The Geological Society of America
Special Paper 535

From public lands to museums: The foundation of U.S. paleontology, the early history of federal public lands and museums, and the developing role of the U.S. Department of the Interior

Gregory A. Liggett
Bureau of Land Management, Montana State Office, 5001 Southgate Drive, Billings, Montana 59101, USA

S. Terry Childs
Department of the Interior, Museum Program, 1849 C Street NW, Washington, D.C., 20240, USA

Nicholas A. Famoso
National Park Service, John Day Fossil Beds National Monument, 32651 Highway 19, Kimberly, Oregon 97848, USA

H. Gregory McDonald
Bureau of Land Management, Utah State Office, 440 West 200 South, Suite 500, Salt Lake City, Utah 84101, USA

Alan L. Titus
Bureau of Land Management, Grand Staircase–Escalante National Monument, 669 South Highway 89A, Kanab, Utah 84741, USA

Elizabeth Varner
Department of the Interior, Museum Program, 1849 C Street NW, Washington, D.C., 20240, USA

Cameron L. Liggett
Bureau of Land Management, Montana State Office, 5001 Southgate Drive, Billings, Montana 59101, USA

ABSTRACT

Today, the United States Department of the Interior manages 500 million acres of surface land, about one-fifth of the land in the United States. Since enactment of the Antiquities Act in 1906, historic and scientific resources collected on public land have remained government property, held in trust for the people of the United States. As a result, the Department of the Interior manages nearly 204 million museum objects. Some of these objects are in federally managed repositories; others are in the repositories of partner institutions.

The establishment of the United States as a nation corresponded with the development of paleontology as a science. For example, mastodon fossils discovered at or near present-day Big Bone Lick State Historic Site, Kentucky, found their way to

Liggett, G.A., Childs, S.T., Famoso, N.A., McDonald, H.G., Titus, A.L., Varner, E., and Liggett, C.L., 2018, From public lands to museums: The foundation of U.S. paleontology, the early history of federal public lands and museums, and the developing role of the U.S. Department of the Interior, *in* Rosenberg, G.D., and Clary, R.M., eds., Museums at the Forefront of the History and Philosophy of Geology: History Made, History in the Making: Geological Society of America Special Paper 535, p. 311–334, https://doi.org/10.1130/2018.2535(21).

notable scientists both in the United States and in Europe by the mid-eighteenth century and were instrumental in establishing the reality of extinction.

Public land policies were often contentious, but generally they encouraged settlement and use, which resulted in the modern pattern of federal public lands. Continued investigation for fossils from public land filled the nation's early museums, and those fossils became the centerpieces of many museum exhibitions.

Case studies of the management of fossils found in Fossil Cycad National Monument, the John Day fossil beds, the Charles M. Russell National Wildlife Refuge and surrounding areas of public land, the American Falls Reservoir, and Grand Staircase–Escalante National Monument are outlined. These examples provide a sense of the scope of fossils on federal public land, highlight how their management can be a challenge, and show that public land is vital for continued scientific collection and research.

INTRODUCTION

How has the United States Department of the Interior (DOI) come to hold a collection of nearly 204 million museum objects (Table 1)? The story is intimately connected with the development of paleontology as a science, the expansion of the nation across the continent and the consequent creation of public lands, and the rise of modern museums and research collections. Initially the federal government took little notice of the museum collections (archaeological and paleontological objects in particular but also any object of scientific or historical interest) made from its lands. That changed in 1906, when the federal government asserted ownership of historic and scientific resources collected from lands it managed. With the assertion of ownership in trust for the American people, the collection of museum objects to be managed by the DOI grew significantly, creating a museum collection that is now one of the largest in the United States.

Following its successful war for independence, the newly established United States of America immediately began to document the lands and resources it had acquired and to determine how those resources could be used to the country's advantage. From the very beginning, scientific inquiry, based on collection, was a key component of the study of the newly acquired lands. The vast spaces of the nation held significant historical and scientific assets including archaeological, paleontological, geological, and biological resources. The development of the young science of paleontology was intimately intertwined with the expansion of the young nation, because fossils from the West would significantly add to the scientific dialogue.

