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Cover Photograph: *Mammuthus columbi* skull fragment with in situ large tusks from Waco Mammoth National Monument (WACO), Texas (photo courtesy NPS).

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Proboscideans from US National Park Service Lands

Jim I. Mead[1*], Justin S. Tweet[2], Vincent L. Santucci[3],
Jeffrey T. Rasic[4], and Sharon E. Holte[5]

Abstract - Proboscideans (Mammalia, Proboscidea) are an ubiquitous part of North American vertebrate faunas throughout the Miocene, Pliocene, and Pleistocene. Here we discuss the fossil record of proboscideans found on public lands administered by the National Park Service (NPS), which is comprised of 419 units. At least 276 of these units contain some aspect of fossil heritage for the USA. We present 63 NPS units and affiliated areas that have records documenting fossil proboscideans. The geological and paleoecological diversity preserved and represented in these 63 units record fossils from Arctic to tropical and steppe to rainforest environments. This is an invaluable data set that has yet to be fully recognized. The information presented here, much of which has not been published, is intended as a compilation to support researchers.

Introduction

Since 1916, the National Park Service (NPS, US Department of the Interior) has been entrusted with the care of our national parks, and as their mission, they are to preserve unimpaired the natural and cultural resources. The official emblem contains the arrowhead, mountains, *Sequoia* tree, and bison which represent aspects of our natural and cultural resources and exemplify the overall mission. The National Park System covers more than 85 million acres and is comprised of 419 sites with at least 19 different designations, including 130 historical units, 87 monuments, 61 national parks along with a number of other types of units. In addition, the NPS recognizes, but does not manage, National Natural Landmarks (NNL), National Historic Landmarks (NHL), and other affiliated sites. These preserved and recognized localities represent a significant expanse of geographic area of the USA and embody a tremendous aggregate of natural and cultural heritage to conserve and understand. The geological and paleoecological diversity preserved in these lands and represented in their fossil record (from Arctic to tropical, and steppe to rainforest) is noteworthy and an invaluable data set that has yet to be fully recognized and understood (see overview about fossils on federal lands in Liggett et al. 2018).

On March 30th, 2009 President Barack Obama signed the Paleontological Resource Preservation Act into law authorizing five federal land managing agencies, including the NPS, to understand, preserve, and conserve their fossil resources (see discussion in Santucci 2017). At least 276 NPS units contain some aspect of our fossil heritage. Here we concentrate on the vertebrate resources preserved or recognized by our nation's National Park System (administrated and affiliated) and focus on one iconic group of mega-mammals, the proboscideans. To help better understand the evolution of Proboscidea in North America, we provide

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here in one outlet a sometimes hard-to-assemble resource for researchers and interested public who want to further understand these mammals from all NPS and affiliated lands (Fig. 1). Proboscideans are found as fossils throughout the continent, both east and west of the Mississippi River. Our approach is to view the distribution of fossil proboscideans from NPS administered and affiliated lands (from here on collectively referred to as NPS Units) on a continental-wide scope. The information presented here is intended as a compilation to support researchers, to provide a preliminary examination of the holdings on NPS Units so that more detailed studies can be planned. It is not our intent to present all the actual data in any detailed account, but do indicate which NPS Units contain proboscidean remains. Information about these remains is not always published or readily available to researchers. We also present in a historiographic approach the discovery, recovery, and issues associated with these remains. We hope that this document will help spur further analyses into better understanding this often poorly understood group of land mammals.

Proboscideans

Proboscideans (Mammalia, Proboscidea) are a ubiquitous part of North American vertebrate faunas throughout the Miocene, Pliocene, and Pleistocene. There were still members of three families in greater North America during their waning phase in the late Pleistocene: Gomphotheriidae (Gomphotheres), Mammutidae (Mastodonts), and Elephantidae (Mammoths).

The phylogenetic understanding of Proboscidea is almost purely based upon the paleontological record (Shoshani and Tassy 2005, Tassy 1996). Indigenous proboscideans in North America have been extinct since the end of the Rancholabrean North American Land

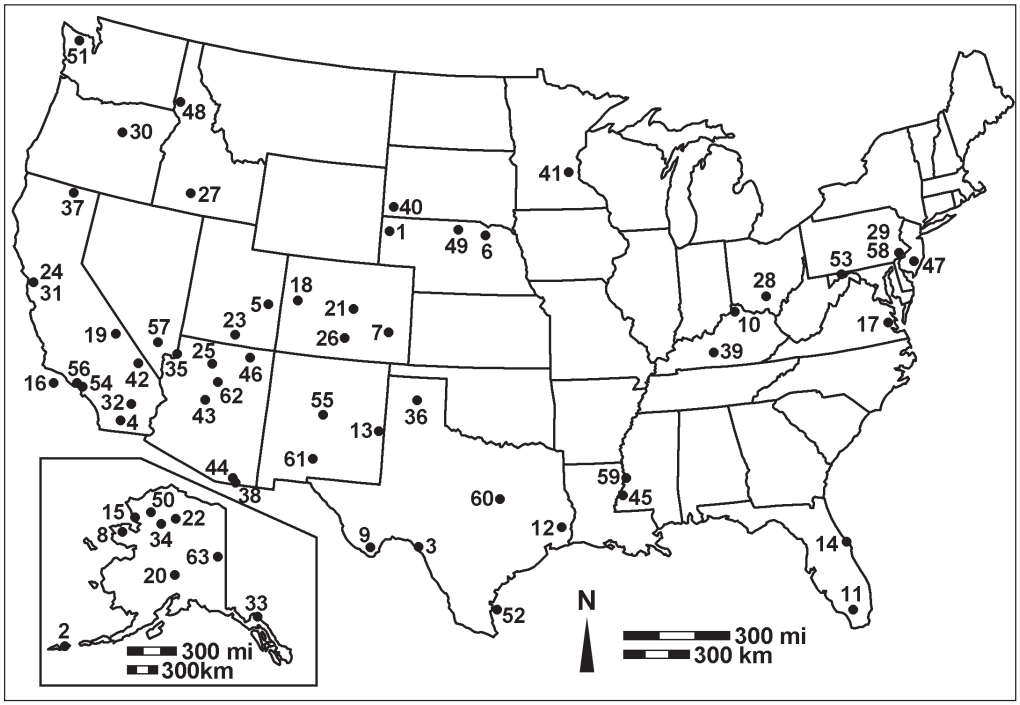

Figure 1. Map of the USA with location of National Park Service Units (as defined in text) that have in situ specimens or records of proboscidean fossils. Numbers refer to NPS Unit names listed alphabetically in the text.

Mammal Age (LMA; end of the late Pleistocene) and the beginning of the Holocene. The precise timing and the ultimate cause(s) of the extinction are still hotly debated and heavily scrutinized. The intent here is not to assess the extinction cause or its finalization.

Proboscideans were the largest land mammals in North America during the late Cenozoic. They originated in the Paleocene in northern Africa and southern Asia along the Tethys Sea (Lambert and Shoshani 1998). At approximately 16 Ma (Barstovian LMA, Ba1), the arrival of *Zygolophodon* (Vacek 1877; Mammutidae) in North America marks the Proboscidean Datum. By 17–15 Ma North America was experiencing the Middle Miocene Climatic Optimum which permitted a rich, warm temperate mixed mesophytic forest with numerous conifers over much of the northern continent and the incipient spread of grasslands. The woodland-grasslands of the Great Plains region of today graded west into a montane coniferous forest and mixed mesophytic deciduous forest biome (see discussion in Woodburne 2004). At approximately 15 Ma the continental climate began to deteriorate into a cooling trend—a possible response to a global shift in the oceanic circulation likely caused by a major expansion of the East Antarctic Ice Sheet (Flower and Kennett 1993). By the late Barstovian (Ba2, ~14.6 Ma) the first arrival of Gomphotheriidae occurred in the Western Hemisphere (Tedford et al. 2004).

During the remaining Miocene and through the Pliocene, Proboscidea of North America included numerous members within two families: Mammutidae and Gomphotheriidae (see discussions in Lambert 1996, Saunders 1996, Shoshani and Tassy 2005). These proboscideans promptly dispersed across North America and ultimately south into South America during the Great American Biotic Interchange of the late Pliocene (Blancan LMA). Climate continued cooling through the Pliocene culminating in the Pleistocene (beginning ca. 2.58 Ma), defined by its multitude of glacial maxima (20+), interglacial warm episodes, faunal dispersals, and evolutionary developments. The first occurrence of Elephantidae in North America during the early Pleistocene marks the beginning of the Irvingtonian LMA with the arrival of the Elephantidae, *Mammuthus* (Brookes 1828). The current and most conservative estimate for the oldest *Mammuthus* in North America is 1.3 Ma. However, the earliest arrival date is still debated (see discussion in Bell et al. 2004).

Proboscideans and our National Park System

Sixty-three NPS Units have a record of proboscideans (Table 1), although not all specimens have been placed into a retrievable numerical dataset system. The summary below provides a synopsis about each park unit or affiliated site and the proboscidean remains that are known from or are curated for the locality. The number accompanying the NPS Unit listed below (text and Table 1) refers to the location on Figure 1. The great majority of NPS proboscidean records are from the late Pleistocene. Specimens diagnostic to the species level are almost all *Mammut americanum* (Kerr 1792 fide Osborn 1936, American mastodon; although see below *Mammut pacificus*, Dooley et al. 2019, Pacific mastodon), *Mammuthus columbi* (Falconer 1857, Columbian mammoth), or *Mammuthus primigenius* (Blumenbach 1799, Woolly mammoth). Many of the specimens have been only provisionally identified. Specific and authoritative taxonomic identifications should be reassessed and studied in more detail. Researchers interested in viewing fossils referred to below should contact the park unit manager even though the actual specimens may be cataloged off-site at a nearby institution or regional repository, and in some cases widely distributed across the USA. The NPS requires that all recovery of fossil specimens be undertaken through an approved research and collecting permit.

Table 1. List of localities from NPS Units (as defined in text) that contain a record of proboscideans. See text for details about identification details for reported proboscideans. Abbreviations: Ameb, *Amebelodon*, Eubel, *Eubelodon*; Gom, gomphothere undefined; Gompho, *Gompotherium*; Mam, *Mammuthus*; Mamut, *Mammut*; Mast, mastodon undefined; Probo, Proboscidea undefined; Rhyn, *Rhynchotherium*; Stego, *Stegomastodon*; Tetra, *Tetralophodon*.; Zygo, *Zygolophodon*.

Map	Locality Name	NPS Abbreviation	Proboscidean Recorded
1	Agate Fossil Beds	AGFO	Mam
2	Aleutian World War II	ALEU	Probo
3	Amistad	AMIS	Mam
4	Anza-Borrego Desert	ANBO-CA	Gompho, Stego, Mam, Rhyn
5	Arches	ARCH	Mam
6	Ashfall Fossil Beds	ASFO-NE	Eubel
7	Bent's Old Fort	BEOL	Mam
8	Bering Land Bridge	BELA	Mam
9	Big Bend	BIBE	Mam
10	Big Bone Lick	BIBO-KY	Mamut
11	Big Cypress	BICY	Mam
12	Big Thicket	BITH	Mam
13	Blackwater Draw	BLDR-NM	Mam
14	Canaveral	CANA	Mast
15	Cape Krusenstern	CAKR	Mam
16	Channels Islands	CHIS	Mam
17	Colonial	COLO	Mamut
18	Colorado	COLM	Probo
19	Death Valley	DEVA	Prob
20	Denali	DENA	Mam
21	Florissant Fossil Beds	FLFO	Mam
22	Gates of the Arctic	GAAR	Mam
23	Glen Canyon	GLCA	Mam
24	Golden Gate	GOGA	Mam, Mamut
25	Grand Canyon	GRCA	Mam
26	Great Sand Dunes	GRSA	Mam
27	Hagerman Fossil Beds	HAFO	Mamut
28	Hopewell Culture	HOCU	Mast
29	Independence	INDE	Mamut
30	John Dave Fossil Beds	JODA	Ameb, Gomph, Tetra, Zygo
31	John Muir	JOMU	Mam
32	Joshua Tree	JOTR	Mam
33	Klondike Gold Rush	KLGO	Mam

Table 1. Continued.

