant of the impact of grazers on ecosystem processes.

Frank & McNaughton 1992 at 2043.

> Drought had a severe effect on grassland and shrub grassland ecosystem function. Results indicate large direct and indirect effects of drought on net energy and nutrient flux in Yellowstone. Direct drought-induced death and injury of plants reduced the base of the food web, and, thus, the energy- and nutrient-capturing capacity of the ecosystem. Direct effects on ungulate condition and indirect effects through wildfire were likely involved in the decline in elk and bison numbers, which in turn meant reductions in both consumption and nutrient flux through grazers (indexed with dung deposited at sites). The decline in grazers probably had indirect cascading effects on trophic processes that should be expected to reverberate in this grazing-dominated ecosystem until herbivore populations recover. These results show how dramatically a severe drought of one-year duration can alter ecosystem function.

Frank & McNaughton 1992 at 2056.

Evaluate and disclose how managers will respond to mass migrations of bison beyond manager delineated enclosures and "tolerance" zones in response to extended drought, widespread fire, and other adverse events.

Evaluate and disclose how managers will respond to mass migrations of bison beyond manager delineated enclosures and "tolerance" zones as a result of ice crusting events.

Evaluate the impacts and effects of managers limiting dispersal and restricting bison's range in relation to chronic, adverse environmental events.

- The forecast for warmer winters under a changing climate may result in more crusting events, that is, snow followed by rain and freezing creating an impenetrable layer of ice above available forage.

Number of years with ≥ 1 snow crusting event in bison winter ranges: 2 in Gardiner basin (1981–2004), 7 in West Yellowstone (1981–2004), 10 in Pelican valley (1981–2004), 10 in Mary Mountain (1981–2004), and 9 in Tower Falls (1989–2004). Gates et al. 2005 at 57 (Table 3.4).

> Winter severity is not the only climatic factor influencing bison populations, as suggested by Bamforth (1988), but decreases in forage availability and quality during periods of reduced precipitation can also have physiological effects on bison. In examining Early Holocene (8500-6300 BC) bison remains from the Lubbock Lake site in Texas, Johnson and Holliday (1986) found a high incidence of dental abnormalities that they attributed to poor range conditions and excess grit on the vegetation. It is also during this time period, and into the Middle Holocene, that environmental stress was being expressed phenotypically through the diminution of bison size (Holliday 1987).
>
> Historic, albeit anecdotal, references to bison having been severely impacted by severe winters is related by Roe (1970:181): "when, according to the reports of mountaineers and Indians, the snow fell to the depth of ten feet on a level. The few buffaloes that escaped starvation are said to have soon afterwards 'disappeared.'"
>
> What archeologists have demonstrated is that climate can have significant influences on bison population density, migration, and physiology.

Cannon 2008 at 79.

"Osborn (2003:210) has stated that "[s]evere winter conditions have adverse, limiting effects on ungulate distribution, abundance, body condition, reproduction, and mortality." Cannon 2008 at 78–79.

"[H]eavy mortality during exceptionally severe winters appeared most important in Yellowstone as a whole." Meagher 1973 at 111.

> Climate as an environmental regulator of bison was an important aspect of early studies of the Yellowstone bison herd (e.g., McHugh 1958). McHugh observed that yearlings and 2-year-olds were particularly vulnerable to severe winter conditions, such as deep snow that would inhibit travel and effective foraging. Calves, on the other hand, may have been less vulnerable because of their close association with

> the cows. While deep snow and limited forage quantity did not appear to be directly related to winter mortality, the combination of severe winter weather effects (i.e., deep snow, cold temperatures, distribution of available forage) would impose incremental physical stresses on the bison, particularly subordinate individuals.

Cannon 2008 at 80.

