September 20, 2023

Office of the Superintendent
Yellowstone National Park
Attn: Bison Management Plan
P.O. Box 168
Yellowstone National Park, WY 82190

Dear Superintendent Cameron (Cam) Sholly,

Thank you for the opportunity to provide public comment on the Yellowstone National Park Bison Management Plan Draft Environmental Impact Statement. Please accept these comments on behalf of Buffalo Field Campaign and Western Watersheds Project.

Buffalo Field Campaign works to stop the harassment and slaughter of Yellowstone's wild buffalo herds; protect the natural habitat of wild, free-roaming buffalo and other native wildlife; and work with all people—especially Indigenous Nations—to honor and protect the sacredness of the wild buffalo.

Western Watersheds Project works to protect and conserve the public lands, wildlife, and natural resources of the American West through education, public policy initiatives, and litigation. Western Watersheds Project staff and members use and enjoy the public lands of Yellowstone National Park and the Greater Yellowstone Ecosystem in Montana, Wyoming, and Idaho and their wildlife, cultural, and natural resources for health, recreational, scientific, spiritual, educational, aesthetic, and other purposes.

Sincerely,

James L. Holt, Sr. Executive Director
Buffalo Field Campaign
PO Box 957
West Yellowstone, MT 59758
(406) 646-0070
Buffalo@buffalofieldcampaign.org
www.buffalofieldcampaign.org

Patrick Kelly-Montana Director
Western Watersheds Project
P.O. Box 8837
Missoula, MT 59807
(208) 576-4314
patrick@westernwatersheds.org
www.westernwatersheds.org

The National Park Service should scrap this plan and start over with the involvement of the U.S. Forest Service, a public trustee for the buffalo's National Forest range and habitat.

The National Park Service's planning process is flawed because it does not include the U.S. Forest Service, and thereby excludes the buffalo's National Forest range and habitat contiguous with Yellowstone National Park.

Without the involvement of the U.S. Forest Service, an ecosystem based approach to restoring self-sustaining wild buffalo herds cannot be achieved because millions of acres of National public trust lands are left out of the planning process.

The National Park Service cooperated with the U.S. Forest Service in 2000 and can do so again using an ecosystem-based planning process that includes the entirety of the buffalo's National Forest range and habitat.

In addition to the fact that involvement of the U.S. Forest Service in this plan would simply make ecological sense and benefit buffalo, collaboration with other federal agencies has also now been explicitly mandated by the Secretary of the Interior. Issued by Secretary Deb Haaland on March 3, 2023, Order No. 3410 gives all Interior agencies a wide-ranging list of goals and directives, all aimed at the following purpose:

> "[T]o enhance the Department of the Interior's (Department) work to restore wild and healthy populations of American bison and the prairie grassland ecosystem through collaboration among the Department's Bureaus and partners such as *other federal agencies*, states, Tribes, and landowners using the best available science and Indigenous Knowledge.

Secretary of the Interior 2023 at 1 (emphasis added).

The failure of the National Park Service to meaningfully engage with the U.S. Forest Service, specifically, the Custer Gallatin National Forest, flies directly in the face of the Secretary's Order and hinders the goal of enhancing buffalo populations in Yellowstone National Park and on the National Forest. Given that the Custer Gallatin's Forest Plan allows for "expanded tolerance" of buffalo on the National Forest, the National Park Service missed the opportunity to work closely with another federal agency to develop an ecosystem-based plan that would seamlessly dovetail with the Custer Gallatin's Forest Plan "to support a self-sustaining population" of wild buffalo. Custer Gallatin 2020 at 58, 57.

This not only fails the buffalo within the Park, it also fails to satisfy one of the core directives in the Secretary's Order. Expressing the vague intent to "continue to collaborate" with the Custer Gallatin National Forest in the future is a clear attempt to kick the can down the road, rather than take the opportunity to collaborate in restoring wild and healthy populations of American bison. Yellowstone National Park DEIS 2023 at 17.