Map	Locality Name	NPS Abbreviation	Proboscidean Recorded
34	Kobuk Valley	KOVA	Mam
35	Lake Mead	LAKE	Mam
36	Lake Meredith	LAMR	Mam, Gom
37	Lava Beds	LABE	Mamut
38	Lehner Mammoth-Kill Site	LEMA-AZ	Mam, Mamut
39	Mammoth Cave	MACA	Mamut
40	Mammoth Site of Hot Springs	MASI-SD	Mam
41	Mississippi	MISS	Mam
42	Mojave	MOJA	Mam
43	Montezuma Castle	MOCA	Prob
44	Murray Springs Clovis Site	MUSP-AZ	Mam
45	Natchez Trace	NATR	Mast
46	Navajo	NAVA	Mam
47	New Jersey Pinelands	PINE	Mamut
48	Nez Perce	NEPE	Mam
49	Niobrara	NIOB	Stego, Mam
50	Noatak	NOAT	Mam
51	Olympic	OLYM	Mam
52	Padre Island	PAIS	Mam
53	Potomac Heritage	POHE	Mamut
54	Rancho La Brea	RALA-CA	Mam, Mamut
55	Salinas Pueblo Missions	SAPU	Mam
56	Santa Monica Mountains	SAMO	Mam
57	Tule Springs Fossil Beds	TUSK	Mam
58	Valley Forge	VAFO	Mamut
59	Vicksburg	VICK	Mam, Mamut
60	Waco Mammoth	WACO	Mam
61	White Sands	WHSA	Mam
62	Wupatki	WUPA	Mam
63	Yukon-Charley Rivers	YUCH	Mam

1. Agate Fossil Beds National Monument (AGFO), Nebraska

Cook (1914) reported that a *Mammuthus* ? *columbi* tooth was recovered from "Niobrara River gravels" from the Cook Family ranch at Agate in 1906. This fossil discovery was within the vicinity of what is now AGFO and potentially within monument boundaries, but the precise locality is not known. The whereabouts of the specimen is also unknown; our queries to the American Museum of Natural History and the University of Nebraska State Museum were unsuccessful in locating the mammoth tooth. Robert Hunt (University of Nebraska State Museum, Lincoln, NE, December 2018, pers. comm.) noted that the Niobrara gravels of Agate occasionally have fossils and originate from the Hartville Uplift to the west.

2. Aleutian World War II National Historic Area (ALEU), Alaska

Proboscidean fossils are recorded in the photographs taken by US military servicemen in the mid-1940s (Fig. 2). The remote islands are the home of the Unangax (Aleut) people for 8,000 years, and during World War II, the islands became a fierce battleground. There apparently is no precise locality information for the fossil remains featured in the photographs. Pleistocene deposits with fossils are rare to almost nonexistent on the Aleutian Islands. The closest credible record of a mammoth to this region is on St. Paul Island which was part of the Bering Land Bridge (see BELA #8 and Graham et al. 2016 for more discussion).

3. Amistad National Recreation Area (AMIS), Texas

Proboscidean fossils have been found at Bonfire Shelter in Mile Canyon near Langtry, southwestern Texas. Although the rock shelter is just outside of the boundary of AMIS by a few tens of meters (set at 348 m [1144 ft] elevation), the lower canyon is included in the recreation unit, thus the record is included here due to its importance to the overall understanding of the region. Dibble and Lorrain (1968) were the first to mention the proboscidean remains, which they cited as "*Elephas*". Bement (1986) identified the fos-

Figure 2. Clifford McGinnis with mammoth remains he found on Amchitka Island (ALEU), a volcanic island of the Rat Island group in the Aleutian chain (photo supplied by NPS by Robert H. McGinnis 1944–1946; memo to file).

sils as *Mammuthus* sp. based on molar remains associated with the skull and mandible. Additional skeletal remains include a fragmented lumbar vertebra, rib fragments, pelvis fragments, tibia, and an unidentifiable long bone fragment. Taxa from the same stratigraphic unit include *Bison*, *Camelops*, *Capromeryx*, *Equus*, and others (Bement 1986). Most of the distinction of the locality and its contents comes from the *Bison* and cultural remains. The site is thought to represent a bison jump and processing area, but this has been contested (see discussion in Bement 2007). The importance here is that *Mammuthus* was recovered from this steep-sided canyon adjacent to the Rio Grande River, a region where its Pleistocene fauna are not fully understood. Lands abutting the canyons to the north include the southern end of the Edwards Plateau and the Southern High Plains, areas well-known to contain proboscidean remains.

4. Anza-Borrego Desert State Park National Natural Landmark (ANBO-CA), California

ANBO-CA in southern California is the largest of California's state parks, and was designated a National Natural Landmark in 1974. It has an outstanding stratigraphic record of the past 10 million years, including both marine and terrestrial rocks and fossils. Among the fossil resources is a significant record of proboscideans. McDaniel and Jefferson (2006) reported more than 80 proboscidean localities within the state park. Most of the finds are fragmentary, but at least four taxa at the genus or species level can be distinguished: the gomphotheriids *Gomphotherium* sp. (Burmeister 1837) and *Stegomastodon* sp. (Pohlig 1912) and the elephantids *Mammuthus columbi* and *M. meridionalis* (Nesti 1825, Southern mammoth; McDaniel and Jefferson 2006; although see the supplementary information from Lister and Sher 2015 and Lister 2017 for a different assessment of the *M. meridionalis* specimens). Records of *Mammut* and *Cuvieronius* (Osborn 1923) have been re-evaluated as representing other taxa (McDaniel and Jefferson 2006, Murray 2008). An additional genus, *Rhynchotherium* (Falconer 1868) was not included by McDaniel and Jefferson (2006) but was tentatively accepted by Murray (2008) on the basis of an unpublished specimen. Paleontological work began in what is now the state park in the 1930s, conducted by the American Museum of Natural History (McDaniel and Jefferson 2006). The Natural History Museum of Los Angeles County and Imperial Valley College also made large collections from the 1950s to the 1980s (McDaniel and Jefferson 2006); these specimens, apart from type specimens, are now reposited at ANBO-CA (Cassiliano 1999).

The proboscidean record of ANBO-CA begins in the Miocene, approximately 10 Ma, with tusk and cheek tooth fragments from the Borrego Buttes attributed to gomphotheres. *Gomphotherium* sp. is represented in the Blancan LMA Desguynos Formation and Diablo Formation, at approximately 4.4 Ma and 3.7–3.6 Ma respectively. Two taxa are present in the younger Hueso Formation: *Stegomastodon* sp. and *Mammuthus meridionalis*, the latter showing the beginning of the Irvingtonian LMA here at approximately 1.2 Ma (a 1.4 Ma record is a mistake resulting from a typographical error; Murray 2008). Additional Irvingtonian-age mammoths have been found in the Ocotillo Conglomerate and Bautista beds. Both *M. meridionalis* and *M. columbi* are known from numerous specimens, including a skull and partial skeleton representing the most complete specimen of North American *M. meridionalis*. These specimens show an overlap of the two species from approximately 1.1 to 0.9 Ma (McDaniel and Jefferson 2006). Potential evidence of butchering of this specimen (e.g., Miller et al. 1988, 1991) has been reinterpreted as bite-and-glide marks left by large carnivorans (McDaniel and Jefferson 1997, 1999). Presumed Rancholabrean-age proboscideans have been found near the park in the Salton Trough (McDaniel and Jefferson 2006).

5. Arches National Park (ARCH), Utah

Agenbroad and Mead (1989) reported on a *Mammuthus* sp. mandible recovered from Lower Courthouse Wash in ARCH (Fig. 3). A sample of the bone produced a uranium-series age of 17,200 ± 800 (KU-88-A1) yr. B.P. Santucci (2000) reported that in the 1950s, Chief Ranger Lloyd Pierson discovered the mammoth mandible eroding out of the sediments in a small alcove. The sample has since been curated into the NPS museum collections. No other bones were found by Agenbroad or Mead in the shallow alcove.

6. Ashfall Fossil Beds State Historical Park (ASFO-NE) and National Natural Landmark, Nebraska.

This northeastern Nebraska locality was originally known as Poison Ivy Quarry and contains predominantly articulated mammal skeletons that record the catastrophic impact of a volcanic eruption (Voorhies 1985). Designated a NNL in 2006, the state park (not administrated by the NPS) contains a number of sedimentary formations including Cretaceous, Paleogene, and Neogene fossils (Tucker et al. 2014, Voorhies and Corner 1993). Over 40 volcanic tuff layers are recorded from the stratigraphic units in the park and surrounding area. The locality is best known for its tremendous remains of the articulated rhino, *Teleoceras major*, which are found in ash beds (Ash Hallow Formation; Tucker et al. 2014) and date to 11.93 Ma (Perkins and Nash 2002). Of importance here is the underlying Valentine Formation which is composed of fluvial sands, silts, and gravel and date to the Barstovian Land Mammal Age, 14–13 Ma. In this lower formation numerous disarticulated remains of the proboscidean, cf. *Eubelodon* (Barbour 1914; Gomphotheriidae) are known, reported in a field guide list but not described (Tucker et al. 2014: Table 2). The location is administered by the Nebraska State Parks and the University of Nebraska State Museum.

7. Bent's Old Fort National Historic Site (BEOL), Colorado

A fragmented *Mammuthus* tusk was discovered at BEOL in 1964 in gravel at a borrow pit. The discovery was made accidentally by heavy machinery, and some damage was incurred. This specimen was identified as *Mammuthus columbi* by US Geological Survey

Figure 3. Edentulous mandible of *Mammuthus* from Lower Courthouse Wash, ARCH (photo courtesy NPS).

(USGS) geologist Glenn Scott (Tweet et al. 2015). Additional undescribed fragments of mammoth tusks and teeth have been found at various places in the historic site (Scott et al. 2001, Tweet et al. 2015).

8. Bering Land Bridge National Preserve (BELA), Alaska

BELA protects a remnant of the Bering Land Bridge, the land mass exposed during periods of lowered sea levels through the Pleistocene that connected North America (via Alaska) with Asia (via Chukotka; autonomous federal subject of Russia) and provided an important pathway for faunal exchanges between continents. BELA encompasses the northern half of the Seward Peninsula and is one of the most remote units of the NPS system. Along with other northern Alaskan NPS units (Cape Krusenstern National Monument and Gates of the Arctic National Park) it defines the northwestern-most distribution of proboscidean fossils in the NPS system.

Beginning as early as 1816, numerous vertebrate fossils, including *Mammuthus* sp. (likely *Mammuthus primigenius*) have been observed and collected from eroding coastal bluffs and river banks on the northern Seward Peninsula, most famously at Elephant Point (and nearby Eschscholtz Bay), so named for its numerous well-preserved mammoth finds (Buckland 1831, Hooper 1884, Kotzebue 1821, Maddren 1905, Seemann 1853:33), which include rare examples of preserved mammoth soft tissue and hair (Quackenbush 1909:107–10). While Elephant Point lies ~80 km (50 mi) east of and outside the BELA preserve boundary, the same frozen silt (yedoma) deposits continue into the preserve along its northern and western edges, and the same excellent fossil preservation exists within the preserve. Early research expeditions drawn to Elephant Point also noted scattered finds of mammoth bones and ivory on lands that would later be included within BELA, specifically in the vicinity of Good Hope Bay as well as the western coast of the preserve in areas surrounding Shishmaref Inlet (Gilmore 1908, Maddren 1905, Moffit 1905:42, Quackenbush 1909:93). In 1885 Cantwell (1887), for example, noted the front half of the skull of a mammoth lying on the tundra near Shishmaref Inlet. Quackenbush (1909:123) observed a small mammoth tusk projecting from the surface of the ground near Imuruk Lake, in the eastern interior portion of what would later become BELA.

