Title: Integrated evidence-based extent of occurrence for North American bison since 1500 CE and before

INTRODUCTION

Evaluation of species restoration success requires an accurate and precise baseline for comparison (Burney and Burney 2007, Wingard et al. 2017). Additionally, examination of potential and realized ecological niches hinges upon precise and accurate occurrence data that elucidate relationships between species distributions, environmental traits, and climatic change (Castellanos et al. 2019, Wang et al. 2020). Temporal fidelity is as important as geographic fidelity, because Pleistocene and Holocene global temperature and climate has been widely variable with discrete events, such as the Last Glacial Maximum, Younger Dryas, mid-Holocene Climatic Optimum, Medieval Warm Period (MWP), and Little Ice Age (LIA) (Mayewski et al. 2004, Westover and Smith 2020).

This dataset, compiled as a meta-analysis of many sources, originated as a request from the International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Bison Specialist Group (BSG) to document the maximum historic extent of occurrence (EOO) of bison over the historic period (i.e., since 1500 CE). Our aim was to establish an evidence-based dataset that integrates multi-disciplinary observations that have high data quality and thus high confidence of occurrence to best inform the upcoming Red List and Green List assessments for the species and contribute the historic EOO as a new resource for the species' entry on the IUCN website (https://www.iucnredlist.org/species/2815/123789863) (IUCN SSC Red List Technical Working Group 2021). However, additional project justifications come from discussions in Akçakaya et al. (2018, 2019), Sanderson (2019), and Stephenson et al. (2019) in regards to establishing various restoration benchmarks at either 1750 CE (≈200 years Before Present [yBP]) or 1500 CE (≈450 yBP) in North America.

While we present a historic EOO for bison since 1500 CE below, it is conceivable to create extents of occurrence for bison in various other time periods. That is, other time periods may be of particular interest to explore effects of earliest human arrival or climatic changes over the deeper geologic records. For example, one component often omitted from the literature is the role of global climatic conditions during the late Holocene, especially the Medieval Warm Period (MWP; 950–1250 CE, ≈700–1000 yBP), the subsequent Little Ice Age (LIA; 1450–1850 CE, ≈100–500 yBP), and the transitional phase between these two events. The approximate 2.5°C global temperature difference between these two events would have caused drastic changes in animal biogeographic distribution (Koch and Barnosky 2006, Wanner et al. 2008, Trouet et al. 2009, Viau et al. 2012). The former, MWP, would be more like the temperature conditions currently experienced across the globe. The latter, LIA, was accompanied by colonial westward expansion, introduction of exotic livestock species (i.e., cattle (*Bos taurus*), horses (*Equus caballus*), sheep (*Ovis aries*), etc.) and associated novel diseases (i.e., Texas tick fever, bluetongue, malignant catarrhal fever, etc.), and overharvesting of game populations (Hornaday 1889, Stoneberg Holt 2018). However, during the MWP, the human population was less numerous and largely Indigenous, and the anthropogenic pressures were likely less compared to LIA or today (Hill et al. 2008), offering a more “natural” biogeographic distribution of animals especially in North America. Therefore, mapping the historic EOO of bison during this time is critical for a more accurate and comprehensive baseline assessment of bison restoration and understanding their former realized niche prior to being anthropogenically driven to near extinction during a time similar to current levels of global warming at approximately 1°C above the 20th century average.

METADATA

CLASS I. DATA SET DESCRIPTORS

A. Data set identity:

Title: Integrated evidence-based extent of occurrence for North American bison since 1500 CE and before

B. Data set identification code:

Suggested Data Set Identity Codes: bison_presence_dataset.csv

C. Data set description:

1. Originators: *Jeff M. Martin*, Center of Excellence for Bison Studies, South Dakota State University, Rapid City, South Dakota, USA and Department of Animal Science, South Dakota State University, Brookings, South Dakota, USA; *Rachel A. Short*, Texas A&M University, College Station, Texas, USA and Georgia Institute of Technology, Atlanta, Georgia, USA; *Glenn E. Plumb*, International Union for the Conservation of Nature, Gland, Switzerland; *Lauren Markewicz*, Parks Canada, Gatineau, Quebec, Canada; *Dirk H. Van Vuren*, University of California–Davis, Davis, California, USA; *Bradly Wehus-Tow*, South Dakota State University, Brookings, South Dakota, USA; *Erik Otarola-Castillo*, Purdue University, West Lafayette, Indiana, USA; *Matthew E. Hill, Jr.*, University of Iowa, Iowa City, Iowa, USA.