The National Park Service cannot continue to act as though its' responsibilities to buffalo stop at Yellowstone National Park's boundaries. Not only is this ecologically untenable, it is also a violation of an explicit order given by the Secretary of the Interior. There is still a chance to correct this by conducting a robust analysis of buffalo expansion into the Custer Gallatin National Forest and to partner with another federal agency in the planning process to restore and expand wild herds across their indigenous range.

Actions common to all alternatives and any future plan should include:

- Protecting connectivity to habitat for wild buffalo.

- Getting rid of zones prohibiting buffalo's freedom to roam National public trust lands.

Montana Dept. of Livestock & Fish, Wildlife & Parks 2000 at 8, 14 ("Zone 3 is the area where bison that leave Zone 2 will be subject to lethal removal.",). Incorporated as an objective in the government's annual operating plan. Interagency Bison Management Plan 2022 at 2 ("Clearly define a boundary line beyond which bison will not be tolerated.").

Stop ceding National public trust authority for wildlife and public lands to Montana, a State that has demonstrated it has no interest in conserving a self-sustaining wild buffalo population.

- The "success of the proposed alternatives is contingent upon Montana's cooperation and agreement."
- The assumptions of allowing more buffalo to roam across a larger landscape for public and tribal hunters "are incorrect."
- "Montana's tolerance is limited" and expansion of government-imposed "tolerance" zones "presumes too much."
- "[T]he failure to successfully meet the 3,000 goal does not mean that the goal should be changed, or, worse, revised to embrace failed management." (Demanding the baseline for analyzing "No Action" should be the government's agreed upon overall target population of 3,000 buffalo as decided in 2000).
- The alternatives should include "an in-park disease suppression regime" targeting buffalo.

Gov. Gianforte 2022 at 1–4.

Self-sustaining buffalo herds can be realized far into the future by including millions of acres of National Forest habitat contiguous with Yellowstone National Park.

Intertribal cooperation among hunters can help buffalo reach more habitat on National public trust lands. Retaining knowledge of secure habitat to roam is an important learned behavior for sustaining future generations of buffalo.

Scrap this plan and start over. The National Park Service already did so when the agency re-initiated public scoping in 2022 and terminated its 2015 scoping notice with the intransigent State of Montana. 87 Fed. Reg. 4653, 4656 (Jan., 28, 2022).

Yellowstone National Park's range of alternatives fail wild buffalo and need to be scrapped.

An additional justification to scrap this plan and start over begins with Yellowstone National Park's range of alternatives which are not based on sound science, and do not meet the principles of managing buffalo as a wild species.

The "No Action" Alternative 1 is not a true no action alternative.

Buffalo Field Campaign asked for Yellowstone National Park to examine a No Plan alternative as a baseline to compare the range of alternatives, such as managing wild buffalo like wild elk, for the public to comment on. Had it done so, the public would be able to examine and comment on how managing cattle in Designated Surveillance Areas is protecting the tri-state region's cattle industry.

Yellowstone National Park is obligated to avoid harm and minimize management actions, and thereby reduce adverse consequences for buffalo and the ecosystem the wild species depends on for adaptation and survival. Yellowstone National Park could have done so, and it didn't.

Continuing with costly, intensive, and destructive management actions targeting wild buffalo for government removal is based on "incorrect" premises, "unproven" assumptions, "perpetuated myths and misperceptions" that the public would be made aware of had Yellowstone National Park examined a No Plan alternative or an alternative to manage wild buffalo like wild elk. (Quoting in part P.J. White, Rick Wallen, and Chris Geremia, *Resolving Intractable Governance Issues to Recover Wild Bison While Maintaining Public and Tribal Trust*, (unpublished manuscript 2018 at 13) ("*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."*).

Hence, there is no examination of and the public cannot comment on the effects, benefits, and costs of an environmentally preferred No Plan alternative or a manage-wild-buffalo-like-wild-elk alternative.