Similar reports of isolated finds of mammoth bones, usually in detrital contexts, have continued to accumulate over the past two centuries and through recent decades. USGS collections by David Hopkins from 1967–1970 yielded at least 18 *Mammuthus* sp. skeletal specimens from scattered locations across the Seward Peninsula that were primarily within BELA at locations that include Good Hope Bay, Nuglungnugtuk River estuary, and Shishmaref Lagoon (Repenning 1967, 1970). Santucci et al. (1995) reported a previously undocumented juvenile mammoth specimen curated in the collections of the Colorado School of Mines, but this specimen was not confidently identified in a recent inquiry (D. Gertenbach, D. Schlegel, and S. Luallin, Colorado School of Mines, Golden, CO, March 2019, pers. comm.). BELA museum collections include additional isolated proboscidean (likely *Mammuthus* sp.) remains: a leg bone from a beach within the park, and five specimens of teeth, tusks, and miscellaneous bones.

In 2012, NPS staff documented skeletal remains of *Mammuthus primigenius* in a shallow lake context in the northern portion of the preserve (Rasic 2012) (Fig. 4). As with previous finds from BELA these also derived from ice-rich silt permafrost deposits, but unlike these isolated finds from secondary contexts, the "Mammoth Lake" locality contains multiple post-cranial elements (at least 6) from a single individual and was found in near-primary context (Rasic 2012). Additional elements are embedded in the muddy bottom of a shallow

thaw lake and preservation of a substantial portion of a complete skeleton was indicated by a geophysical survey of the site conducted in 2015 (Urban et al. 2016). As such this is one of the more complete mammoth skeletons known from the region. Collagen from a tooth and a vertebra yielded radiocarbon ages of 12,330 ± 50 BP (Beta-329841) and 12,430 ± 50 BP (Beta-331336), respectively (Rasic 2012).

Four late Pleistocene age *Mammuthus primigenius* specimens are known from an inland dry cave context at the Trail Creek Caves locality in the western portion of the preserve. This series of small caves was used intermittently by people for some 10,000 years (Lanik et al. 2017, Larsen 1968, Lee and Goebel 2016) and has both archeological and paleontological components. Extensive excavations undertaken in 1949–1950 yielded extinct late Pleistocene age fauna such as bison and horse from Cave 9 (Larsen 1968, Pasda 2012), but not until 1985, in the course of excavations by NPS archeologists, were mammoth specimens identified in a separate cave, Cave B (Vinson 1988, 1993). Recent AMS dating of collagen from the 1985 collections, a scapula and a vertebra, produced radiocarbon ages of 13,940 ± 70 (Beta-258437) and 13,770 ± 60 (Beta-258436) (Rasic and Shirar 2009). These dates are favored over previous radiocarbon assays, one anomalously young and not subsequently replicated, and one with a substantial standard error (Schaaf 1988:456, Vinson 1988:415). No human association with the mammoth remains at Trail Creek Cave B is indicated.

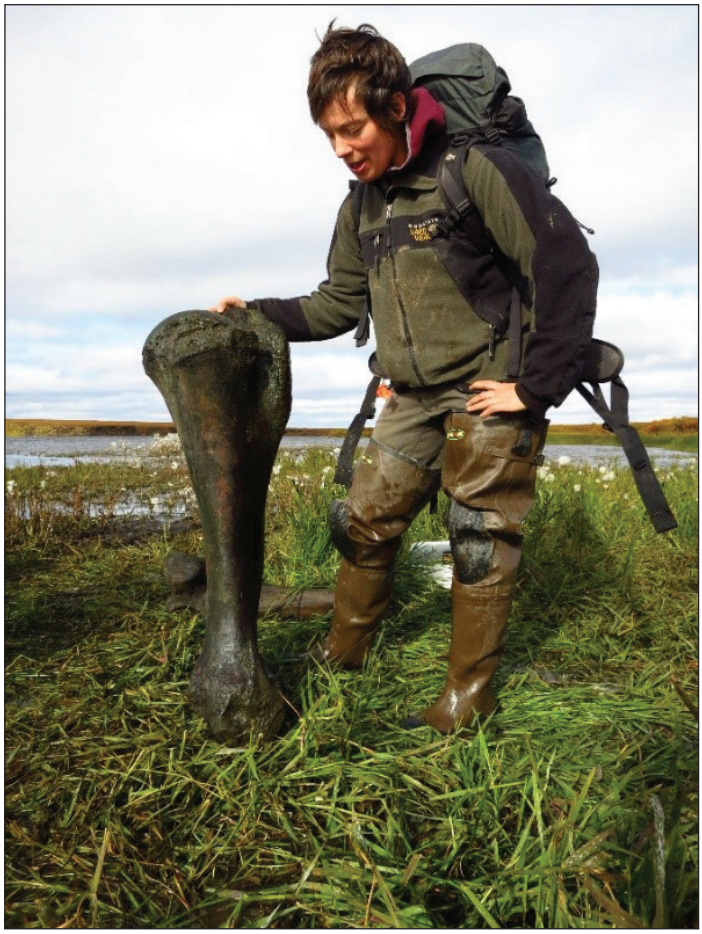

Figure 4. Geologist Louise Farquharson with a woolly mammoth humerus recovered from a shallow lake bed in Bering Land Bridge National Preserve in 2012. NPS photo by J. Rasic.

9. Big Bend National Park (BIBE), Texas

Proboscidean remains are known from BIBE but have not been reported on in any detail. Pliocene-age silts and gravels from Estufa Canyon in BIBE have produced a mandible, rib, and vertebrae from a long-jawed mastodon (Stevens 1993). Maxwell et al. (1967) mention that two "elephant" teeth (presumed to be *Mammuthus*) were found in the Grapevine Spring area. Wick and Corrick (2015) suggest this locality may be a Pleistocene-age cienega (spring) deposit. A fragmentary tusk of a Pleistocene proboscidean was found in a wash in the northern part of the park in 1987 (Reeder 1987).

10. Big Bone Lick National Natural Landmark (BIBO-KY), Kentucky

BIBO-KY (not administered by NPS), named for its voluminous megafaunal remains, is also a State Historical Park in Boone County, Kentucky. Native Americans knew of the bones and the tremendous amount of salt in the springs, and Europeans learned of the existence of Big Bone Lick from them. A French-Native military expedition under Charles Le Moyne (Baron de Longueuil) secured the first specimens for scientific study in 1739, and a 1744 map of Louisiana marks the locality as the "place where they found the elephant bones in 1739". Meriwether Lewis visited the site in 1803 on his way to join the Corps of Discovery and sent a box of specimens back to President Thomas Jefferson. Jefferson sent William Clark in 1807 to Big Bone Lick to discover more about the local fossils, making this the first organized paleontological expedition in the USA.

Although well known for many decades, the fossil deposit was not studied in detail until the 1960s (Schultz et al. 1963, 1967). The potential occurrence of Clovis PaleoIndian artifacts with *Mammut americanum* from BIBO-KY are discussed in Tankersley et al. (2009). Specimens from the locality are archived in institutions including the Museé National d'Histoire Naturelle (Paris), Academy of Natural Sciences of Drexel University, University of Nebraska State Museum, Museum of Comparative Zoology, and the US National Museum.

11. Big Cypress National Preserve (BICY), Florida

A partial molar of *Mammuthus* was found at the "Jetport Site" (a reference to the Dade-Collier Training and Transition Airport) within BICY. This Pleistocene site also produced a small number of horse, camel, and tortoise fossils. The mammoth specimen is curated at the Florida Museum of Natural History.

12. Big Thicket National Preserve (BITH), Texas

A *Mammuthus* tooth and associated mandible fragment are within the archived collections at BITH, Menard Creek Unit. The molar was removed in 1981 from the Trinity River Pleistocene sediments. The mandible is archived at Texas Memorial Museum, Austin. Pleistocene fossils at BITH are found mixed with reworked sediments of the Miocene-age Fleming Formation (Kenworthy et al. 2007). Additional but not currently identified skeletal remains have been retrieved from the same area as the molar (Fay 2009).

13. Blackwater Draw National Historical Landmark (BLDR-NM), New Mexico

Blackwater Draw includes one of the most significant archeological sites in North America. Blackwater Draw Locality #1, the site that has come to exemplify the Clovis culture, including the type Clovis points and abundant examples of artifacts in association with mammoths and extinct bison (Hester 1972, Katz 1997). The excavation areas and the public museum are owned and operated by Eastern New Mexico University. Located in eastern

Roosevelt County, New Mexico near the border with Texas, the Blackwater Draw drainage today is intermittent, but in the recent past the area was wetter and supported large mammals such as bison, horses, and mammoth. At the close of the Pleistocene and into the Holocene, early North American people butchered large mammals at a spring-fed pond perched above the draw (Haynes and Agogino 1966, Hester 1972). The pond dried up approximately 8000 years ago (Hester 1972).

In the early 1930s, a gravel pit was established at the pond site. *Mammuthus* and *Bison* bones were reported to E.B. Howard in November 1932 (Howard 1935), leading to the first of a number of investigations. The active use of the site as a gravel pit for decades had a significant influence on scientific investigations. Gravel is below the fossiliferous sediments, necessitating removal of the sediments to get at the gravel (Hester 1972). Much of the scientific work at the site can be described as salvage archeology and paleontology (Katz 1997). The economic use of the site halted early efforts to preserve some part of it (Hester 1972). Nevertheless, a number of significant finds have been made; beyond its archeological reputation, Blackwater Locality #1 is the most prolific mammoth site in New Mexico (Lucas and Effinger 1991). Material is assigned to either *M. columbi* or the less specific *M.* sp., and comes from the gray sand and brown sand wedge units (Lucas and Effinger 1991).

Cotter (1937) provided the first description of mammoth bones associated with artifacts at the site. More spectacularly, in November 1962 the first of what turned out to be five mammoth skeletons was found, associated with more than 100 Clovis artifacts (Hester 1972). One of the mammoths shows definite evidence of butchering and three others were probably or possibly butchered (Hester 1972). They are in different states of articulation and preservation, and probably died at different times; they may have been attacked in water, where movement would have been more difficult (Lundelius 1972). Reportedly, additional mammoths were present at the 1962 find but were lost to bulldozing (Katz 1997). Humans may have been both scavenging and actively hunting (Katz 1997). Blackwater Draw Locality #1 became a National Historic Landmark in 1982.

14. Canaveral National Seashore (CANA), Florida

CANA museum collections contain teeth and a small bone fragment described as mastodon, recovered from Merritt Island National Wildlife Refuge, located adjacent to CANA (Tweet et al. 2009a). No formal description or their chronology exists for the specimens.

15. Cape Krusenstern National Monument (CAKR), Alaska

CAKR was created to preserve an extensive sequence of ancient beach ridges with a rich archeological record spanning the last four millennia, but also contains fossil-bearing Quaternary deposits in the form of ice-rich frozen silt. Pockets of large mammal fossil material are known from these yedoma deposits and often accumulate at the base of coastal bluffs. A site at Imik Lagoon is the best documented example of such a fossil locality and was recorded by NPS archeologists in 1987 (McClenahan and Gibson 1990). Here, a diffuse scatter of Pleistocene fossil bones was noted along a 3 km stretch of the lagoon shore above and below the waterline and at the base of the adjacent bluff. Among the finds are at least 8 *Mammuthus* sp. bones and tooth fragments. None were found in situ, although the bone is reported to have been unweathered and in good condition.