2. Abstract: Following the near extinction of bison (*Bison bison*) from its historic range across North America in late 19th century, novel bison conservation efforts in the early 20th century catalyzed a popular widespread conservation movement to protect and restore bison among other species and places. Since Allen’s initial delineation (1876) of the historic distribution of North American bison, subsequent attempts have been hampered by knowledge gaps about bison distribution and abundance previous to and following colonial arrival and settlement. For the first time, we apply a multi-disciplinary approach to assemble a comprehensive, integrated geographic database and meta-analysis of bison occurrences over the last 200,000 years BCE, with particular emphasis over the last 450 years before present. We

combined paleontology, archaeology, and historical ecology data for our database totaling 6,438 observations. We derived the observations from existing online databases, published literature, and first-hand exploration journal entries. To illustrate the conservative maximum extent of occurrence of bison, we created a concave hull using observations occurring over the last 450 years (*n* = 3,379 observations) which is the broadly accepted historical benchmark at 1500 CE covering 59% of the North American continent. While this distribution represents a historical extent of occurrence — merely delineating the maximum margins of the near-continental distribution — it does not replace a density-based approach reconstructing potential historical range distributions that identify core and marginal ranges. However, we envision the contained observations of this database will contribute to further research in the increasingly evidence-based disciplines of bison ecology, evolution, rewilding, management, and conservation.

D. Key words/phrases: archaeology, benchmark, bison, conservation, historical ecology, North America, paleontology, restoration.

E. **Summary:** Temporally, the historical, archaeological, and paleontological data were compiled into one dataset that spans a temporal range from 1992 CE to 198,050 years BCE (*n* = 6,438; Figure 1; Table 1). While we report 6,438 observations with high-quality provenance data associated with each locality, these likely only represent a fraction of total observations (i.e., non-exhaustive) of bison across these three disciplines, however these observations represent a comprehensive understanding of bison presence and activity on the landscape. Moreover, these observations do not represent relative nor absolute abundance of the population. In the dataset, however, we include a variable of minimum number of individuals associated with each observation that may be useful for future research.

F. **Description:** We present the data within their respective disciplines prior to presenting the aggregated data as a meta-analysis. However, we omit contemporary Modern occurrences of bison observations, we instead direct readers to Global Biodiversity Information Facility (a.k.a., GBIF) entry for bison (*Bison bison*; https://www.gbif.org/species/2441176).

Historical dataset

Historical ecology data (*n* = 2,826; Table 1) are sourced from first-person wildlife observations in journal entries from early colonial explorers, settlers, hunters, missionaries, and naturalists across Canada, United States, and Mexico as well as museum collections specimens (i.e., bison crania) curated in national and local museums, and private collections (Kay 2007). These records are indicative of ephemeral presence-only records for bison across various geographic ranges between the periods of 1500 CE to Present. Location for first-person observations were logged as nightly campsites and location for history museum specimens were transcribed from accession labels. Because bison are large bodied and relatively non-cryptic on the landscape, there is a high level of confidence that observers made the correct species identification.

Archaeological dataset

Archaeological data are sourced from spatially and temporally well-constrained archaeological sites ranging across North America (*n* = 2,522; Table 1). The records are sourced from published and unpublished archaeological site reports in databases (Canadian Archaeological Radiocarbon Database (CARD v2.1)) and primary literature that present information on animals that were killed and butchered by Indigenous peoples and of those, 438 are within the historic period (Hill 2007, 2008, Martindale et al. 2016, Otárola-Castillo 2016, Otárola-Castillo et al. 2022). Due to the size and morphology of bison remains from archaeological contexts, there is a high level of confidence that analysts made correct species identification (Olsen 1960, Balkwill and Cumbaa 1992). More recently, morphological and genetic studies corroborate that *Bison antiquus* and *B. occidentalis* are chronospecies of *B. bison* as a body size cline in relation to global temperature (Shapiro et al. 2004, Wilson et al. 2008, Martin et al. 2018).

Archaeological sites used in this study include residential camps, which reflect time-averaged (e.g., days, weeks, or months) deposits resulting from food preparation and consumption activities, and single-event bison kill localities or special-use localities (i.e., burials). To make inferences regarding bison distributions using these faunal remains, it is worth asking how well these data represent their local environment in the past. After all, kill sites are located at some distance from residential camps. In addition, Great Plains people hunted bison on foot until the adoption of the horse in the CE 1600s. Consequently, such pedestrian hunters frequently consider when, how, and whether to transport bison parts, including their bones, from kills to camps (Perkins and Daly 1968, Binford 1978, 1981). However, the probability that pedestrian hunters transport bones of large animals to their residential sites is low at walking distances greater than 250-minutes from camp (Schoville and Otárola-Castillo 2014). The adoption of the horse by Great Plains people likely increased the average distances between bison kills and residential camps (Bethke 2017). However, to facilitate the transport of edible products, hunters with horses usually fillet the meat off the bones for processing into biltong or jerky to reduce weight and maximize the edible products transported (Bartram 1993). Nonetheless, most archaeological samples in this study come from before horse reintroduction. As a result, anthropogenic effects on bison habitat distribution bias seems low. The precision of site location for most archaeological localities is high. Still, for some records, the area of the site can only be established be within the county level (USA) where the site is located. For several localities, archaeologists determined the age of the bison remains by directly radiocarbon dating them. However, for other sites, the age of the bison remains could only be estimated through cross-dating with age-diagnostic artifacts recovered in association with the bison. Alternatively, archaeologists also cross-date *Bison* remains by using the age of the geological deposit containing the bison and prehistoric features.