While Yellowstone National Park claims Alternative 2 would reduce trauma and injuries to buffalo with "increased use of low-stress handling techniques," the agency avoids evaluating the actual incidence of trauma, injury, trampling, goring, death by stress, calf abandonment, and other adverse effects spanning more than two decades of management actions. Yellowstone National Park DEIS 2023 at 52.

Reducing wild buffalo to captivity is unavoidably stressful and traumatic. Government trapping and holding in captivity is a technique used in domesticating buffalo taken from the wild. As such, Yellowstone National Park's plan fails to meet the principles of managing buffalo as a wild species.

Under all alternatives, doubling the "input and output" of buffalo trapped for quarantine inside Yellowstone National Park will increase the number of buffalo shipped to slaughter. Yellowstone National Park DEIS 2023 at 11.

Trapping for slaughter will not "immediately cease" if Yellowstone National Park continues to trap buffalo for quarantine. Yellowstone National Park DEIS 2023 at iv, 27. Slaughtering buffalo is a feature of quarantine. Quarantine is also domestication.

It is highly objectionable to turn Yellowstone National Park into a factory of inputs and outputs that deprives buffalo of a natural life in the wild.

Alternative 3 does not resemble an alternative to manage wild buffalo like wild elk, that is, a plan favoring wild buffalo freely roaming the same range and habitat permitted to wild elk.

Furthermore, Yellowstone National Park misrepresents how wild elk are managed in Montana.

> If the risk of bison mingling with livestock increases in the future, the NPS would take more aggressive management actions, such as increasing captures, hazing, hunting outside the park, and removals, in collaboration with other IBMP partners. Montana uses these techniques to manage brucellosis transmission risk from elk mingling with livestock in the Paradise Valley (Rayl et al. 2019) and, for over two decades, the IBMP partners have demonstrated these same techniques work for bison.

Yellowstone National Park DEIS 2023 at 30 (government trapping and harassing buffalo from habitat are techniques that are used against, not for, wild buffalo; the techniques work for managers in getting rid of buffalo).

> 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.

Neither the State of Montana nor Yellowstone National Park captures wild elk for mass slaughter, or excludes elk migrations across millions of acres of range and habitat, or harasses elk from entire landscapes in government-led hazing operations. All of these management actions are common to all alternatives proposed for wild buffalo.

Whatever risk is present can be managed on small, local scales by limiting actions to move female-led groups of buffalo away from cattle ranches.

The government's sledge-hammer approach excluding buffalo from reaching vast ranges and habitat throughout the ecosystem is unreasonable and unjustified as pointed out by Yellowstone National Park biologists in an unpublished manuscript. White, Wallen & Geremia 2018 entire.

State and federal managers need to stop using a sledgehammer on buffalo across large geographical scales when and where cattle are not present.

The lack of a coherent alternative for managing a localized risk, if any exists, is a serious defect in manager's plans for conserving wild buffalo in the wild.

The lack of scholarly analysis also keeps the public in the dark about the "adverse demographic and genetic effects" of "frequent, large" scale Yellowstone National Park buffalo capture for slaughter operations. Yellowstone National Park DEIS 2023 at 55.

Yellowstone National Park has had over two decades to collect, examine, and publish scientifically relevant data and it has not done so. As a consequence, the public cannot determine the full extent of management action's adverse effects on the population structure of the Yellowstone buffalo population and viability of each distinct herd. This is a significant gap in "scholarly analysis" that must be examined for the public to see and comment on.

For far too long, the effects of frequent, large scale slaughter of wild buffalo have been an unexamined feature of the government's outdated and unscientific plan.

Yellowstone National Park must stop hiding the effects of its management actions behind deceptive words like "could," a word too often used in place of actual analysis of evidence.

> Differential killing significantly reduced the Central herd's numbers and growth; non-random, large-scale killing "could have consequences that persist for multiple generations" in long-lived, age-structured buffalo subpopulations.