> [T]he condition of the snow may be even more important in winter survival. Deep snow, hard crusts, cold air temperature, and limited access to forage may result in greater mortality. A simple correlation between snow depth and mortality may not be a robust index for understanding winter severity. For example, early snows followed by mid-season rain and freezing can create a hard crust on the surface of the snow, limiting herbivores ability to access forage. Prolonged exposure to cold air temperatures, strong winds, and deep snow will further deplete fat reserves of animals. While some herbivores, such as bison, are bigger and stronger and can travel and forage in deeper snows, their condition going into winter also has an influence on survival (Farnes 1997:10).
>
> I calculated the snow severity index using the weighted measures as suggested by Cheville et al. (1998) and correlated it with bison populations for the northern and central herds as from 1970-1993 presented in Taper et al. (2000:Table A1).
>
> The population trend of the northern and central herds between 1970 and 1997 shows that the bison population had a strong growth rate. The only years in which the annual increment was below the regression line were severe winters (Figure 4.4). Cheville et al (1998:64) illustrate a similar trend for the entire YNP [Yellowstone National Park] population from 1970 to 1997.
>
> . . .
>
> Migration to more conducive winter range appears to be the preferred strategy of bison in order to maintain social bonds. However, while bison can survive by breaking social bonds by scattering into smaller groups to seek out areas of limited resources (e.g., geothermal areas), they preferentially move to maintain a higher level of aggregation (Meagher et al. 2002). If the area they are moving into is unoccupied, they will be able to survive largely intact. If the area is occupied, the migrating herd will either displace the resident herd or cause additional expansion of winter range. *Migrate or die seems to be a fairly accurate way to define bison behavior in relation to winter severity*.
>
> What is apparent from this short review of the effect of weather on bison is that it is a complicated issue based not only on the severity of winter, but also physiological conditions of the bison going into the winter, population size, and the ability of bison to migrate to more amenable habitats. Short-term severe weather conditions appear to play a role in bison population dynamics as illustrated in Figure 4.4 for the northern and central herds throughout the 1970s, when severe winters were common (Appendix A).

Cannon 2008 at 82–83, 85–86 (emphasis added).

“[C]limate-induced dispersal of bison from the central herd to the northern range during winter could create a source–sink dynamic that exacerbates the current controversy about management of bison . . . These movements will also complicate future analyses of bison time series because removals at the northwestern boundary can no longer be reliably assigned to the northern herd.” Fuller, Garrott & White 2007 at 1931.

“[T]he population growth rate of the central herd was negatively correlated with snow pack . . . similar to the findings of numerous studies of large ungulates in relation to winter severity (Gaillard et al. 2000, Clutton–Brock and Coulson 2002, Garrott et al. 2003, Jacobsen et al. 2004, Wang et al. 2006. We did not observe a negative effect of snow pack on the northern herd, possibly due to influx from central herd bison during or immediately after severe winters.” Fuller, Garrott & White 2007 at 1931.

“Winters are more severe in the central region of YNP [Yellowstone National Park], and the drier northern range would be a logical option for dispersing central-herd bison.” Fuller, Garrott & White 2007 at 1930.

Evaluate and disclose the additive, synergistic, and cumulative impacts and effects from rapid climate change in combination with each alternative and action common to all alternatives.

- Bison’s long distance migrations within their home ranges has been followed by a series of management actions spanning decades inside the protected area of Yellowstone National Park and on adjacent National Forest habitat that cannot be sustained in a rapidly changing climate.

- Instead of creating and preserving habitat corridors to connect bison with reserves and refuges to cope and adapt with environmental conditions and rapid climate change, State and federal managers are permitting barriers and traps to thwart migration and killing the migrants en masse.

- As the climate rapidly changes, and suitable habitats shift resulting in bison migrations beyond the fixed boundaries of protected areas, without corridors and pathways for migration and dispersal to cope with chronic environmental and human stressors, the risk of local extinction for bison increases exponentially.

As part of our scoping comments, Buffalo Field Campaign is submitting an electronic copy of our sources for review and incorporation into Yellowstone National Park's Environmental Impact Statement and development of a respectful bison management plan.

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