As an historical science, paleontology posits that we cannot understand the present without understanding the past. Likewise, to place in context present-day struggles related to public land, it is informative to explore the history of public lands. As the United States added to its land holdings and stretched across the continent, numerous policies were designed to encourage

TABLE 1. LIST OF BUREAUS AND OFFICES WITHIN THE DOI AND THE NUMBER OF MUSEUM OBJECTS CURRENTLY IDENTIFIED UNDER THEIR MANAGEMENT IN FISCAL YEAR 2016

Bureau	Objects (millions)	Linear (ft)	Volume (cubic ft)
BIA	3.736	450.0	6585
BLM	11.824	2541.5	5868
BOR	8.742	0	6086
FWS	4.473	0	0
IACB	0.011	0	0
IM	0.008	0	0
NPS	175.060	0	0
USGS	0.056	0	0
Totals	203.910	2991.5	18,539

Note: Several bureaus or offices with very small collections are not shown. Numbers given in millions. Numbers of objects are rounded. BIA—Bureau of Indian Affairs; BLM—Bureau of Land Management; BOR—Bureau of Reclamation; FWS—Fish and Wildlife Service; IACB—Indian Arts and Crafts Board; IM—Department of Interior Museum; NPS—National Park Service; USGS—United States Geological Survey.

development, use, and settlement. Early on, little regard was given to notions of preservation, and this was reflected in the lack of federal focus on the huge numbers of fossils from federal public land filling the nation's early museums. However, in the late nineteenth and early twentieth centuries, that began to change as a conservation ethic emerged. Concern over the obvious loss of resources, such as forested lands, and a desire to set areas aside slowly turned the course of the government away from promoting exploitation of resources. A landmark law for museums and federal public land was the Antiquities Act of 1906, in which for the first time the government laid claim to historic and scientific resources coming from the public land.

This paper provides brief histories of early fossil finds from the wilds of the continent, the early development of paleontology, and the rise of the modern museum. Also examined are the story of the United States public land (Fig. 1) and the laws and policies that directed its development. This will illuminate the DOI's role as trustee for a tremendous national treasure and will show that in this role, the DOI faces significant challenges that will last into the future. Included throughout the paper are illustrative examples, historic and recent, of the collection and management of fossil resources on public land. (The terms "public land" and "public domain" refer to federal public land and are used synonymously throughout this paper. Also, the terms "paleontological resources" and "fossils" can be thought of as meaning fossils holding scientific interest.)

FIRST FOSSILS FROM NORTH AMERICA

In 1739, long before the birth of the United States, a French military group came upon a site in what is today northern Kentucky. Fossil bones from an elephant-like creature from the site were shipped down the Mississippi River to New Orleans and transported to Paris, where they were studied by the first practitioners of paleontology, Georges Cuvier and Georges-Louis Leclerc, Comte de Buffon. Certainly, people had taken notice of fossils in North America for millennia (Simpson, 1943), but this event is one of the earliest that influenced science. The locality that the bones most likely came from is today called Big Bone Lick State Historic Site (see Simpson [1942] and [1943] for discussions). It was frequented by frontiersmen and Native Americans of the area due to the saline springs, but the visitors also marveled at the bones. Over the succeeding decades, fossils from Big Bone Lick were sent to Benjamin Franklin, George Washington, and other colonial leaders and scientists. Bones, teeth, and tusks of large proboscideans captivated the scientists of Europe and North America. This animal was called a "mammoth" at that time, although we now identify it as a mastodon. Questions about the bones' origins and their taxonomic affinities were subjects of great debate. Some thinkers favored the notion that these beasts must have come to Kentucky by way of a connection between North America and Asia. Others questioned how elephant-like animals (which live only in the tropics today) could have survived in temperate Kentucky. Still others argued that the remains represented more than one type of animal, and were a mixture of proboscidean (as evidenced by the tusks) and hippopotamus (as evidenced by the teeth) (Turner, 1799; Semonin, 2000).

On 21 January 1796, the French scientist Georges Cuvier read his paper, "On the species of living and fossil elephants," for the National Institute of Sciences and Arts in Paris. He pointed out that the species in the New World and those known from Siberia were not the same as the modern Asian and African elephants (Cuvier, 1799). With careful anatomical work and reasoning, Cuvier articulated the best evidence for extinction presented to date.