White et al. 2011 at 1331.

> "Due to risk management and other concerns, more than 3,600 bison were removed from the population during 2001 to 2010, with more than 1,000 bison and 1,700 bison being removed from the population during winters 2006 and 2008, respectively. These culls unintentionally removed more calf and female bison from the central breeding herd which, if continued over time, could result in alterations of the sex and age structure of the population and consequent changes in demographic processes that could persist for decades (White et al. 2011)."

Geremia et al. Sept. 2011 at 2.

> "*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.

Despite manager's public assurances recurrent, large-scale government slaughters occurred again with >1,200 buffalo killed in 2016–2017 (23% of the total population) and >1,100 buffalo killed in 2017–2018 (24% of the total population). Geremia et al. Sept. 2018 at 1, 17.

Recommendations by park biologists "to remove bison in proportion to their occurrence in the population," do not represent actual year-to-year killing of buffalo in government management actions. "As a result, the 2018 population continued to move away from objectives for sex ratio and juvenile proportion." Geremia et al. Sept. 2018 at 8.

As a result of government management actions, park biologists report "limited observations" of older-aged buffalo. Autellet et al. 2015 at 86.

The consequences of losing this vital age-structured demographic in Yellowstone's herds, and the evolved social and dominance relations around older-aged adults, combined with the forecast for more "frequent, large" scale government slaughter bodes ill for wild buffalo.

Alternatives driving management actions that alter, adversely effect, or artificially select against wild traits and genetic diversity, and buffalo's natural resistance and immunity to disease need to be scrapped.

Yellowstone National Park failed to examine and take into account that cattle are being managed in Designated Surveillance Areas as an action common to all alternatives, and thereby the "identified need" for another intrusive buffalo population management plan.

Yellowstone National Park deprived the public of examining an important change driving the unstated but primary purpose of yet another heavy-handed government plan: cattle are being managed in Designated Surveillance Areas in the buffalo's range and habitat, and the industry is protected by the new rules.

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.

Over two decades ago, the overwhelming majority of the public indicated "extremely strong support" for managing cattle and letting buffalo freely roam National public trust lands in the ecosystem. U.S. Dept. of the Interior & U.S. Dept. of Agriculture Record of Decision 2000 at 21 ("[T]he environmentally preferred alternative" is the one that "causes the least damage to the biological and physical environment and best protects, preserves and enhances historic, cultural and natural resources.").

Despite numerous accounts of wild elk infecting cattle with brucellosis, the U.S. Dept. of Agriculture-approved rules have protected each State's brucellosis free status in Montana, Idaho, and Wyoming.

Based on a review of the best available science, buffalo's biological behavior, the presence of scavengers, and environmental conditions conspire to reduce and prevent the risk of disease transmission to cattle in the buffalo's range. Cheville et al. 1998 at 51 ("Predation and scavenging by carnivores likely biologically decontaminates the environment of infectious *B. abortus* with an efficiency unachievable in any other way."); Aune et al. 2012 at 260 ("[O]ur 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.").

> Regardless of habitat type or management strategies, the amount of time fetal units remained on the landscape before they were removed by scavengers in our study area was less than the estimated time *B. abortus* remains viable on the landscape (several days to weeks; Cook et al. 2004, Aune et al. 2012). Because the amount of time *B. abortus* remains on the landscape is directly tied to transmission risk (Aune et al. 2012, Cross et al. 2015), our research indicates scavengers, particularly coyotes, eagles, and foxes, are important species on the landscape for removing brucellosis transmission risk, especially on private rangelands.

Szcodronski & Cross 2021 at 11.

Even under a No Plan alternative, whatever quantifiable risk exists is localized, "predominantly low," "zero under all scenarios," and is being addressed by managing cattle. Kilpatrick et al. 2009 at 1, 8.

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

Avoid, minimize, and mitigate harm to buffalo by considering cattle are being managed in Designated Surveillance Areas in a manner protecting the States' cattle industry.