Six specimens of human-modified *Mammuthus* ivory, presumably representing recent/Holocene use of fossil ivory, exist in the museum collections of CAKR (Elder et al. 2009). Little else is known about these specimens.

16. Channel Islands National Park (CHIS), California

The Channel Islands are a series of islands off the coast of southern California. The northern Channel Islands (Anacapa, San Miguel, Santa Cruz, and Santa Rosa) plus Santa Barbara Island of the southern Channel Islands are included in Channel Islands National Park (49 km [31 mi] off shore today from the city of Santa Barbara). The islands have a long history of ranching and exploration (see Schoenherr et al. 1999). During the late Pleistocene glacial episode, with lower sea levels, the four northern islands coalesced to form one large island, Santarosae, which was a mere 7.2 km (4.5 mi) from the coastal mainland (Muhs et al. 2015). The islands have been prospected for paleontological and archeological remains since the second half of the 19th century, yet much remains to be discovered, analyzed, and published.

Mammoths were first reported from the islands by Stearns (1873).The islands are famous for their endemic pygmy mammoth (Agenbroad 1998a, b; Roth 1996), originally described as *Elephas* (*Mammuthus) exilis* (Stock and Furlong 1928, Pygmy mammoth). Most of the remains are found as scattered and isolated skeletal elements but in 1994 a near complete skeleton was recovered (Agenbroad 1998b, Agenbroad et al. 1999). Although small in stature, *M. exilis* were highly variable in size (Roth 1993). The islands also have mammoth skeletal remains attributed to the mainland-sized form, *M. columbi* (Pigati et al. 2017). There is a long debate on the possibility of human association with the pygmy mammoth, developed at great length by Phil Orr in the 1950s and 1960s (Agenbroad et al. 2005, Orr 1968). The diet of *M. exilis* has been reconstructed (Semprebon et al. 2016, Smith and Desantis 2018).

Pygmy or dwarf proboscideans are not limited to the Channel Islands of California. They have been recovered from various islands in the Mediterranean basin (*Elephas falconerii*, *Mammuthus creticus*, and *Palaeoloxodon* spp.; Herridge and Lister 2012, Palombo 2007), Wrangel Island (Russia; *Mammuthus primigenius*; discussion in Tikonov et al. 2003), and various islands of South-East Asia (*Elephas*, *Stegodon* [Stegodontidae] Van den Bergh et al. 1996).

17. Colonial National Historical Park (COLO), Virginia

One of the earliest potential reports of proboscideans for a NPS unit comes from the Williamsburg area. The Williamsburg-area mastodon was first reported in 1811 (Anonymous 1811). The details vary from report to report, but apparently the bones were found 10 km (6 mi) south (Anonymous 1811) or east (Mitchill 1818) of Williamsburg on the south bank of the York River. It is unclear where the former location would be, but the latter is potentially within COLO, in the vicinity of Bellefield Plantation and the mouth of Indian Field Creek. Anonymous (1811) reported that the site was a few yards within high water near the home of Gawin Corbin. The fossils include 2 tusks, 2 vertebrae, 1 pelvis, 1 femur, and partial mandibles with 7 associated teeth (Mitchill 1818). Given the presence of molars, it is surprising that Mitchill (1818) identified the specimens as mammoth, yet Hay (1923) reported them as a mastodon (*Mammut*). Hay (1923) reported that the bones were probably destroyed in the 1859 fire at the College of William and Mary. Clark and Miller (1912) refer this specimen to the Pleistocene of the Talbot Formation (a now-obsolete name). See more historical discussion in Tweet et al. (2014a).

18. Colorado National Monument (COLM), Colorado

A proboscidean tooth was found in 1965 in No Thoroughfare Canyon, but has apparently been lost (Scott et al. 2001, Tweet et al. 2012b). No formal write-up exists.

19. Death Valley National Park (DEVA), California and Nevada

Proboscideans are represented in the Pliocene and Pleistocene deposits of DEVA. The Pliocene specimens are all tracks, found in the Copper Canyon Formation (Fig. 5). Some of the key references for the Copper Canyon tracks include Scrivner (1984), Scrivner and Bottjer (1986), Santucci (1998), Santucci and Nyborg (1999), and Nyborg (2011).

Pleistocene proboscidean skeletal remains are known from the "Rogers Beds" (formerly called "Lake Rogers"), including a roughly "3-foot" tusk of a "mastodon" reported in an abstract by Clements (1952:1324). Based upon known faunas from the region, *Mammuthus* is more likely than *Mammut*. The "Rogers Beds" were long interpreted as lacustrine in origin but have recently been investigated in more depth (Springer and Pigati 2018, Springer et al. 2018a) and have been reinterpreted as "spring-derived desert wetlands" such as are found at TUSK (Tule Springs Fossil Beds National Monument, see below). These latter authors have found abundant fossils including *Mammuthus*.

20. Denali National Park and Preserve (DENA), Alaska

Mammuthus fossils have been briefly reported from the Teklanika River area of eastern DENA (Blong 2018, Guthrie 1985, Ten Brink and Waythomas 1978). In 2018, NPS staff archeologist Jess Peterson discovered in situ in DENA a mammoth tusk preliminarily identified as *Mammuthus primigenius* (Fig. 6). Subsequent excavation also yielded a M3 and skeletal elements of other taxa. Work on the project is currently on-going.

21. Florissant Fossil Beds National Monument (FLFO), Colorado

Although FLFO is known for its plant and insect fossils from Eocene lacustrine shales, in 1996 a *Mammuthus columbi* specimen was excavated from a Pleistocene gravel deposit within FLFO (Meyer and Weber 1995). This specimen, a mandible with molars, has been radiocarbon dated to 49,830 ± 3290 yr. BP (CAMS-22182; Veatch et al. 2004). Pollen as-

Figure 5. Proboscidean trackway in Copper Canyon, DEVA (photo courtesy NPS).

sociated with the remains were reported in Veatch et al. (2010). Significantly, this discovery shows that the mammoth was inhabiting a high elevation (~2500 m; 8200 ft) prior to the Last Glacial Maximum.

22. Gates of the Arctic National Park and Preserve (GAAR), Alaska

Gates of the Arctic is a large, roadless, remote, and mountainous park in northern Alaska, which encompasses some 8 million acres of the Brooks Range Mountains and spans both arctic and subarctic environments. One of the richest Pleistocene vertebrate fossil localities in Alaska (Mann et al. 2013) lies immediately north of GAAR along north-flowing drainages such as the Ikpikpuk River, which cuts through fossil-bearing and permanently frozen silt deposits (yedoma) that in rare cases include mummified soft tissue (Guthrie and Stoker 1990). Local Inupiaq residents are familiar with these abundant Pleistocene fossils and mammoth ivory and bone has been used traditionally as a raw material for tools and crafts. Encounters with mammoths and other giant animals are recounted in Inupiaq oral histories (Gubser 1965:33, Rasmussen 1932), and may be informed by fossil finds. Proboscidean specimens in GAAR that are identifiable to the species level are all woolly mammoth (*Mammuthus primigenius)* and represent the farthest north examples of the taxa within the NPS.

In 1885 Allen noted a well-preserved "os pubis" of a mammoth on the Alatna River, to the south and outside of GAAR, but in the same fossil-bearing Quaternary deposits that extend into GAAR. Observers noted the fresh appearance of the bone, which "to all appearances had never undergone any process of petrification" (Allen 1887, Smith and Mertie 1930:252).

In 1964 a large segment of a single mammoth tusk was found protruding from the ground surface during the course of archeological surveys on Fortress Creek in the northernmost, Arctic foothills, portion of the park (Schlesier 1967:210). The undated specimen was excavated and collected. No artifacts or demonstrable links to human activity were noted.

Figure 6. Excavation by Jess Peterson of the first mammoth tusk, *Mammuthus primigenius*, from DENA, 2018 (photo courtesy NPS).

In 2006 local residents found a complete woolly mammoth tusk on private lands within the boundaries of GAAR. NPS researchers were permitted to sample it and AMS dating of the collagen fraction yielded radiocarbon ages of 12,620 ± 90 BP (CAMS-131222) and 12,500 ± 60 BP (BETA-226405), demonstrating this to be one of the more recent mammoth finds from Alaska. The specimen also has significance for its ecological setting—a relatively high altitude, mountainous locale—distinct from most mammoth find spots in the region, which are typically in lower elevation open terrain.

23. Glen Canyon National Recreation Area (GLCA), Utah and Arizona

GLCA holds some of the most unusual proboscidean remains in the way of dry-preserved dung. The best-known and most studied late Pleistocene-age locality for mammoth in GLCA is Bechan Cave (a Navajo word for "big feces"). All of the "dung localities" in GLCA including Bechan Cave are rockshelters eroded into sandstone by incising river channels. A test trench excavation by L. Agenbroad and J. Mead in the early 1980s established that the Bechan shelter sediments contain a layer of over 300 m^3 of dung, predominantly *Mammuthus* dung (Agenbroad et al. 1989). The chronology was established using radiocarbon dating (Agenbroad and Mead 1989, Martin 1987, Mead and Agenbroad 1992). The identification of the large boluses and their coarse contents was established in detail via morphology (Mead et al. 1986; Fig. 7), which has since been supported via aDNA (Karpinski et al. 2017). Much of the attention of the dung has been on the dietary reconstructions based on pollen, spores, and macro-botanical remains (Davis 1987, 1990, 2003, Davis and Shafer 2006, Davis et al. 1984, 1985, Mead et al. 1984, 1986, Mead and Agenbroad 1989). Other mammalian taxa also produced dung recovered from the layer (Kropf et al. 2007). Additional, smaller sandstone shelters in GLCA have also produced dung of mammoth and

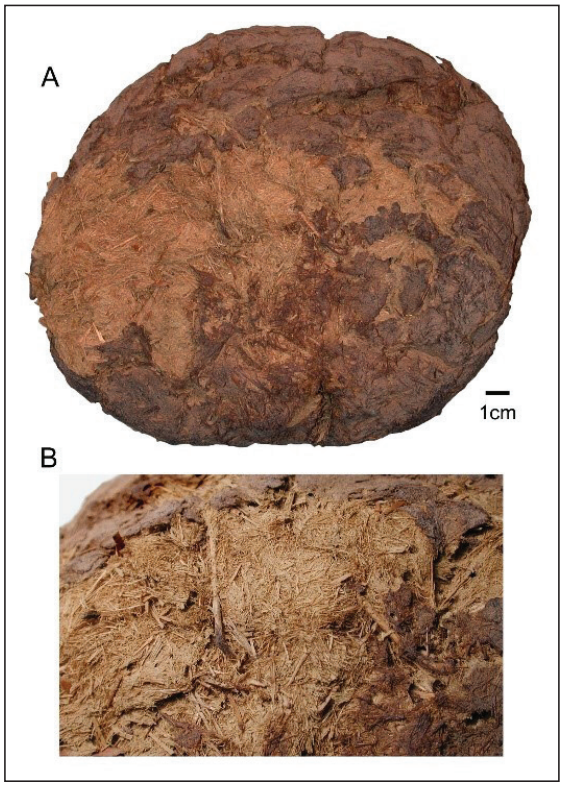

Figure 7. Dung of *Mammuthus* sp. from Bechan Cave, Utah. A, overall morphology; B, close-up showing the graze species, the large number of the long plant fragments illustrates the poor chewing abilities of mammoths. The brown outer surface includes bile acids that record DNA and other biochemical data that has now been assessed for aDNA (see text) (photo and permission by S. L. Swift).

other mammals (Mead and Swift 2012, Withers and Mead 1993). Mammoth bones have also been reported from GLCA, but not in detail (Mammoth Alcove; Agenbroad and Mead 1989, Tweet et al. 2009b). Santucci et al. (2001) and Tweet et al. (2009b) provided detailed overviews about the work and contract reports conducted at Bechan Cave and other rockshelters in GLCA that preserve mammoths and other Pleistocene taxa.