Extinction was a radical idea. It had been contemplated long before, but the world was vast, and the possibility always existed that an organism known only from fossils still lived in some remote, unstudied place of the globe. To some people, extinction implied that there was a flaw in nature's design, which was incompatible with an orderly divine creation. At the very least, the implications of extinction and deep geologic time forced scientists to question long-held understandings of the natural world (Rudwick, 1972). Fossils from the American West added to a vigorous debate of radical new scientific ideas. The contributions of American scientists would soon rival those of their European colleagues (Jaffe, 2000).

Thomas Jefferson took great interest in the "mammoth" bones of the West. The wondrous beast was sometimes referred to as the American *incognitum* (Semonin, 2000). Jefferson sought to acquire the fossils for his own research, and engaged George Rogers Clark to send some to him in 1782 (Semonin, 2000; Hedeen, 2008). After William Clark returned from the western expedition with Meriwether Lewis, he was financed by Jefferson to return to Big Bone Lick in 1807 to collect mostly head and foot bones, which were missing from the American Philosophical Society's "mammoth" skeleton (see the section titled "Peale's Museum" for more on this specimen). Clark's dig was an immense success, recovering over 300 bones of various species, including the coveted "mammoth" cranium. Clark sent the bones to Jefferson at his house. The sheer volume of the collection gave Jefferson the idea to send duplicate specimens to the National Institute of France, and the bones are still curated today at the Muséum National d'Histoire Naturelle in Paris (Semonin, 2000).

In 1797, Jefferson submitted a note to the American Philosophical Society on other bones recently uncovered in a Virginia (today West Virginia) cave. What most impressed Jefferson about these bones were the large claws of the beast, which he at first imagined to be lion-like in appearance and habit. By the time he published his paper on the animal, Jefferson had learned of an extinct giant sloth from South America with similar claws, so he did not specify that the animal was a cat (Boyd, 1958). He dubbed the beast *Megalonyx,* or "giant claw" (Jefferson, 1799).

Jefferson was not a supporter of the new idea of extinction. He subscribed to a notion known as the "Great Chain of Being," a traditional concept with roots in early science and Christian doctrine. This idea imagines a hierarchy that ranks everything in God's creation, inanimate and living, with humans at the top