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 needs to take these new rules and conditions and its own management policies into account in selecting actions common to all alternatives, and articulating the "identified need" for a plan.

Yellowstone National Park's characterization of the Yellowstone buffalo population is not based on the best available science and fails the "scholarly analysis" National Park Service management policies require.

> Yellowstone bison are one of a few populations that meet the viability guidelines recommended by scientists (Freese et al. 2007; Sanderson et al. 2008; Hedrick 2009; Dratch and Gogan 2010; Gross et al. 2010). Geneticist Dr. Philip Hedrick at the University of Arizona indicated "[i]ndividual herds or clusters [of bison] should have an effective population size of 1000 (census number of 2000-3000) to avoid inbreeding depression and maintain genetic variation. If it is not possible to have this primary herd in 1 location, then it could be in 2 or 3 locations with significant genetic exchange between them. Note that this is larger than any of the plains bison herds except for Yellowstone NP [National Park] and any of the wood bison herds except for Wood Buffalo NP and Mackenzie Bison Sanctuary in Canada" (Hedrick 2009:419). Although there is evidence of genetic differences between bison sampled in the central and northern breeding herds (Halbert et al. 2012), monitoring of radio-collared bison suggest Yellowstone bison are a single intermixing population during recent decades, with substantial movements, breeding, and gene flow between bison originating from central and northern Yellowstone (White and Wallen 2012; Wallen and White 2015; Forgacs et al. 2016). Thus, Yellowstone bison meet Dr. Hedrick's criteria for sustaining an effective population size and maintaining genetic variation.

Yellowstone National Park DEIS 2023 at 47–48.

Yellowstone National Park's statement fails the "scholarly analysis" required by National Park Service management policies.

Yellowstone National Park is also misleading the public by misrepresenting the science.

First, there has been no scientific study of Yellowstone buffalo population viability despite the fact that Yellowstone National Park identified long-term population viability as a high priority more than two decades ago. U.S. Dept. of the Interior and U.S. Dept. of Agriculture 2000 Final EIS Vol. 1 at 731.

Second, Geneticist Dr. Philip Hedrick, Arizona State University, is one of the co-authors of the peer-reviewed study published in 2012 finding "strong evidence for the existence of 2 genetically distinct subpopulations of bison." Halbert et al. 2012 at 368.

Third, White and Wallen's 2012 response contained no new data to refute Halbert's findings.

Fourth, the reference to Wallen and White 2015 to support the Park's suggestion of "a single intermixing population during recent decades" is premised on a paper that has not been peer-review published nor is it readily available in the public domain: variously referenced as Wallen et al. 2013 and Wallen et al. 2013 updated.

> These observations of female emigration and subsequent reproduction on a new breeding range support estimates of 10 to 20 genetic migrants per decade based on recent sampling of microsatellite genotypes (Wallen et al. 2013).

Wallen and White 2015 at 124.

Does Wallen's unpublished data provide evidence of a substantial number of males and females from the Central herd breeding with the Northern herd, and a substantial number of males and females from the Northern herd breeding with the Central herd, each generation? Does "10 to 20 genetic migrants per decade" represent significant gene flow in a population of 4,000 buffalo?

> [I]t is quite difficult to distinguish between genetic differences caused by human actions and important ancestral variation contained in separate populations without data from early time periods. Therefore, to not lose genetic variation that may be significant or indicative of important genetic variation, the generally acceptable management approach is to attempt to retain this variation based on the observed population genetic subdivision (Hedrick et al. 1986).
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> [E]mpirical genetic data are needed to establish the subpopulation origin of individuals: movement of individuals is not equal to gene flow. Furthermore, even if higher gene flow is occurring today, unidentified loci, differentiated due to selection, may be still present among the YNP subpopulations.

Halbert et al. August 2012 at 754, 754–755.

Yellowstone National Park has had a decade to subject its' data and research to peer review and it has not done so.