24. Golden Gate National Recreation Area (GOGA), California

Proboscideans are reported from two stratigraphic units at GOGA: the upper Pliocene-lower Pleistocene Merced Formation and the upper Pleistocene Colma Formation. Two fragments of *Mammut americanum* were recovered from the Merced Formation at Fort Funston (Fleishhacker Beach) in 1939 and 1975 (by T. Hall; see Henkel et al. 2015; Fig. 8). P.E. Peabody collected *Mammuthus* tooth, tusk, and vertebra from the Merced Formation at Mussel Rock; the Thornton Beach locality of the same unit has produced molar fragments of *Mammuthus*. Hunter et al. (1984) suggested that the sedimentary convolutions in the T2 unit of the upper Merced Formation between Wood's Gulch and Fort Funston were produced by mammoths and other large mammals. Hay (1927) reported observing a right M2 of *Mammuthus columbi* in the collections of Golden Gate Memorial Museum of San Francisco, collected from Cliff House Beach in 1908. Dooley et al. (2019) indicated that the newly-recognized *Mammut pacificus* pertains to all mastodon specimens from the Sierra Nevada west to the Pacific Coast and into southern Idaho, and that *M. americanum* is not found in California. These specimens referred to from this park should be reassessed based on the *Mammut* analysis of Dooley et al. (2019).

25. Grand Canyon National Park (GRCA), Arizona

The Grand Canyon contains the largest number of caves in the National Park System. Due to the steep physiographic setting for most of this region, it is understandable that remains of graviportal proboscideans are rare in this park. Caves along the Marble Canyon

Figure 8. *Mammut* molar from GOGA (photo courtesy NPS). Although originally identified as belonging to *M. americanum*, analyses by Dooley et al. (2019) could alter this—see text.

platform of the upper Colorado River area within the eastern Grand Canyon were systematically prospected and select caves excavated in the early 1980s. Interestingly, Emslie (1987, 1988) reported a fragmented tooth plate of *Mammuthus* from the condor (*Gymnogyps*) nest deposit in Sandblast Cave. Prior to this discovery, mammoths were not known from cave or alluvial deposits within GRCA (Mead 1981). It appears that mammoths were not within the steep corridor canyons within GRCA but were on the flat platforms adjacent to and forming the rims to the river corridor and side canyons. Northwestern reaches of the Grand Canyon, within the Grand Canyon-Parashant National Monument (PARA) and GRCA (portions of the Shivwits Plateau) have yet to be prospected for paleontological remains in caves and sinkholes that proboscideans could have visited, similar to those at Bechan Cave and others in GLCA mentioned above.

26. Great Sand Dunes National Park and Preserve (GRSA), Colorado

Although mammoth remains from GRSA have not received official description or chronology in a publication, Scott et al. (2001) mention that a *Mammuthus* femur has been collected from the park.

27. Hagerman Fossil Beds National Monument and National Natural Landmark (HAFO), Idaho

HAFO is internationally significant because it protects one of the world's richest known fossil deposits from the late Pliocene epoch, 3.5 million years ago, providing a window on the time just before the Pleistocene. A multitude of publications detail the various vertebrate and invertebrate fossils recovered from HAFO and surrounding region (see review Mead et al. 1998, Sankey 2002). The only proboscideans (*Mammut*) from HAFO come from the middle Pliocene Glenns Ferry Formation (Blancan; Gazin 1936, Ruez 2009).

HAFO also curates an unusual "occurrence" from Craters of the Moon National Monument and Preserve (CRMO). The excavation of a circa 1920s–1930s trash dump revealed a number of large, charred, partially-burned *Mammuthus* bones near the bottom of the trash layer. H.G. McDonald, head of the excavation, indicated that the mammoth remains were not in situ and may have been brought to the dump from a nearby gravel quarry (mammoth remains are relatively common in the Snake River Plain gravel pits of Pleistocene age sediments).

28. Hopewell Culture National Historical Park (HOCU), Ohio

HOCU (formerly Mound City Group National Monument) has no definite in situ proboscidean records; however, Mills (1922:286) reported "mastodon tusk" fragments from Mound 23. Unfortunately the specimens are apparently lost and no formal write-up of the remains exists (Hunt et al. 2008).

29. Independence National Historical Park (INDE), Pennsylvania

There is a historic record of a *Mammut* tooth fragment from INDE, from an archeological excavation of an area near Benjamin Franklin's property. The specimen is of historic interest because Franklin received mastodon fossils and wrote about them in his journal. This specimen is from an archeological context and may have been owned and written about by Franklin. A second historic occurrence of proboscidean fossil remains are associated with INDE. During the early 1800s, Charles Willson Peale's natural history museum was located on the second floor of Independence Hall. Among the exhibits on display at Peale's museum was a mastodon skeleton, as shown in his 1822 self-portrait "The Artist in His Museum" (Fig. 9).

30. John Day Fossil Beds National Monument and National Natural Landmark (JODA), Oregon

JODA records the longest paleontological record for the Cenozoic in the NPS system (55–7 Ma) (Fremd 2010). The Mascall Formation (lower-middle Miocene) and the Rattlesnake Formation (upper Miocene) at JODA are known to produce proboscidean remains, which are among the oldest such remains in the NPS (see overview in Fremd 2010, Kenworthy et al. 2005). Based on Fremd (2010), The Rattlensake Formation contains both *Amebelodon* (Barbour 1927) and *Tetralophodon* (Falconer 1857). A tooth from the Mascall Formation (Fig. 10) is the anterior portion of a molar which lacks central conules in the medial sulcus and, therefore can be attributable to *Zygolophodon*, although listed as "Proboscidea Indet." in Maguire et al. (2018). This formation has both *Gomphotherium* and *Zygolophodon* (Fremd 2010). Fremd et al. (1994) and Prothero et al. (2006) indicate that *Gomphotherium* is known from the Mascall sediments but the study by Maguire et al. (2018) did not find evidence for this taxon in the type area of the Mascall Formation. The fossils curated at JODA also contain proboscidean remains from outside the park boundaries.

31. John Muir National Historic Site (JOMU), California

JOMU has a single tusk cataloged into its historic collection. John Muir collected the tusk in Alaska in 1881 (Kotzebue Sound, Eschscholtz Bay), and discussed the find in his book "The

Figure 9. "The Artist in His Museum". Oil on canvas by Charles Willson Peale, 1822. Courtesy of the Pennsylvania Academy of the Fine Arts, Philadelphia. Sarah Harrison (The Joseph Harrison, Jr. Collection) (INDE).

Cruise of the Corwin" (Muir 1917). The tusk is a 30 cm (12″) section at the alveolar end with the other end sawed flat (V. Bones, JOMU, San Francisco, CA, December 2018, pers. comm.). It appears to be *Mammuthus primigenius*.

32. Joshua Tree National Park (JOTR), California

Proboscidean fossils at JOTR are from the informally designated upper Pleistocene "Pinto Formation" in Pinto Basin, in the eastern section of the park. The "Pinto Formation" includes lacustrine, fluvial, alluvial, and eolian sediments deposited in a time frame including at least 25,000–16,500 years ago. Fossils attributable to *Mammuthus columbi* and *Mammuthus* sp. have been found since 2005, but have not yet been described in detail. See also discussions in Scott et al. (2006) and Tocci et al. (2018).

33. Klondike Gold Rush National Historical Park (KLGO), Alaska

KLGO has curated an artifact pendant made of fossil *Mammuthus* ivory. It was a gift to the NPS from the Moore family, descendants of the Moores who built the historic Moore House (now KLGO property). Herman Kirmse, the first jeweler in Skagway, moved into the Moore House about 1908. Kirmse made the pendant out of Alaskan mammoth ivory, but the original sources of the fossil is unknown (D. Boettcher, KLGO, Skagway, AK, December 2018, pers. comm.).

34. Kobuk Valley National Park (KOVA), Alaska

There are several reports of *Mammuthus* from KOVA. Several specimens of *Mammuthus primigenius* and *Mammuthus* sp. have been reported from the important and well-researched stratigraphic section at Epiguruk Bluff along the south bank of the Kobuk River (Hamilton et al. 1993). Although most of the bluff, including the documented mammoth fossils is located just outside the park boundary, similar Quaternary alluvial deposits with scattered fos-

Figure 10. *Zygolophodon* sp. from JODA (photo courtesy NPS and Nicholas A. Famoso).

sil material extend inside the park and are exposed along the Kobuk River. USGS geologists working on the Kobuk River through the 1970s and 80s recovered numerous Pleistocene vertebrate fossils, including several *Mammuthus* sp. specimens from these contexts (Repenning 1982). Elder et al. (2009) mentioned finds of a *Mammuthus primigenius* lower molar from along the Kobuk River (from Epiguruk Bluff outside unit boundaries but important to know); a fragment of *M. primigenius* tooth is in park collections. Giddings (1962:11), in a description of the Onion Portage site on the Kobuk River, reported finding a "broken fish-shaped fishing lure of mammoth tooth", a clear record of Holocene people making use of Pleistocene-age fossils.

Along the lower and middle reach of the Kobuk River as far up stream as the village of Shungnak—a portion of the river that spans KOVA—Cantwell (1887, 1889) observed ice-rich Quaternary deposits in high bluffs along river banks that included many "elephant" (*Mammuthus* sp.) tusks, teeth and bones. "Quantities of mammoth tusks were observed in this clay and its debris where undermined by the stream". He observed that in many of the villages on the Kobuk River fossil ivory in use by local residents to carve ornaments and tools, including large soup ladle.

A brief survey for archeological and fossil finds in Kobuk sand dunes has been conducted, with an emphasis on Pleistocene age deposits. Work that followed identified bison and mammoth paleontological remains, which remain undated and not published on (Stanford et al. 1990).

35. Lake Mead National Recreation Area (LAKE), Arizona and Nevada

The first discovery of *Mammuthus* in LAKE was made by John Strong Newberry on the 1857–1858 J. C. Ives expedition to the Colorado River. Newberry found a mammoth maxillary tooth at the base of a pyramidal hill (now dubbed "Elephant Hill") on the east side of the Colorado River (Hay 1927:45, Newberry 1861; whereabouts of specimen unknown). This fossil is usually attributed to the Chemehuevi Formation (Longwell 1963), but may have come from an underlying unit instead (Malmon et al. 2011). Numerous additional reports and discoveries of mammoth specimens are reported from LAKE but are only briefly described; further information can be found in the following: Agenbroad and Brunelle (1993), Bonde et al. (2018), Hay (1927), Longwell (1963), and Malmon et al. (2011). LAKE also curates late Pleistocene material, including *Mammuthus*, from the Glendale local fauna which was collected just outside of the park along the south side of the Muddy River at Glendale, Nevada (Scott et al. 2004).

36. Lake Meredith National Recreation Area (LAMR), Texas

LAMR has at least two records of proboscideans. Hunt and Santucci (2001) reported that a now-lost proboscidean tooth was recovered from the Ogallala Formation in Cedar Canyon near the eastern end of LAMR during the placing of a restroom pipe. The fossil was initially identified as a *Mammut* tooth but was probably from a gomphothere instead. It came from the medial sandy interval of the Ogallala Formation. In addition, a proboscidean humerus tentatively identified as *Mammuthus* was found in a cliff of alluvium adjacent to an oil well in an inset terrace just west of LAMR's boundary with Alibates Flint Quarries National Monument (Hunt and Santucci 2001).

37. Lava Beds National Monument (LABE), California

Many *Mammut* specimens have been recovered from lava tube caves (Fossil Cave particularly) at LABE (Fig. 11). The park collections contain a number of these remains,

some of unknown provenience (see details in Kast 2008, Santucci et al. 2001, Santucci and Kenworthy 2009). These specimens should be reassessed based on the *Mammut* analysis of Dooley et al. (2019).