Paleontological dataset

Bison records data were sourced from paleontological sites ranging across North America over the last 200,000 years (*n* = 1,090; Table 1) and of those, 115 are within the historic period. These records were sourced from literature (Rostlund 1960, Martin et al. 2017, 2018) and from the

Neotoma Paleoecology Database (http://www.neotomadb.org; (Williams et al. 2018)) using the R package ‘neotoma’ (Version 1.7.4; (Goring et al. 2015)). The paleontological occurrence data come from sites that are described as non-archaeological (i.e., lacking evidence of human interaction as determined by each fossil site original lead investigator) that are temporally well-constrained, in that the locality information includes either absolute radiometric dating or relative faunal dating of geological strata to establish temporal provenance.

We include bison occurrences going back nearly 200,000 years BCE, merely to document the full history of bison in North America. However, over the course of bison evolution spanning the Rancholabrean North American Land Mammal Age (Bell et al. 2004), there are potentially several species that could be included in this meta-analysis. While other recent publications have determined that species such as *Bison bison*, *B. antiquus*, *B. occidentalis* are considered a chronospecies morphologically indistinguishable (Martin et al. 2018) for the exception of body size, as well as genetically indistinguishable (Shapiro et al. 2004, Wilson et al. 2008, Zver et al. 2021), however, we continue to list the conventional taxonomic nomenclature of the above species in the database. The above stated species, collectively considered *Bison bison*, span the last 60,000 years (Jiménez-Hidalgo et al. 2013). The remaining species of *Bison priscus* and *B. latifrons* are likely valid species and range as old as 200,000 years BCE south of 55 °N (Bell et al. 2004) and have been omitted from the data analysis. Sites lacking temporal provenance were omitted from this meta-analysis.

Dataset integration

We collapsed duplicate localities based on latitude, longitude, year (geologic age), and site name, to maximize available metadata, such as original reference sources and minimum number of individuals. To reconstruct the bison historic EOO, we restricted our analysis, only using data acquired from 1500 CE to Present (total n = 3,379; historical ecology n = 2,826, archaeological n = 438, paleontological n = 115; Table 1). The data were then used to create a convex hull, following IUCN guidelines for measuring EOO, and subsequently clipped to the unprojected North American continental margin (datum = WGS84). The resulting polygon represents the historic EOO of bison distribution after 1500 CE. After data integration into one database, elevation was extracted from the GLOBE digital elevation model with a resolution of 30 arc-seconds (GLOBE Task Team et al. 1999, Hastings and Dunbar 2008). Data management, data summaries, and graphical visualizations were conducted in Stata/IC (v16.1). The historic extent of occurrence polygon (convex hull) was produced using the package ‘grDevices’ 4.1.1 in R (R Core Team 2021). The accompanying dataset with this article hosted on FigShare will be updated periodically; please contact the corresponding author if you have questions (Martin et al. 2022).

Table 1. Summary table of occurrences by temporal bin and by discipline.

Observation Category	**1750 CE – Present**	**1500 CE – 1749 CE†**	**1000 CE – 1499 CE‡**	**< 1000 CE**	**Total**

Historical Ecology	2,511	315	0	0	2,826
Archaeology	138	300	484	1,600	2,522
Paleontology	68	47	178	797	1,090
Total	2,717	662	662	2,397	6,438

Symbology: † Inclusive of the Little Ice Age (LIA); ‡ Inclusive of the Medieval Warm Period (MWP).