At the same time, Wallen and White admit population subdivision is evident in the Yellowstone buffalo population:

> Bison that live in the central and northern regions of Yellowstone have significantly different distributions of alleles and genotypes, and are genetically distinguishable based on 20 alleles only found in one of the two regions (14 central; 6 northern; Halbert et al. 2012).

Wallen and White 2015 at 123.

Finally, Yellowstone National Park's citation to Forgacs to support the suggestion of a "single intermixing population" is misleading as Forgacs' objective was to investigate whether Yellowstone buffalo carried an hypothesized, detrimental mitochondrial DNA and mitochondrial DNA haplotype

diversity, not population substructure or subdivision. Forgacs et al. 2016 at 2; Wallen and White 2015 at 123.

While Forgacs found mutations in the Northern herd and not in the Central herd, the scientists did not find evidence the mutations were harmful due to "the lack of any kind of reported lesion or disease" affecting "a large proportion of Yellowstone bison." What they did find was significant: ten unique haplotypes from 25 Yellowstone buffalo 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.

Halbert's evidence of genetically distinct subpopulations is based on a STRUCTURE analysis using 46 nuclear microsatellites from 661 Yellowstone buffalo sampled from 1997–2003. Halbert et al. 2012 at 362.

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

> The reason for the difference in the findings could be due to differences in the structure and function of the genomic regions analyzed, the differences in mutation rates, and the sensitivities of the statistical tests used.
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> 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 et al. 2016 at 5, 7.

Recognition of subpopulation structure is essential for conserving genetic variation because it reduces the effective population size of Yellowstone buffalo. Another way of expressing this risk is subpopulation structure requires larger census sizes for each herd to avoid inbreeding and maintain genetic diversity in the wild.

State and federal government actions have decimated the Central herd, an indicator that one of the essential backups in the Yellowstone buffalo population is failing to recover from systematic pressures. Geremia 2022 at 5–6 (documenting a significant loss in the Central buffalo herd from 3,553 to 847 in the period 2005–2017).

From 2008 to the present, the number of Central herd buffalo has been far below conservation biology thresholds "to avoid inbreeding depression and maintain genetic variation." Geremia 2022 at 5–6 (Table A1); Hedrick 2009 at 419.

Intensive human selection for disease control has whip-sawed the size of Yellowstone's subpopulations with the Northern herd fluctuating from 590 to 4,507 (2000–2022), while the Central herd was decimated and severely reduced from 3,553 to 1,432 (2005–2022) with a low of

847 counted in 2017. Geremia 2022 at 5–6; Halbert et al. 2012 at 368 (57% of the Northern herd killed in 1996–1997).

This is not a comment on Halbert versus Wallen and White with Forgacs refereeing for new science. There is far more distinction that is at risk if Yellowstone National Park maintains its course based on a suggestion and not the best available science. Significant findings of herd distinctions in the Yellowstone buffalo population include:

- Different tooth wear patterns (Christianson et al. 2005 at 674).
- Different 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. Feb. 2011 at 6).
- Spatial separation between herds (Olexa & Gogan 2007 at 1536).
- Differences in diet (Birini & Badgley 2017 at 6–7).
- 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).
- Detection of strong substructure in mitochondrial DNA (Gardipee et al. 2008).

Furthermore, the ecological settings for the Central and Northern herds are distinct, reflecting the geographic, genetic, and life history variation found in the Yellowstone buffalo population.

> Ecological conditions differ between the Northern and Central ranges in Yellowstone National Park (Chapter 3), making it necessary to consider population and distribution trends of Northern and Central bison subpopulations separately. Two previous analyses have considered YNP bison as if they were one population (Cheville et al. 1998, Klein et al. 2002). Lumping population subunits ignores important gradients in environmental conditions between YNP bison ranges that differentially influence reproduction and survival, and spatial ecology of bison, elk and their predators.
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> Ecological conditions are markedly different on the Northern and Central bison ranges requiring separate consideration of population and trophic ecology. On the Northern Range, reduced snow cover in the grassland habitat of the Gardiner basin provides refuge habitat for bison during harsh winters. In contrast, there is no range-wide gradient in snow conditions on the Central Range. Rather, geothermally-influenced areas provide refuge for a significant part of the Central subpopulation in harsh winters.