38. Lehner Mammoth-Kill Site NHL (LEMA-AZ), Arizona

While Emil Haury (1953) excavated mammoths from the Naco Mammoth Site in southeastern Arizona (Haury 1953), mammoth remains were also found exposed not far away at the Lehner Ranch, Cochise County (Haury et al. 1959). Since the excavations in the middle 1950s and subsequent field seasons in 1974 and 1975, a multitude of geological, paleontological, paleoecological, and archeological research has been conducted at the locality and other sites along the San Pedro River Valley (Mehringer and Haynes 1965, Metcalfe et al. 2011). All research at this locality is decisively linked to the work at the Murray Springs Clovis Site (# 44 below; Haynes and Huckell 2007) and other localities in the valley. The Lehner locality contained the remains of *Mammuthus columbi* (Lance 1959, Saunders 1970) and *Mammut* (Mead et al. 1979) recovered from late Pleistocene sedimentary units. The locality is administered by the Bureau of Land Management and was designated a NHL in 1967.

39. Mammoth Cave National Park (MACA), Kentucky

Fittingly, MACA has proboscidean fossils. Ron Wilson (1981, 1985) reported finding material of a mammoth or mastodon in 1979 within the Proctor section (aka Proctor Cave) of Mammoth Cave (Santucci et al. 2001). Per an unpublished note by Wilson (in NPS paleo archives) on fossils collected from MACA and reposited at the Carnegie Museum of Natural History, the 1979 proboscidean material was only a possible metapodial fragment, with

Figure 11. *Mammut americanum* molar (partial) located in the UCMP collections from LABE (photo courtesy NPS). Although originally identified as belonging to *M. americanum*, analyses by Dooley et al. (2019) could alter this—see text.

additional proboscidean material collected in 1980 which consisted of 20 fragments of a tusk. Later, Dan Fisher (University of Michigan) identified the tusk fragments as *Mammut americanum* (Colburn 2017).

40. Mammoth Site of Hot Springs (MASI-SD), South Dakota

The Mammoth Site of Hot Springs (a National Natural Landmark and a 501 (c)(3) nonprofit organization; not administrated by the NPS) is located in the southern Black Hills of southwestern-most South Dakota. A hill on the southern side of the town was slated to be removed for a housing project in 1974. Earth removers immediately uncovered skeletal and ivory remains and halted excavation. Larry Agenbroad and Jim Mead were called in to evaluate the fossils and declared in the summer of that year that *Mammuthus* remains were in situ and abundant. The locality is a filled-in sinkhole measuring about 25 by 50 m (82 by 165 ft). Coring of the deposit indicates that at least 20 m (67 ft) of sediments and mammoth bones fill the sinkhole, which contained a warm-water pond for much of its existence. Steep-sided edges of the sinkhole made the pond a lethal trap and for the most part just a mammoth-selective trap. Excavation in the 1970s and 1980s produced most of the exposed and recovered skeletal remains. By the middle 1980s it was determined that the site should be preserved and made into an active, nonprofit research and educational institution. By 1986 the entire sinkhole was within a building, now with an attached museum, archival lab, and preparation lab (see discussions in Agenbroad and Mead 1994). Radiocarbon analyses produced an age of approximately 26,000 yr. B.P. but that was always assumed to be a minimum. In 2018 OSL (Optically Stimulated Luminescence) analyses by two labs have shown the top of the sinkhole deposit dates to approximately 140,000 years ago and the lowest excavation produced an age greater than 190,000 years old; there are more than 14 m (45 ft) of sediments and fossils below that level to be dated. A minimum of 60 mammoth individuals have been recovered based on the number of tusks (two per individual in elephants). Currently both *M. columbi* and *M. primigenius* (3 specimens) are reported from the deposit. The locality is a working research institution with excavations occurring at various times throughout the year but especially during the summer. Tours are given all year long to approximately 102,000 visitors per year.

41. Mississippi National River and Recreation Area (MISS), Minnesota

Several finds of isolated proboscidean fossils have been made in and around the "partnership park" MISS (Stauffer "1945", Tweet 2014). Stauffer produced an inventory of Pleistocene finds in Minnesota through 1948 (hence the quotation marks around 1945, the year usually given for the citation). In the report there are three finds that are most likely from land now within MISS, and three potentially from within MISS.

The three records likely from MISS are: 1) a tooth and tusk found in 1878 in terrace gravel along Coon Creek on the east bank of the Mississippi River attributed to *Mammuthus columbi* ("*Parelephas jeffersoni*" of Stauffer "1945"); 2) a fragmentary *Mammuthus primigenius* molar dredged from the Mississippi River near St. Paul in 1924; and, 3) the probable head of a mammoth femur from the terrace gravel at Hasting. The Hastings specimen was probably found in 1909 rather than 1923 as stated in Stauffer (Tweet 2014). Stauffer's Coon Creek report is broadly similar to a report in Johnson (1874) of tusk fragments and a tooth in drift 8 km (5 mi) above St. Anthony Falls on the east bank of the Mississippi, but differs in many details, such that it is improbable that they are the same unless Stauffer had a different information source.

Three other finds cited by Stauffer ("1945") have such general provenance information that it is impossible to know whether or not they were found in the river corridor: a pro-

boscidean tooth found at an unstated time in the glacial drift of Minneapolis; a *Mammuthus columbi* molar from glacial gravel within Minneapolis, now at Yale (collected in 1895); and another Columbian mammoth molar from glacial deposits near Hastings. As noted by Hay (1924), the Yale specimen may be referred to obliquely in Lull (1908:198).

42. Mojave National Preserve (MOJA), California

Based on NPS records, three localities in MOJA have yielded fossils attributed to *Mammuthus* sp. All three are near the southwestern boundary of the park; see discussions in Jefferson (1991), Reynolds et al. (2003), and Tweet et al. (2016).

43. Montezuma Castle National Monument (MOCA), Arizona

MOCA has one of the oldest proboscidean records in the NPS. Fossil proboscidean tracks (Fig. 12) are known from the middle Miocene–Pliocene Verde Formation within the monument, at a locality known as "Elephant Hill" (#33 in Twenter 1962) (Tweet et al. 2008, Santucci et al. 2014). The site has been mapped by McGeorge and Schur (1994). Although known about earlier, Brady and Seff (1959) were the first to report these presumed proboscidean tracks. They have been covered several times with soil to protect them, and are currently buried (Protas 2002). Czaplewski and Davies (2007) questioned the identification of the tracks.

44. Murray Springs Clovis Site, NHL (MUSP-AZ), Arizona

Murray Springs (archeological site AZ EE:8:25 ASM; administered by the Bureau of Land Management and designated a NHL in 2012) is a Clovis cultural site with multiple activity areas in the San Pedro River Valley of southeastern Arizona (Haynes and Huckell 2007). In 1966 Vance Haynes and Peter Mehringer found multiple areas along the dry arroyo exposure while working to understand the valley sedimentary deposits. As with the nearby Lehner Mammoth Kill Site (#38 above), skeletal fossils were under and in contact with a distinctive black mat. Among a number of megafaunal species, *Mammuthus* was

Figure 12. Proboscidean track at MOCA (photo courtesy NPS).

abundant. All bone was highly leached of organics; enamel and dentine components of teeth were typically well preserved. Amongst the many lithic artifacts recovered was a bone shaft straightener constructed of mammoth bone (Haynes and Hemmings 1968: fig. 1, Hemmings 2007). An average age (of eight samples) of 10,900 ± 50 years B.P. (not corrected) was determined for the Clovis occupation and utilization of mammoth and other megafaunal species (Haynes and Huckell 2007). Multiple reports about local and regional paleoecological and geological analyses are presented in Haynes and Huckell (2007). Multiple skeletons and footprints of *Mammuthus columbi* were recovered (Saunders 1970, Hemmings 2007).

45. Natchez Trace Parkway (NATR), Alabama, Mississippi, and Tennessee

Archeological investigations undertaken during the completion of the NATR uncovered three fragments of proboscidean teeth (C. Smith, NATR archeologist and museum curator, Tupelo, MS, February 2018, pers. comm.). Two are identified as mastodon, and the third enamel fragment is identified as mammoth or mastodon. The small size of the specimens and the presence of a small creek nearby suggest a detrital origin. No details or descriptions exist for these remains.

46. Navajo National Monument (NAVA), Arizona

There are two non-specific references to *Mammuthus* finds in the vicinity of two of the three units of NAVA in Agenbroad and Mead (1989). "#17 Tsegi" (Agenbroad and Mead 1989: Table 1) refers to Tsegi Canyon with a description of the sediments from Betatakin Ruin to Marsh Pass at the canyon mouth of Laguna Creek at the community of Tsegi. Original description of the canyon sediments is attributed to Hack (1942) but this author does not mention proboscidean remains in the discussion of the Tsegi and Jeddito formations in the canyon. However, Saunders (1970: JJS 3 site 50) does indicate one *Mammuthus* find from the canyon mouth at Tsegi. *Mammuthus* remains are found throughout the region around the various NAVA units, including in the canyon near Inscription House (Agenbroad and Mead 1989, Agenbroad et al. 2013); unfortunately no formal description of the NAVA specimen exists.

47. New Jersey Pinelands National Reserve (PINE), New Jersey

PINE is the first National Reserve and is administered as a partnership between the NPS and the State of New Jersey. At least one *Mammut* find can be attributed to PINE. The area around Pemberton, at the northwestern boundary of the unit, has produced a number of *Mammut* specimens, but most can be placed outside of PINE. Rogers (1840) mentioned bones including a skull, tusk, tibia fragments, and ribs found north of the road between Pemberton and (New ?) Lisbon and 2.4 km (1.5 mi) from the latter, on the Forsyth property. "New Lisbon" and "Lisbon" were used interchangeably at the time, and New Lisbon is well within PINE.

A find mentioned by Heilprin and Leidy (1887), although superficially similar, is not the same as Rogers' (1840) mastodon because the former specimen was recovered in 1877 (Rhoads 1903, Hay 1923). Kitchell (1856) added another mastodon skull (found in 1855) from John Ewens's meadow. Rhoads (1903) included accounts of two mastodon specimens from Pemberton, including Heilprin and Leidy's specimen and a second skull from a swamp. Hay (1923) reported several occurrences, although all of the finds where the locality can be distinguished are outside of PINE. Hay did not include Rogers' report, but did mention that the Academy of Natural Sciences of Philadelphia (now the Academy of Natural Sciences

of Drexel University) had two complete molars and two partial molars from Pemberton, credited to G.C. Forsyth, which could be part of the 1840 find.

48. Nez Perce National Historical Park (NEPE), Idaho, Montana, Oregon, and Washington

NEPE is composed of 38 small units across four states (Idaho, Montana, Oregon, and Washington), of which six are on NPS land. *Mammuthus* fossils have been found at 1 of the other 32 sites, Tolo Lake, Idaho. This site is managed by the Idaho Department of Fish and Game (Kenworthy et al. 2005). In the fall of 1994, heavy equipment operators unearthed mammoth bones, which prompted an excavation in the summer of 1995. More than 400 well-preserved mammoth fossils, attributed to *M.* cf. *M. columbi*, were recovered, representing at least 10 subadult to adult individuals. Among the fossils was a ~95% complete skeleton, perhaps the most complete mammoth found in Idaho (Miller et al. 1998). The excavations sampled a small fraction of the encasing lake bed, so it is likely that there are more mammoth remains still in situ. The lake has since been refilled. The primary repository is the Idaho Museum of Natural History in Pocatello, with some specimens at the University of Idaho (Moscow) and the Grangeville Chamber of Commerce Visitor Center (Kenworthy et al. 2005).