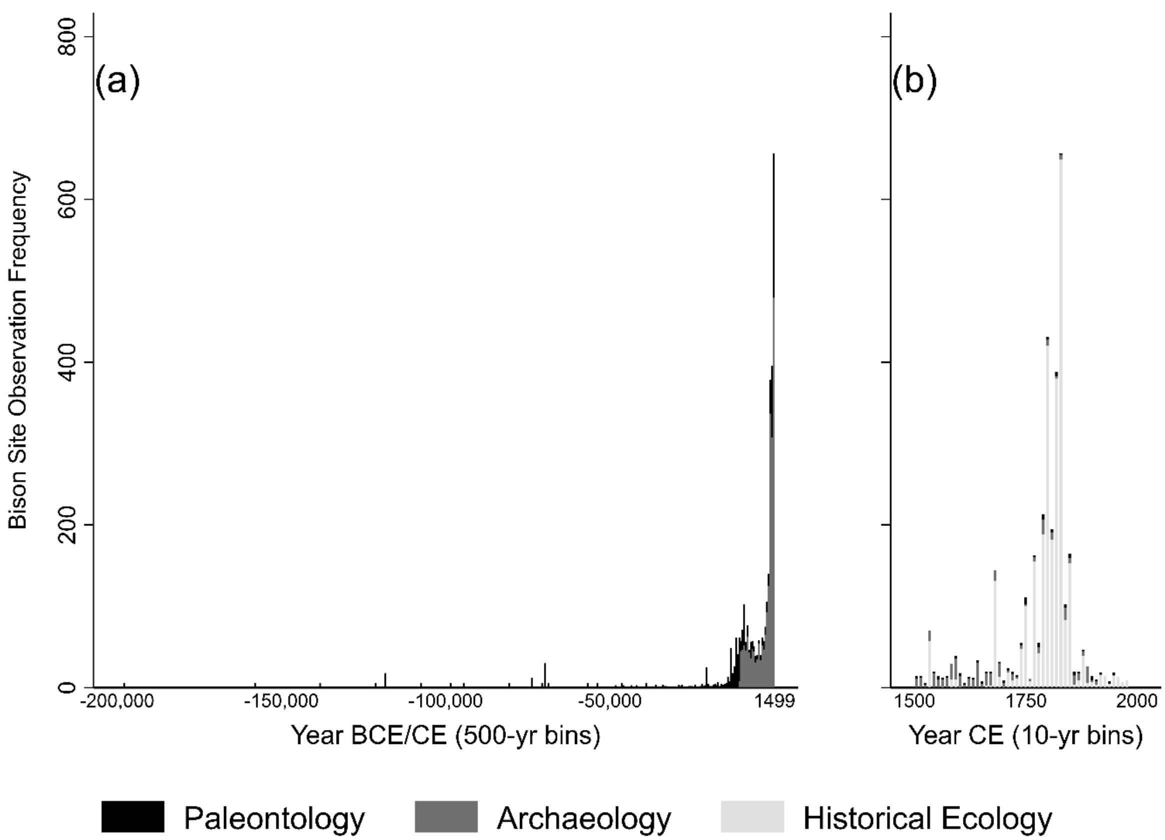

Figure 1. Stacked histogram of bison site observation frequencies (N = 6,438) over time (BCE/CE) from (a) 200,000 BCE to 1499 CE; summed in 500-year bins, and (b) from 1500 CE to Present; summed in 10-year bins. Note: observations older than -40,000 years (BCE) are magnified 3-times for visualization purposes.

Prehistoric extent from 200,000 BCE to Present

The prehistoric extent of bison distribution in North America ranges from 13.56°N to 71.12°N latitude, and from -77.12°W to -163.44°W longitude, occurring across all temporal scales over the last 200,000 years BCE (n = 6,438; Table 1 and Figure 2a,b,c). Distribution limits of bison, using all occurrences across all temporal scales (≤200,000 years BCE) extend from the northwestern margins of Alaska, USA through the Cordilleran of western Canada (Northwest Territories, Yukon, British Colombia, Alberta, Saskatchewan, and western Manitoba) into the northern regions of the continental United States. Distribution of prehistoric bison locality elevation varied widely from -337 to 3,382 meters above sea level (masl), averaging 1,030 ± 656 masl. Throughout the continental United States, bison appear in every state west of the Mississippi river. East of the Mississippi river, there are occurrences of bison in the Midwest region: Wisconsin, Illinois, Indiana, and Kentucky; in the Gulf of Mexico coastal region: southern Mississippi, southern Alabama, southern Georgia and throughout Florida; near the Atlantic coastal region: eastern Georgia, South Carolina, North Carolina, Virginia, West Virginia, and Pennsylvania. Bison also occur throughout northern and central Mexico, including the states of Sonora, Chihuahua, Coahuila, Nuevo León, Durango, Jalisco, San Luis Potosí, Guanajuato, Michoacán, México, Puebla, Veracruz, Oaxaca, and Yucatán, with their southern-most extent in Belize (Churcher 2019) and El Salvador (Stirton and Gealey 1949, Webb and Perrigo 1984). Though, these southern-most localities occur during the late Pleistocene and mid-Holocene, sometime between 6,500 and 160,000 years ago without any more recent occurrences at such low latitudes.