Gates et al. 2005 at 113, 127.

Based on genetics alone, an effective population size of 5000 adults or more is needed for long-term viability of buffalo to adapt and persist in an ecosystem undergoing 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-Soulé 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.
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> 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-Soulé number, increasing the management goal from *Ne* = 500 to *Ne* = 5000.

Lande 1995 at 782, 786.

> Synergistic interactions among different genetic and demographic factors contributing to the risk of population extinction (Gilpin & Soulé 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.").

While Yellowstone National Park does not recognize strong scientific evidence of genetically distinct subpopulations, the agency has the discretion to prevent irreparable harm in the face of uncertainty.

Using the precautionary principle and commencing with the additional studies Forgacs recommended to determine Yellowstone buffalo's population structure is a prudent approach.

In the meantime, there is no harm in adopting the recommendation of conservation biologists who call for a census of 2,000–3,000 for each individual buffalo herd in the Yellowstone population to "avoid inbreeding depression and maintain genetic variation." Hedrick 2009 at 419.

> *Maintain More than 1,000 Bison in the Central and Northern Breeding Herds:* Bison breed in northern or central geographic regions of the park with some interchange of animals between breeding areas among years (Wallen and White 2015). The founding maternal lineages of the population are found in both breeding areas (Forgacs et al. 2016). The NPS would seek to maintain more than 1,000 bison in each breeding area to help protect any existing unique diversity or rare alleles (genes) within each area (Hedrick 2009).

> *Sustain a Viable, Wild Population*: A population viability analysis indicates Yellowstone bison should retain about 95% of existing allelic (genetic) diversity for neutral nuclear microsatellites ('genes') for centuries with total abundance averaging at least 3,000 to 3,500 bison, provided intermixing and gene flow continue between bison in the two primary breeding herds (Pérez-Figueroa et al. 2012). However, more diversity is expected to be lost unless removals are mainly or only juveniles (Pérez-Figueroa et al. 2012).
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> Under any alternative, the NPS does not want bison abundance to decrease below 3,500 total in the population because this could substantially decrease genetic diversity (Halbert et al. 2012; Pérez-Figueroa et al. 2012; see Alternatives and Alternative Elements Considered but Dismissed from Detailed Analysis).

Yellowstone National Park DEIS 2023 at 14–15.

The citation to Hedrick fails to support Yellowstone National Park's objective of more than 1,000 buffalo in each breeding territory "to help protect any existing unique diversity or rare alleles (genes) within each area (Hedrick 2009)."

"There is no justification to select for preservation of specific rare bison microsatellite alleles in populations." Hedrick 2009 at 419.

The Park's citation is also misleading, as an effective population size of 1,000 buffalo requires a census of 2,000 to 3,000 for each individual herd or cluster.

Hedrick recognized the Yellowstone buffalo population experienced a "2-generation bottleneck" from a small number of founders "which may have reduced overall genetic variation in the Yellowstone herd." Hedrick 2009 at 417.

Hedrick also recognized that the "large ancestral population size and high amounts of ancestral gene flow" may not reflect the genetic variation in the few, isolated buffalo populations remaining in the wild today.

> When the total number for plains bison was in the many millions and there was generally gene flow throughout the subspecies, there presumably was high variation for genes having detrimental, neutral, and advantageous effects. . . . if the variation at neutral loci or sites is lower today than historically, this may indicate significant bottleneck effects and a consequent potential for increase in some detrimental variants.

Hedrick 2009 at 419.

Hence, Hedrick's recommendation is for much larger census sizes than the Park's objective of more than 1,000 buffalo in each breeding territory.