49. Niobrara National Scenic River (NIOB), Nebraska

Verifying the provenience of records in the Niobrara River corridor can be challenging, because NIOB boundaries provided by various sources are inconsistent, and the history of research goes back to the mid-19th century, when standards for reporting locality information were more relaxed. Many of the oldest publications simply report "Niobrara Valley" as the locality for various discoveries. An example of this issue can be found in Leidy (1858), in which he named two species from the Niobrara Valley, *Mastodon* (*Tetralophodon*) *mirificus* (now *Stegomastodon mirificus*, Leidy 1858) ("Bed F", possibly the "Loup Fork Beds") and *Elephas* (*Euelephas*) *imperator* (now a synonym of *Mammuthus columbi*). Detailed locality information is lacking, so it is unclear where along the valley these species were found, therefore it is unknown if they are from NIOB.

Multiple reports of proboscideans of Miocene and Pleistocene age can be confirmed within NIOB, which is one of the most productive NPS units for proboscideans. For example, Voorhies (1990) provided specimen lists and other information for a number of paleontological localities over roughly a quarter of what became NIOB in 1991, from approximately Allen Bridge to just downstream of the Norden Dam site. In this section of NIOB, Voorhies (1990) reported 12 Miocene sites and 8 or 9 Pleistocene sites (one site is very close to the park boundary) that had yielded proboscidean fossils. The great majority of these finds were tooth fragments, but they illustrate the potential of the corridor.

Reports of Miocene proboscideans in NIOB in the literature pertain to the Valentine Formation. Almost all of the specimens appear to represent gomphotheres, although a tooth and possibly a radius from the Norden Bridge site, low in the Valentine Formation, are attributable to the mammutid cf. *Zygolophodon* sp. (Voorhies 1990). Per Holman (1977) and Skinner and Johnson (1984), the Kuhre site (Cornell Dam Member) has a vertebra of cf. *Serridentinus* (now *Gomphotherium*). Of the gomphothere remains, most are indeterminate beyond Gomphotheriidae, although some Norden Bridge site specimens appear to represent a large species of *Gomphotherium* comparable to *G. osborni* (Voorhies 1990). The most significant Miocene proboscidean find from NIOB (Rockford or Rocky Ford site) is the holotype of *Tatabelodon gregorii* (Frick 1933; a palate and partial mandible; now *Gomphotherium*). Voorhies (1990) reported finding additional proboscidean remains at the site

that may represent the same individual as reported by Frick (1933). These fossils are at the University of Nebraska State Museum and include the neural arch of an axis, proximal ulna, distal femur, metapodial, phalanx, and lunar.

The Pleistocene specimens (almost entirely tooth fragments) were found in unnamed high terrace deposits at various locations overlooking the Niobrara River. The fossils all appear to represent *Mammuthus*, but Voorhies (1990) could not assign any to species.

50. Noatak National Preserve (NOAT), Alaska

NOAT lies in northwestern Alaska and encompasses the northernmost extent of the Rocky Mountain chain, the Brooks Range Mountains. It was established to preserve ecosystems and resources of the Noatak River Basin, one of the continent's largest mountain-ringed basins. *Mammuthus* sp. (likely *Mammuthus primigenius*) fossils are moderately common in this area, and appear to be concentrated in Pleistocene age valley bottom sediments where they are typically found after having been eroded by river action and accumulated in secondary contexts. USGS explorations in the early 1900s were the first to note fossil material in the Noatak River valley. Smith and Mertie (1930:252) note "large pieces of mammoth tusk … found in the Quaternary gravels about 20 miles [32 km] downstream from the mouth of the Cutler River" and parts of a skull and thigh bones of mammoth along the Noatak River between the Nimiuktuk and Kugururok Rivers. They also encountered Alaska Natives who reported "finding a good deal of this old ivory on the Noatak" (Smith and Mertie 1930:252).

The use of fossil mammoth ivory has historic depth and occurs in prehistoric archeological sites dating to the last millennia. Hall (1971), for example, reported 133 fragments of mammoth ivory from the 16th century Kangiguksuk site near the confluence of Kangiguksuk Creek and Noatak River. Twenty-six specimens show signs of cutting, including one large piece from a transverse cut across a tusk. Among the remains were three pieces of mammoth ivory fashioned into single or multi-pronged fish spear tips, another drilled to serve as a harpoon socket, three fragments that may have been unfinished berry spoons, and five unidentified worked pieces. A single unmodified mammoth tusk fragment and nine pieces of mammoth tooth were also identified. Radiocarbon dating of other extinct Pleistocene fauna from Kangiguksuk (*Bison priscus*) yielded ages beyond 30 kbp, demonstrating that the site occupants obtained these materials long after the animal's death (Rasic and Matheus 2007), which is certainly also the case for the mammoth specimens. Hall (1971) reported that mammoth ivory and other remains of extinct animals were frequently washed from the banks when the Noatak River shifted its course, and that two tusks were found while he was in the field. The Maiyumerak Creek Site near the confluence of Maiyumerak Creek and the Noatak River is another Late Prehistoric age Inupiat site in the Noatak basin, in this case approximately 500 years old. At this locality the finds include a waterworn piece of mammoth ivory evidently procured from a river gravel bar (Shirar 2009).

NOAT museum collections include a "poorly preserved mammoth tusk identified as *Mammuthus primigenius*" (E. Devinney, Western Arctic National Parklands, Kotzebue, Alaska, November 2009, pers. comm.) (Elder et al. 2009).

51. Olympic National Park (OLYM), Washington

The only proboscidean remains associated with OLYM are those curated in their park museum. OLYM has five mammoth fossils in its collections, which include four specimens of *Mammuthus* sp. molars and one tusk. Three of the molars have no locality information. One molar is from a gravel pit on Morse Creek near Highway 101 and the tusk is from Whiskey Creek, both near but outside of OLYM boundary (Fay et al. 2009).

52. Padre Island National Seashore (PAIS), Texas

PAIS does not have in situ proboscidean fossils, but mammoth teeth are known to wash into the park from Seven and One Half Fathom Reef a couple of miles offshore. Some specimens have been entered into PAIS museum collections (Kenworthy et al. 2007).

53. Potomac Heritage National Scenic Trail (POHE), West Virginia, Virginia, Maryland, and District of Columbia

Mammut fossils have been recovered from Cumberland Cave (Gidley and Gazin 1933, 1938), which hosts a middle Pleistocene (Irvingtonian Land Mammal Age) faunal assemblage, rare for the eastern half of the United States. The site is northwest of Cumberland, Maryland, adjacent to the former Western Maryland Railway along POHE. The site was first brought to the attention of paleontologists in 1912 when it was encountered during construction of the railroad. *Mammut* remains are uncommon in the cave, presumably because the sinkhole entrance was too small for adult proboscideans to enter. Gidley and Gazin (1938:70) reported four juvenile molars ("second, third, and fourth left, and third right of the lower-jaw") and a tibia without epiphyses, all consistent with *Mammut americanum*.

54. Rancho La Brea (RALA-CA), NNL, California

RLBR in southern California is a globally significant tar pit and asphalt deposit preserving a rich and diverse assemblage of late Pleistocene animals and plants. The fossil locality was designated a National Natural Landmark in 1964 and is managed in association with the George C. Page Museum, Los Angeles County. The mammalian fauna from RALA-CA exemplify the Rancholabrean LMA; the deposit is the type locality for the age. The Rancholabrean LMA is defined by the first appearance of the bovid *Bison* in North America (Bell et al. 2004).

The occurrence of fossilized remains of extinct fauna at RALA-CA was first noted by Denton (1877). The composition of the mammalian fauna is dominated by the skeletal remains of carnivores, representing approximately 90% of the identified elements (Marcus 1960, Merriam 1911, Stock 1929). Two extinct proboscideans have been documented at RLBR including the Columbian mammoth (*Mammuthus columbi*) and the American mastodon (*Mammut americanum*). Life-size reconstructions of both the mammoth and mastodon are iconic displays exhibited in and around the on the grounds of Hancock Park at the La Brea Tar in the Page Museum.

A relatively complete specimen of an adult male *Mammuthus columbi* was excavated during the 2006 construction of an underground parking facility for the Los Angeles County Museum of Art adjacent to the tar pits. This mammoth specimen nicknamed "Zed" was determined to be between 48 and 52 years old at the time of its death approximately 37,000 years ago (El Aldi et al. 2015). Specimens from the Hancock Collection at RALA-CA were used in the analysis and description of *Mammut pacificus* in Dooley et al. (2019).

55. Salinas Pueblo Missions National Monument (SAPU), New Mexico

Mammuthus remains have been found at two of the three parcels of SAPU. At the Abó unit, eight mammoth tusk fragments were discovered and collected in 1987 by Fredrico Sisneros, likely from north of the mission. These specimens are held at the Western Archeological and Conservation Center (WACC) in Tucson (Thorpe et al. 2017).

The discovery of a mammoth at Quarai was first mentioned in Hibben (1941), who reported that "a complete but disarticulated mammoth was excavated by the expedition near

the ruins of Quarai". The 1939–1940 excavations at Quarai, a joint Museum of New Mexico and Work Projects Administration archeological and stabilization project, were documented in detail by Hurt (1990), who stated only that during road construction "the bones of a mammoth [were found]". Until recently, these two passages were the only documentation of a Quarai mammoth; all other reports (e.g., Morgan et al. 2001) lead back to these two sources. Thorpe et al. (2017) contacted the Maxwell Museum of Anthropology at the University of New Mexico, the Museum of Southwestern Biology at UNM, the New Mexico History Museum, and the New Mexico Museum of Natural History and Science, but were unable to find the fossils.

In October and November 2018, work in SAPU archives by Marc LeFrancois (SAPU chief of facilities and resource management) uncovered photos of the mammoth excavation, and an early draft of Hurt (1990) provided by Khaleel Saba (WACC) included a photo of the discovery locality. On November 14, Marc and Ron Fields (SAPU integrated natural and cultural resource specialist) were able to use the photo of the locality to place the locality on the SAPU side of the entrance road into the Quarai unit. The SAPU staff have suggested that the mammoth was uncovered but not excavated, and thus may still be in situ. Pleistocene fossils, particularly those of mammoths, were reported as common near Punta de Agua (~1 km, less than a mile northeast of Quarai) by Hibben (1941).

56. Santa Monica Mountains National Recreation Area (SAMO), California

Proboscideans are known from Quaternary sediments in SAMO as mentioned in Koch et al. (2004) and Tweet et al. (2012b), but have not been reported in detail in the literature. The records consist of specimens in the collections of the Natural History Museum of Los Angeles County (LACM), and at a minimum they include *Mammuthus* sp.

57. Tule Springs Fossil Beds National Monument (TUSK), Nevada

TUSK is a recent addition to the NPS, having been established in 2014. Proboscidean fossils have been reported from the TUSK area since the early 20th century, when Josiah Spurr (1903) noted the presence of "mastodon" (more likely mammoth) bones from between Corn Creek Spring and Tule Springs. Archeologists became interested in the area in the 1930s due to the possibility that human artifacts had been found with Pleistocene megafauna fossils, but unequivocal evidence was not found (Harrington 1934). The development of radiocarbon dating renewed interest in the area, and in 1962–1963 the Tule Springs Expedition crossed the future area of TUSK with trenches, looking for artifacts and material that could be dated. Although the archeological results proved to be disappointing, abundant fossils were encountered, and the trenches permitted detailed stratigraphic work (Haynes 1967). Scientists from the San Bernardino County Museum conducted extensive paleontological investigations from the 1990s into the early 2010s, leading to the creation of TUSK.