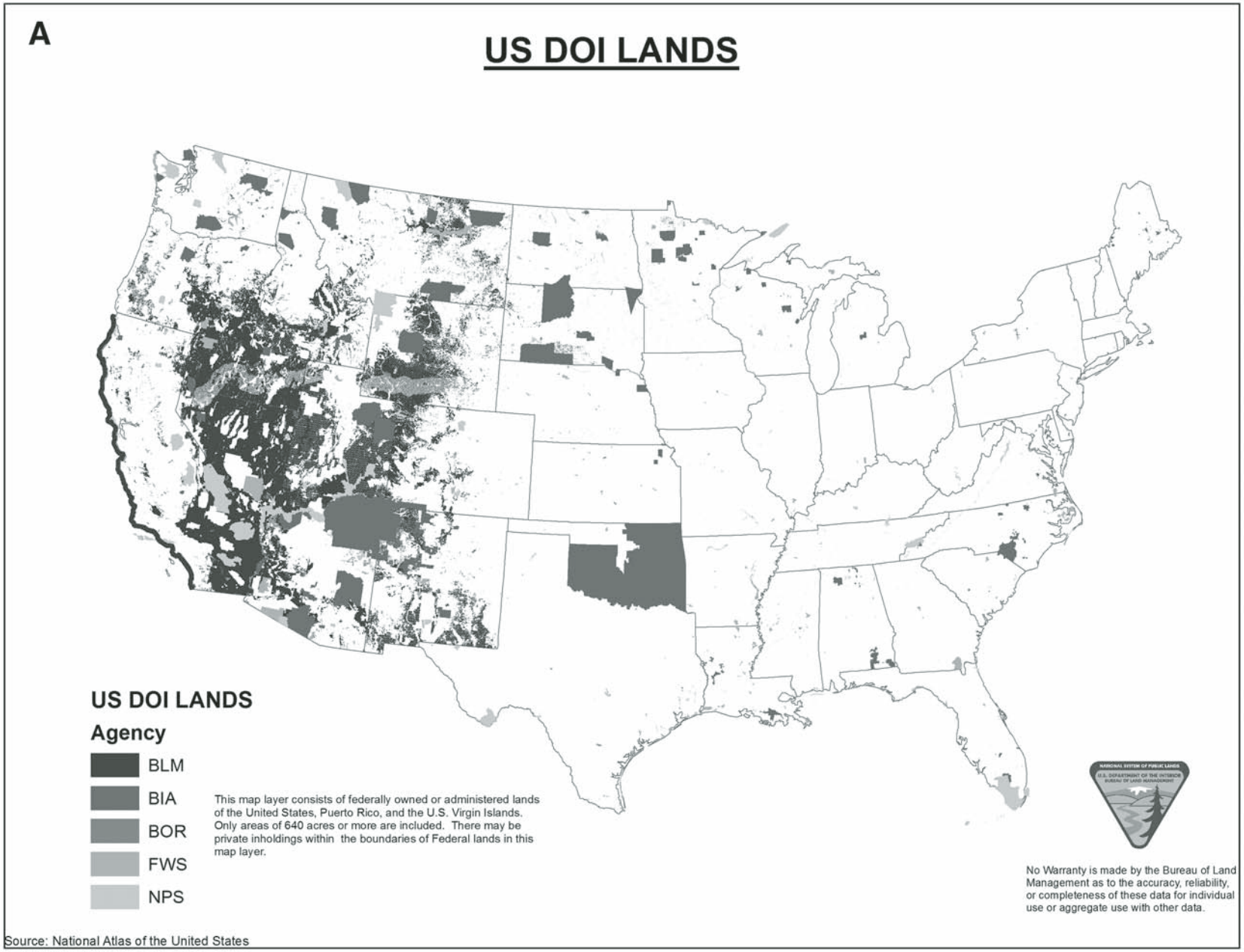

Figure 1 (*Continued on facing page*). Current United States Department of the Interior–managed lands: (A) in the continental United States; and (B) in Alaska. BLM—Bureau of Land Management; BIA—Bureau of Indian Affairs; BOR—Bureau of Reclamation; FWS—Fish and Wildlife Service; and NPS—National Park Service.