Historic extent since 1500 CE

Geographically, following guidelines of the "Mapping Standards and Data Quality for the IUCN Red List Spatial Data" (2021), we provide both a resource of occurrence data from observational point localities (Figure 2a,b,c) and polygon data as a maximum convex hull map with limits of distribution informed by the occurrence data (Figure 2d; EOO). The edges of the limits of distribution or EOO, broadly represent the historical (since 1500 CE) maximum possible extent of distribution for bison (area = 13,065,476 km^2 [59.1% of continental North America; Figure 2]). The historic extent of bison distribution in North America contracted from the prehistoric extent, ranging from 25.16°N to 70.14°N latitude, and from -78.57°W to -163.22°W longitude, occurring since 1500 CE (n = 3,379; Table 1 and Figure 2d). Distribution of historic bison locality elevation varied widely from -21 to 3,382 masl, averaging 1,098 ± 682 masl. This EOO conveys that bison likely occurred within this region through time; with expected highly temporally and spatially variable abundance, including from very low to very high local density (IUCN SSC Red List Technical Working Group 2021). One artefact of using the convex hull technique implemented by the IUCN (IUCN SSC Red List Technical Working Group 2021), especially over continental scales, is that this methods results in including regions that bison are absolutely absent from such as the Pacific Ocean or the Gulf of Mexico (Figure 2d) and potentially the adjacent lands to those bodies of water. To partially resolve this issue, we have clipped the historic EOO to the continental margins because bison are non-marine mammals, but we do not adjust the margins within the continent because that would emulate a concave hull as opposed to a convex hull. This historic EOO should not be considered a historic range map, which would require a more restrictive definition of range that is more appropriate for conservation planning purposes, as it may contain areas in which bison have not and likely never will be documented. Even under a more restrictive definition of historical range, bison abundance and distribution varied widely, with areas of near-continual use by large numbers of bison and areas with only intermittent low-density populations that may have experienced long periods of absence under certain climatic conditions (Flores 1991, Isenberg 2000, Stephenson et al. 2001, List et al. 2007, Gates et al. 2010, Plumb et al. 2014, Flores 2016). Any conservation action with bison should carefully consider these variable patterns and local context and not confuse the historic EOO with evidence that bison were once found throughout the entirety of the area.

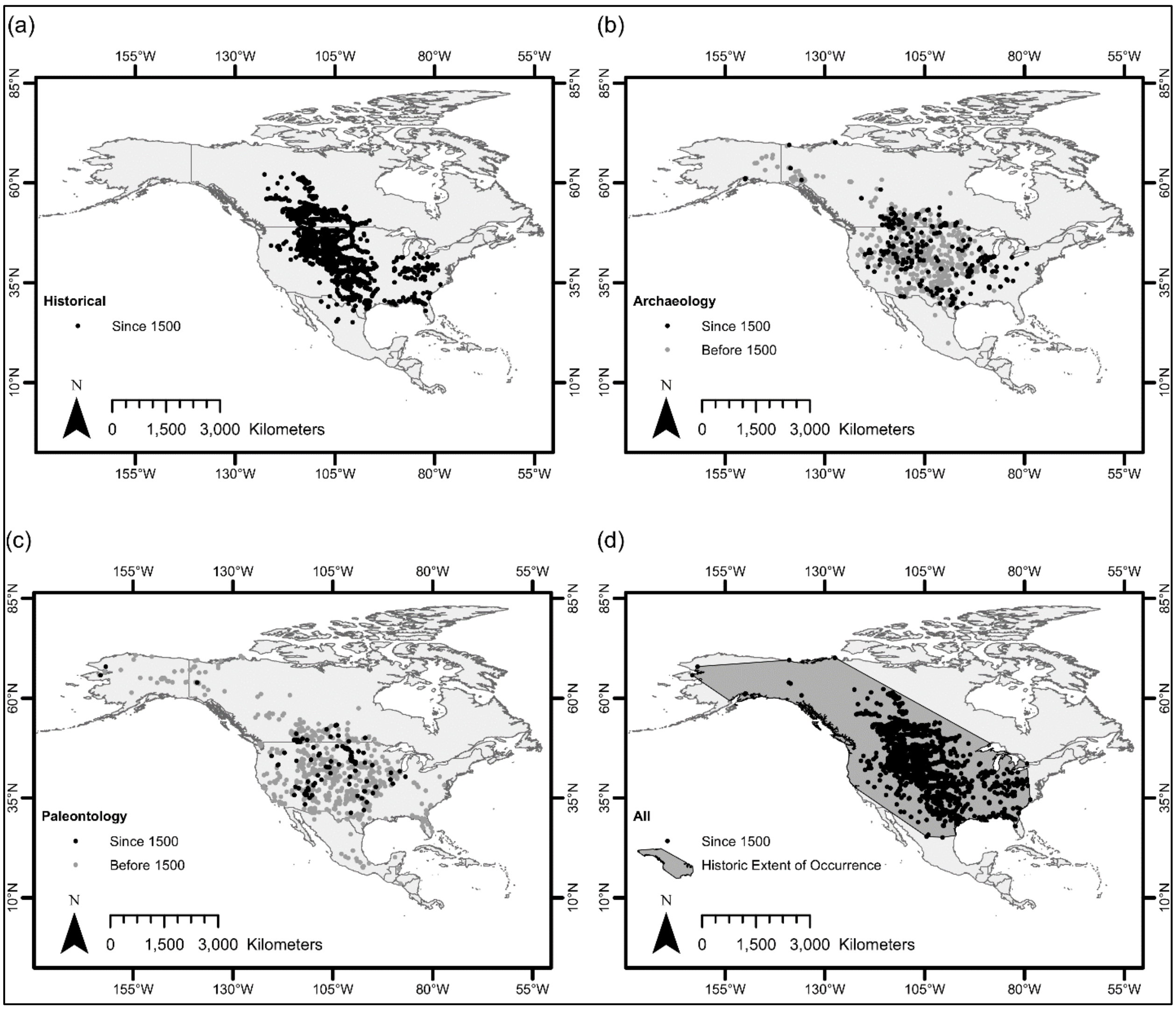

Figure 2. Panel of bison observations prior to 1500 CE (gray points) and since 1500 CE (black points) by disciplines of (a) historical ecology, (b) archaeology, (c) paleontology, and (d)

integrated historic EOO since 1500 CE (dark gray polygon) of bison displayed as a minimum convex hull clipped to continental margins.