Mammuthus columbi is the iconic animal of TUSK (Springer et al. 2018b). It is the most abundant large mammal of the Tule Springs Local Fauna, although its relative abundance may be somewhat overstated due to the size of adult mammoth elements and the relative ease of identifying their remains, even when fragmented (Scott and Springer 2016, Scott et al. 2017, Springer et al. 2017). Of definite interest is the recovery of neonate/juvenile *Mammuthus* remains (Fig. 13). The host sediments, the Las Vegas Formation, were originally interpreted as lacustrine, but have been re-identified as spring deposits (Springer et al. 2018c). Deposition occurred from approximately 573,000–8,530 years ago (Springer et al. 2018c), although the local fauna is restricted to approximately 100,000–13,000 years ago (Springer et al. 2017).

58. Valley Forge National Historical Park (VAFO), Pennsylvania

VAFO includes Port Kennedy Bone Cave, one of several notable Irvingtonian Land Mammal Age bone caves in the eastern states. This cave, a sinkhole in the Cambrian Ledger Formation, was encountered by quarrymen in 1870, with one of the first recognized fossils being a *Mammut* molar (Daeschler et al. 1993). Fossils were removed in 1870 and 1894–1896, and were described by Cope (1871, 1895, 1896, 1899), Wheatley (1871), and Mercer (1899). After this series of early publications the site sank into obscurity with its location lost until investigations in the 1990s and 2000s (Daeschler et al. 1993, 2005). Proboscideans at the cave are represented by *Mammut americanum*, notably "a high proportion of juvenile and sub-adult individuals" (Daeschler et al. 1993:37).

59. Vicksburg National Military Park (VICK), Mississippi

Mammut and *Mammuthus* remains are common in the area in and around Vicksburg, Mississippi. At least one occurrence of fossil proboscidean is potentially known from VICK. Wailes (1854:284; referenced in Hay 1923:125) reported that mastodon fossils had been found in the deep railroad cut at Vicksburg. As discussed in Kenworthy et al. (2007), there is a large railroad cut within VICK for the Vicksburg and Meridian Railroad, near the Railroad Redoubt, a Civil War site in the southeastern arm of the park. This cut exposes loess deposits, known for Pleistocene fossils. It is possible, but not confirmed, that this is Wailes's proboscidean locality. VICK staff assisted in the initial study of a mastodon skeleton discovered near the site of the Pemberton Square Mall, approximately 1.9 km (1.2 mi) southwest of VICK (Knox and Pitts 1984).

Figure 13. *Mammuthus columbi* neonate/juvenile right mandible from TUSK (photo courtesy NPS).

60. Waco Mammoth National Monument (WACO), Texas

WACO is a recently established national monument and is managed in partnership with the City of Waco and Baylor University. Many of the fossil mammoth remains along the Bosque River are left in situ for the public to see (Fig. 14); those fossils removed are curated at the Mayborn Museum, Baylor University. As reported by the NPS, the mammoth fossils represent the largest herd of *Mammuthus columbi* that died in a single catastrophic event (Nordt et al. 2015; although see Wiest et al. 2016, Esker 2018). At least 26 mammoths are known to occur in the deposit, along with a few other taxa. The age and cause(s) of death are subjects of discussion, but there is an OSL analysis putting the time of death at about 66,800 ± 5k yr. B.P. (MIS 4 [Marine Isotope Stage]; Nordt et al. 2015).

61. White Sands National Monument (WHSA), New Mexico

Vandiver (1936) investigated a report of *Mammuthus* bones and teeth north of WHSA in what is now White Sands Missile Range, but found only fragmentary remains. The proboscidean record at WHSA today consists of many thousands of in situ tracks (ichnofauna megatracksite) preserved in the gypsum sand and playa lake deposits, which were first encountered at the missile range as early as 1981 (Santucci et al. 2007). Diverse and abundant late Pleistocene tracks have been found within park boundaries, most notably human tracks associated with Pleistocene megafaunal tracks of a ground sloth (Bustos et al. 2018). The proboscidean tracks (Fig. 15) have been described recently in terms of their biological attributes, and using new technologies including magnetometry and 3-D radar imaging for detecting and documenting the tracks (Urban et al. 2018, 2019).

62. Wupatki National Monument (WUPA), Arizona

A single *Mammuthus* specimen is reported from the sediments immediately outside the boundary of WUPA (Saunders 1970: a right tibia, site 52). Henderek et al. (2017) in-

Figure 14. *Mammuthus columbi* skull fragment with in situ large tusks from WACO (photo courtesy NPS).

dicated that this specimen is most likely the tibia collected from the Navajo Reservation west of Inscription Point in 1948 by D. Jones and J. Bean. This geographic feature is just east of the location given by Saunders (1970). The fossil locality (MNA.LOC.1114 Inscription Point West Area) is described as being located on the bank of the Little Colorado River less than 1.6 km (1 mi) north of the WUPA boundary in undifferentiated Quaternary alluvium.

63. Yukon-Charley Rivers National Preserve (YUCH), Alaska

Located in east-central Alaska along the Canada border, YUCH straddles a 185 km (115 mi) portion of the Yukon River and the entire Charley River basin. The Preserve's enabling legislation tasks the NPS with protection of an extensive geological and fossil record (Santucci et al. 2011). Alluvial deposits along the preserve's rivers are known to contain Pleistocene fossils, which are typically found after having eroded and accumulated along the base of stream banks and gravel bars. Placer gold mining in the 20th century, including extensive industrial scale mechanical dredge mining, is another process that has exposed and accumulated fossil material. Mining districts in YUCH include Fourth of July, Coal, Ben and Woodchopper Creeks, all of which have yielded some mammoth specimens. A single juvenile woolly mammoth (*Mammuthus primigenius*) molar was reported immediately downstream from the mined area of Fourth of July Creek in 1986 (National Park Service 1989:106), and a molar and tusk of a young woolly mammoth were exposed by placer mining in Ben Creek in western YUCH (National Park Service 1990).

Some of the earliest reported and most extensive finds have occurred at Woodchopper Creek, roughly 80 km (50 mi) upriver from the Yukon River community of Circle. Gold was first discovered here during the 1898 Klondike Gold Rush, and while little profitable gold

Figure 15. Proboscidean trackway in playa deposit at WHSA (photo courtesy NPS).

was initially obtained at this locale, Woodchopper Creek achieved national fame when miners encountered a mass of well-preserved extinct large mammal bones reportedly encountered in a mine shaft 24 m (80 ft) below the ground surface The *Mammuthus primigenius* specimens among them included the skull and lower jaw, with both tusks and all the molars; pelvis; 1 scapula; 2 limb bones; 12 vertebrae; 15 ribs; and "some small bones" (Gilmore 1908:25, Quackenbush 1909:124) (Fig. 16).

NPS archives contain a photograph from the George Beck collection showing several people including members of the Biederman family with a *Mammuthus* tusk near the Yukon River, thought to have been taken in the 1930s somewhere in YUCH. The Biederman homestead is today a private inholding in YUCH near Biederman Bluff.

Discussion and Conclusions

The National Park System covers more than 35,612,000 ha [~85 million ac], comprised of 419 national parks and affiliated lands. These federal and affiliated holdings represent a significant geographic area of the continent and embody a tremendous aggregate of natural and cultural heritage. At least 276 NPS Units (as defined above) contain some aspect of the North American fossil heritage, and here we have concentrated on those units and affiliated lands that contain proboscidean remains. Proboscideans are a ubiquitous part of the North American vertebrate faunas throughout the Miocene, Pliocene, and Pleistocene. Their presence in greater North America included gomphotheres, mastodonts, and mammoths to the end of the Rancholabrean, the most recent fully accepted LMA within the Pleistocene, equivalent to approximately 11,000 radiocarbon years ago. Although these federal and affil-

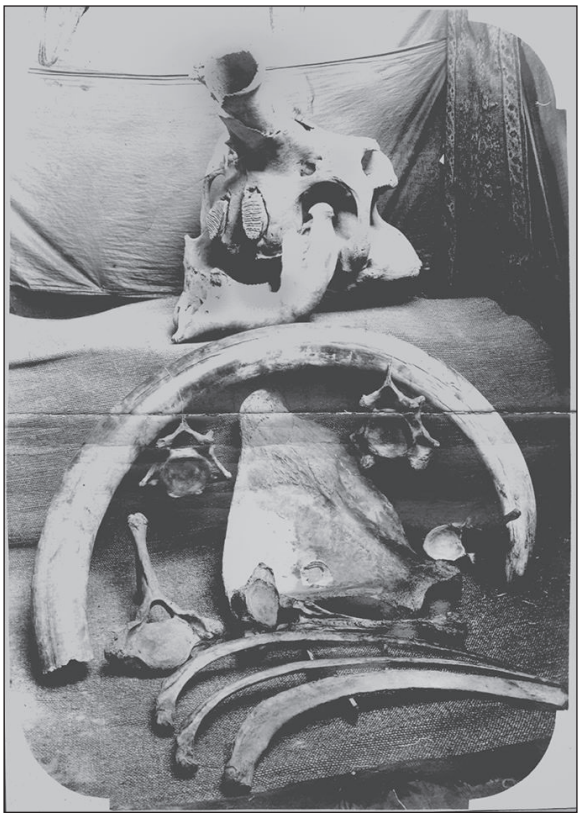

Figure 16. *Mammuthus primigenius* bones from Alice Creek (YUCH) on display in 1908 before they were purchased by the Field Museum of Natural History, Chicago (photo courtesy NPS).

iated lands preserve vertebrate remains, it does not mean that all these fossils are recorded, studied, or published about in any detailed, systematic form.

Within NPS units and affiliated localities that have fossils, we documented 63 that have records concerning proboscideans. Proboscidean fossils from these units range from the abundant skeletal remains, to the less common and less diagnostic track records, to rare, dry-preserved dung. No frozen or mummified soft tissue remains have yet been encountered on NPS or affiliated holdings, but there are strong prospects for such finds in park units in northern Alaska where frozen contexts promote excellent preservation.

Based on data in Table 1, gomphotheres are the least represented group recorded from NPS and affiliated lands. Of the NPS and affiliated localities, late Pleistocene (Rancholabrean) localities are more commonly assessed than are older fossil sites; therefore, it can be expected that there will be more records of mammoth and mastodon remains than gomphotheres. In most cases the records that exist clearly point out that additional, more detailed analyses of the remains are warranted to better understand generic and specific distributions.

This broad and admittedly superficial survey of proboscidean fossils from NPS and affiliated lands highlights the considerable and mostly untapped research potential of fossil data from these lands and museum collections. Admittedly, the distribution of the 63 NPS Units shown in Figure 1 is a biased presentation of proboscidean fossil distribution across North America. Certain areas, particularly east of the Mississippi River, are not well-represented for various reasons.

Several conclusions come from our survey. 1) There are many NPS and affiliated units that have field inventories of fossils bearing proboscidean remains. Our review here points out that select, known-proboscidean fossil areas should be investigated further, in some case intensely. This would be a first step toward management of these non-renewable resources. 2) The numerous unidentified and preliminarily described fossil occurrences should be re-assessed by qualified vertebrate paleontologists to determine the precise taxonomy and chronological assignment. 3) Specimens need to be entered into a museum collection management system (ICMS, or MCMS) and made web-available. 4) This inventory and similar inventories are intended to compile baseline paleontological resource data that is derived from various sources of unpublished and often hard to obtain records, archives, field notes, personal or email communications and other sources. Through this information collection and data mining, it is often possible to demonstrate a more significant scope and distribution of the fossil record being studied than would otherwise be understood through a review of published literature. 5) As NPS and affiliated site holdings of proboscidean remains are verified/identified and placed into a management system, collection managers should consider having the information placed into a clearing house database system such as, but not limited to, Neotoma Paleoecology Database, FAUNMAP, ePANDDA, iDigBio, and Paleobiology Database. This would allow students, researchers, and interested public have access to the wealth of information not easily discovered today.

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