Pérez-Figueroa et al. 2012 is a model with too many uncertainties, unknowns, and assumptions that Yellowstone National Park has not ground-truthed using real data since its' publication. Among the assumptions, limits, and qualifications of the model the authors identified include:

> • Yellowstone is one deme (an interbreeding group within a larger buffalo population).
> • Actual male reproductive success in buffalo is unknown (four scenarios were used).
> • DNA-based paternity analysis was not used (the data is not being collected).
> • Selection and mutation were not included.
> • Actual levels of allelic diversity could be even higher than those obtained in the model's simulations (mutation was not considered; selection could enhance genetic diversity in isolated ungulate populations).
> • Culling was random among all age classes or random within age groups.
> • Culling was conducted whenever population size exceeded a threshold value of 4,500 or 3,500 depending on the scenario.
> • Individuals were culled until the target population size (2,500 or 3,000) was reached (loss of family group lineages were not considered).

Pérez-Figueroa et al. 2012 at 165, 161, 164.

Furthermore, the authors "did not consider high variance in female reproductive success or heritability of fitness, both of which could increase the rate of loss of variation (heterozygosity) by perhaps 10-20% (Ryman et al., 1981)." Pérez-Figueroa et al. 2012 at 165.

Not wanting a total population that does not fall below 3,500 assumes biologists know and understand what alleles or functions will be lost.

> With current population levels and lesser population goals, the significance of a gradual loss of alleles due to natural genetic drift is uncertain. A bison herd of 2000–3000 animals has been estimated to lose 5% of its alleles, due to drift, each 100 years. However, at important immune-system loci, and at other loci with relatively rare alleles, this loss may be at least 10% . . .
>
> The most important concern for current genetic adequacy of Yellowstone bison is the replacement of much natural selection by hunting and by capture for slaughter and other removals. These practices contribute to drift for many alleles and replace much natural selection for post-juvenile animals.
>
> . . .
>
> Effects of the comparative weakening of natural selection upon the wild bison genome will occur gradually over decades and may defy detection. But evolutionary theory predicts such negative effects upon wildness. For the nation's only wild plains bison herd, extremely conservative prudence is justified. The ultimate goal should be to limit the effects of a preponderance of human-caused mortality and to maintain the irreplaceable wildness of Yellowstone bison. But the future of a truly wild Yellowstone bison herd depends largely upon Montana's position on allowing bison outside the Park.

Bailey 2017 at 2, 3.

Pérez-Figueroa is also not a population viability study which looks at a number of factors and threats, for example, the synergistic effects of rapid climate change, extended drought, severe winter, loss of range and habitat, loss of migration corridors, and buffalo's resilience to changing circumstances in the face of management actions imposing exclusionary boundaries limiting migration.

It is axiomatic that the less habitat available for wild buffalo to adapt and evolve, the greater the risk to long-term viability and persistence for each distinct herd in a population that has been isolated for over 120 years.

Incorporate a safety-net halting lethal government management actions if a subpopulation or distinct herd is below the census of 2,000–3,000 buffalo.

Incorporate a mechanism reporting to managers and Indigenous tribes with treaty hunting rights, the movement of any herd below the conservation biology threshold that could be subject to government management action or harvest.

Wild buffalo should have freedom in defining their own biological presence on National public trust lands for perpetuating natural variation and evolutionary resilience in the Yellowstone ecosystem and the Greater Yellowstone bioregion.

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.

Yellowstone buffalo have lived in isolation for more than 120 years, and there is no prospect of significant gene flow with any other wild population, if any remain.

A series of population bottlenecks, few founders, relatively small population sizes (a consequence of limiting range and loss of habitat), and long-term isolation (a consequence of loss of migration corridors and natural connectivity between wild buffalo populations) are cautionary factors supporting the clarion call to prevent loss of genetic diversity in Yellowstone's distinct and unique buffalo herds whatever the cost.

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