Limitations of dataset use – Extent of occurrence circa 1500

Each discipline has intrinsic spatial and temporal biases including data sampling (Monsarrat et al. 2019), specimen preservation (Lam et al. 1999), and taxonomic identification in collections (Martin et al. 2017) that effectively alter ecological interpretations if left uncorrected. The data were assembled to create a conservative historic EOO for bison since the colonial era; without the explicit intention of assessing broader ecological interpretations or identifying density-dependent core and marginal distributional ranges. That is, the term “conservative” to indicate that future historical ecology, archaeological, and paleontological studies may reveal additional localities that may contribute to an increasingly more comprehensive and spatially expansive dataset. However, the combination of these disciplines works together to balance biases. For example, sampling biases of historical ecology is limited to presence-only of colonial explorers. Some of these sampling biases are balanced by the presence of archaeological and fossil remains, but the northern and eastern fringes of this range may appear less dense in these geographically expansive regions due to preservation biases resulting from acidic soils in these regions and/or discovery biases due to sparse human presence and activity. A dearth of records from historical encounters between humans and bison does not necessarily mean absence of bison in this territory, merely a paucity of the types of evidence used in this study. Moreover, additional evidence forms may be applicable for future studies, including place names for geographical landmarks for points-of-interest, buffalo trails, roads, cities, and river crossings, etc.; as well as integrating Indigenous traditional ecological knowledge to further understand historic dynamics of the bison range. Though these types of evidence lack temporal resolution needed for this study, they may substantially contribute to future studies.

While what we provide is an assessment of a multidisciplinary meta-analysis of sites contributing to a more comprehensive understanding of the maximum extent of where bison have occurred since 1500 CE, the guiding protocols and criteria of IUCN result in too coarse of a filter to resolve temporally dynamic range shifts in response to various pressures, be they anthropogenic or environmental. Plumb and McMullen (2018) describe the importance for conservation of species at the edges of their perceived distributional ranges, even though there are intrinsic temporal variation in species’ population abundance and distribution. They posit two primary topics of concern, 1) that relatively cryptic presence in historical, archeological, or paleontological records may not necessarily equate to non-native status for the species in that region (Martin et al. 2017) and 2) that environs at the edges of species distributional ranges may exert particularly strong selection pressures that drive evolutionary trajectories including adaptation, migration, and extinction (Bell and Gonzalez 2009); adaptations — genetic or phenotypic — that are critical for the future survival of the species in a changing world.

Compiling these discrete data streams into a multidisciplinary dataset provides a more comprehensive, evidence-based context for reconstructing species historic and prehistoric geographic distributions. What this meta-analysis suggests, is that bison have basic life history traits that enable surviving and thriving across a wide distribution of many biomes. It also suggests that while bison may have occurred at any point within the historic EOO, it is unlikely they always occupied the entirety of this space, and it includes areas that were likely never occupied. It also adjusts the current understanding of historic occurrence for the species, expanding into several regions (e.g., desert southwest, Gulf of Mexico coast, and subarctic) while contracting in some regions (i.e., northeastern U.S.) compared to earlier versions of historic bison distribution reconstructions (Allen 1876, Hornaday 1889, Roe 1970, McDonald 1981, Gates et al. 2010).

Our methodology can be repeated for many species of interest. We present this historic EOO as one example of what this dataset can elucidate for the conservation of a species. However, we also call for additional studies to utilize this dataset and contribute to the topics below. Moreover, we anticipate that these data may be helpful for the following: 1) validating bioclimatic species distribution models, 2) understanding the effects of climate variables on the bison habitat suitability (Wendt et al. 2022), 3) creating a better understanding of the distribution of bison across several temporal scales to improve knowledge of trends in reliance on hunting bison among the subsistence practices of Indigenous peoples, and 4) evaluating restoration status of bison into their *in situ* habitat. Although impending climate change is expected to alter the geographic distribution of fundamental abiotic and realized biotic ecological niches for bison, it is likely that the maximum extent of observations (i.e., presence/absence) in the historical and prehistorical record may assist in elucidating regions of increased macroevolutionary selection, patterns, and processes. Thus, reintroducing bison into these areas may be of considerable interest for conservation of the species in anticipation of further climate change, agricultural intensification, urban encroachment, and land use/land cover change.

CLASS II. RESEARCH ORIGIN DESCRIPTORS

A. Overall project description

1. **Identity:** Integrated evidence-based extent of occurrence for North American bison since 1500 CE and before
2. **Originators:** *Jeff M. Martin*, Center of Excellence for Bison Studies, South Dakota State University, Rapid City, South Dakota, USA and Department of Animal Science, South Dakota State University, Brookings, South Dakota, USA; *Rachel A. Short*, Texas A&M University, College Station, Texas, USA and Georgia Institute of Technology, Atlanta, Georgia, USA; *Glenn E. Plumb*, International Union for the Conservation of Nature, Gland, Switzerland; *Lauren Markewicz*, Parks Canada, Gatineau, Quebec, Canada; *Dirk H. Van Vuren*, University of California–Davis, Davis, California, USA; *Bradly Wehus-Tow*, South Dakota State University, Brookings, South Dakota, USA; *Erik Otarola-Castillo*, Purdue University, West Lafayette, Indiana, USA; *Matthew E. Hill, Jr.*, University of Iowa, Iowa City, Iowa, USA.
3. **Period of study:** 2020-2022
4. **Objectives:** This dataset, compiled as a meta-analysis of many sources, originated as a request from the International Union for Conservation of Nature (IUCN)

Species Survival Commission (SSC) Bison Specialist Group (BSG) to document the maximum historic extent of occurrence (EOO) of bison over the historic period (i.e., since 1500 CE). Our aim was to establish an evidence-based dataset that integrates multi-disciplinary observations that have high data quality and thus high confidence of occurrence to best inform the upcoming Red List and Green List assessments for the species (IUCN SSC Red List Technical Working Group 2021). However, additional project justifications come from discussions in Akçakaya et al. (2018, 2019), Sanderson (2019), and Stephenson et al. (2019) in regards to establishing various restoration benchmarks at either 1750 CE (≈200 years Before Present [yBP]) or 1500 CE (≈450 yBP) in North America.

5. **Abstract:** Same as above.
6. **Sources of funding:** MEH acknowledges funding from Iowa Center for Research by Undergraduates Research Fellow Program and Archaeological Institute of America-National Endowment for the Humanities. EOC acknowledges funding for this project from the Purdue University College of Liberal Arts' Exploratory Research in the Social Sciences award and the Margo Katherine Wilke research internship fund. This work is supported by the NSF Postdoctoral Research Fellowship in Biology Program under Grant No. 2010680 awarded to RAS. Support for JMM during this project was provided in part by the USDA National Institute of Food and Agriculture as Hatch Project #1026173 and the Center of Excellence for Bison Studies at South Dakota State University.

B. Specific subproject description

1. **Sites description**
    a. **Site type:** 6,438 historical observations, archeological, and paleontological localities across North America
    b. **Geography:** Continental North America
    c. **Geology, landform:** Neogene and Quaternary deposits and Anthropocene observations
2. **Project personnel:** Jeff M. Martin, Rachel A. Short, Glenn E. Plumb, Lauren Markewicz, Dirk H. Van Vuren, Bradly Wehus-Tow, Erik Otarola-Castillo, and Matthew E. Hill, Jr.

CLASS III. DATA SET STATUS AND ACCESSIBILITY

A. Status

1. **Latest update:** July 2022
2. **Latest archive date:** July 2022
3. **Metadata status:** July 2022; metadata are complete and up-to-date
4. **Data verification:** *Jeff M. Martin*, with assistance from *Bradly Wehus-Tow* and *Rachel A. Short*, collated final records and eliminated duplications submitted by

Matt E. Hill, *Jeff M. Martin*, *Rachel A. Short*, *Lauren Markewicz*, and *Dirk H. Van Vuren*.

B. Accessibility

5. **Storage location and medium:** The dataset is available as Supporting Information to this Data Paper publication in *Ecology*. A digital version of the dataset in .CSV and .XLSX format is available on FigShare: Martin, J. M., R. A. Short, G. E. Plumb, L. Markewicz, D. H. Van Vuren, B. Wehus-Tow, E. Otárola-Castillo, and M. E. Hill. 2022. Integrated evidence-based extent of occurrence for North American bison (*Bison bison*) since 1500 CE and before: dataset. FigShare. doi:10.6084/m9.figshare.19314455.
6. **Contact person:** Jeff M. Martin (jeff.martin@sdstate.edu) 711 N. Creek Dr., Rapid City, SD 57703
7. **Copyright restrictions:** None.
8. **Proprietary restrictions:** None.
9. **Costs:** None.

CLASS IV. DATA STRUCTURAL DESCRIPTORS

A. Data set file

1. **Identity:** bison_presence_dataset.csv
2. **Size:** Number of records, record length, total number of bytes, etc. 6,438 observations (excluding header) and 25 fields. 1.45 MB.
3. **Format and storage mode:** comma separated values (.csv)
4. **Header information:** See IV.B.
5. **Row information:** Each row represents one locality. One locality may have multiple temporal occurrences within a single geographic point (*sensu lato* geologic strata, soil horizons, soil lenses).
6. **Alphanumeric attributes:** Mixed
7. **Special characters/fields:** None.
8. **Authentication procedures:** None.

B. Variable information

Table 2. Description of the fields/variable names related to locality information – bison_presence_dataset.csv and bison_presence_dataset.xlsx. Note: site names and author names may have special characters that appear correctly in the Excel file but will appear incorrectly in the CSV.

Field/Variable Name	Description

OID	Object identifier number for this dataset
Longitude	Longitude in degree decimals
Latitude	latitude in degree decimals
Code	disciplinary code, 1 = historical ecology, 2 = archaeology, 3 = paleontology
Observation	Numerical entries refer to Neotoma Paleoecological Database, otherwise non-numerical text refers to expedition journal entries
Sitenumber	Site Number, numerical entries refer to MioMap Database numbers, otherwise non-numerical text refers to State Historical Preservation collections archival numbers.
Sitename	Site name, provides the common name of the site or journal observation entry
Unit	Unit refers to archaeological or paleontological strata/horizon within a locality
Sitetypeshortremarks	Site type and short remarks, provides context for type of archeological site type or remarkable event in journal observation entry
Elevation (masl)	Elevation reported as meters above sea level
Youngdatebp	Young Date B.P., refers to the minimum age (often a calibrated radiocarbon date) of the site Before Present (from 1950 AD).
Olddatebp	Old Date B.P., refers to the maximum age (often a calibrated radiocarbon date) of the site Before Present (from 1950 AD).
Year	Refers to year of observation in common era, CE (positive values) or before common era, BCE (negative values).
Month	If applicable, month of observation (usually for historical ecology journal observations)
Day	If applicable, day of observation (usually for historical ecology journal observations)
Archaeologicalculturalperiod	Archaeological cultural period
Country	Country of locality
State.Provinces	State/Province territorial region of locality
U.S. Counties	County of locality
NISP	Number of Individual Specimens (typically counts of bones/teeth/artefacts)
MNI	Minimum number of individuals
Species	Species, referring to either *Bison bison, Bison antiquus (Bison bison antiquus), Bison occidentalis (Bison bison occidentalis), Bison latifrons,* or *Bison priscus*. May also generally refer to *Bison* or *Bison* sp.
SpecimenID	Specimen ID, identification number for museum voucher

References	List of reference numbers for the locality
References_number	Provides singular number for “References”
Reference_citation	Provides full citation for “References_number”

CLASS V. SUPPLEMENTAL DESCRIPTORS

A. Data acquisition

1. **Data entry verification procedures:** Procedures employed to verify that digital data set is free of errors

Data were compiled from three disciplines: historical ecology, archaeology, and paleontology. Data collection, verification, and integration are detailed in Class 1 Section F.

B. Quality assurance/quality control procedures: Identification and treatment of outliers, description of quality assessments, calibration of reference standards, equipment performance results, etc.

We collapsed duplicate localities based on latitude, longitude, year (geologic age), and site name, to maximize available metadata, such as original reference sources and minimum number of individuals.

C. Computer programs and data-processing algorithms: Description or listing of any algorithms used in deriving, processing, or transforming data

To reconstruct the bison historic EOO, we restricted our analysis, only using data acquired from 1500 CE to Present (total n = 3,379; historical ecology n = 2,826, archaeological n = 438, paleontological n = 115; Table 1). The data were then used to create a convex hull, following IUCN guidelines for measuring historic EOO, and subsequently clipped to the North American continental margin (datum = WGS84). After data integration into one database, elevation was extracted from the GLOBE digital elevation model with a resolution of 30 arc-seconds (GLOBE Task Team et al. 1999, Hastings and Dunbar 2008). The resulting polygon represents the historic EOO of bison distribution after 1500 CE. Data management, data summaries, and graphical visualizations were conducted in Stata/IC (v16.1). The historic range polygon (convex hull) was produced using the package ‘grDevices’ 4.1.1 in R (R Core Team 2021). Maps were made using the packages ‘sf’, ‘sfheaders’, and ‘sp’ in R (R Core Team 2021).

D. History of data set usage

1. **Data request history:** None.
2. **Data set update history:** Originated in March 2022.

3. **Review history:** July 2022.

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DATA AVAILABILITY STATEMENT

Data are available in the supplementary material of this article and permanently archived on FigShare (doi:10.6084/m9.figshare.19314455) and cited under Martin et al. (2022).

ORCID

Jeff M. Martin, 0000-0002-4310-8973

Rachel A. Short, 0000-0001-6180-3294

Glenn E. Plumb, 0000-0001-9974-0241

Lauren Markewicz, 0000-0002-8173-3091

Dirk H. Van Vuren, 0000-0001-9925-2838

Bradly Wehus-Tow, 0000-0002-1107-7498

Erik Otarola-Castillo, 0000-0002-7806-494X.

Matthew E. Hill, Jr., 0000-0002-6978-8188

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