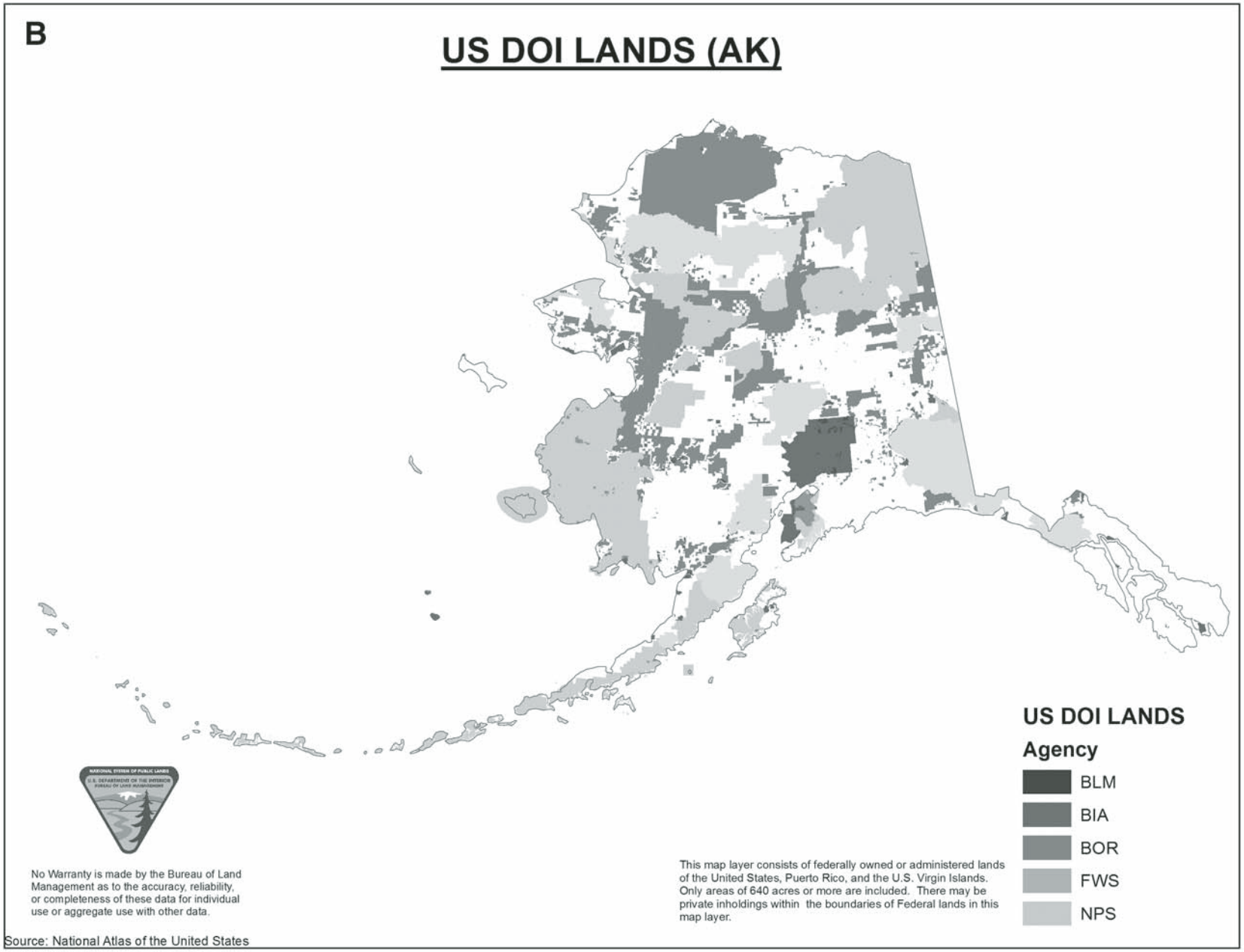

Figure 1 (*Continued*). AK—Alaska.

of the biological world (Semonin, 2000). Taking the notion further, some held that above humans were the moon, stars, angels, and then God. Like a physical chain, the linkages of all of creation could only endure if every link remained intact. If one link, or one species, were lost, it was thought that the entire system would collapse. "It may be asked," wrote Jefferson, "why I insert the Mammoth [as living in North America], as if it still existed? I ask in return, why I should omit it, as if it did not exist? Such is the economy of nature, that no instance can be produced of her having permitted any one race of her animals to become extinct; of her having formed any link in her great work so weak as to be broken" (Jefferson, 1788).

DEVELOPMENT OF THE PUBLIC DOMAIN

The territories west of the Appalachians and the issue of public domain were matters of early interest as the thirteen colonies joined in the War for Independence. Six states had been given charters from England granting them land beyond the Appalachian Mountains: Virginia, Massachusetts, Connecticut, North Carolina, South Carolina, and Georgia. New York also claimed land to the west from a concession by the Iroquois Nation (Muhn and Stuart, 1988). However, the other colonies not holding similar claims to western land worried that their economic and political power would be diminished compared to those with lands in which to expand. In November, 1776, Maryland contended "… that the back lands claimed by the British crown, if secured by the blood and treasure of all, ought, in reason, justice, and policy, to be considered as a common stock …" (Scharf, 1879, p. 276) and threatened not to sign the Articles of Confederation that sutured the young nation together. Gradually, the land-claim states ceded their interests in the more western lands to the federal government, and Maryland joined in the struggle for independence.

The public domain again grew substantially after the purchase of the Louisiana Territory from France in 1803 (Fig. 2). President Thomas Jefferson authorized several exploratory and scientific expeditions of the continent, with Lewis and Clark's Corps of Discovery (1803–1806) being the most well-known. Paleontology was again not far from the minds of statesmen. Jefferson fully expected that Lewis and Clark would discover

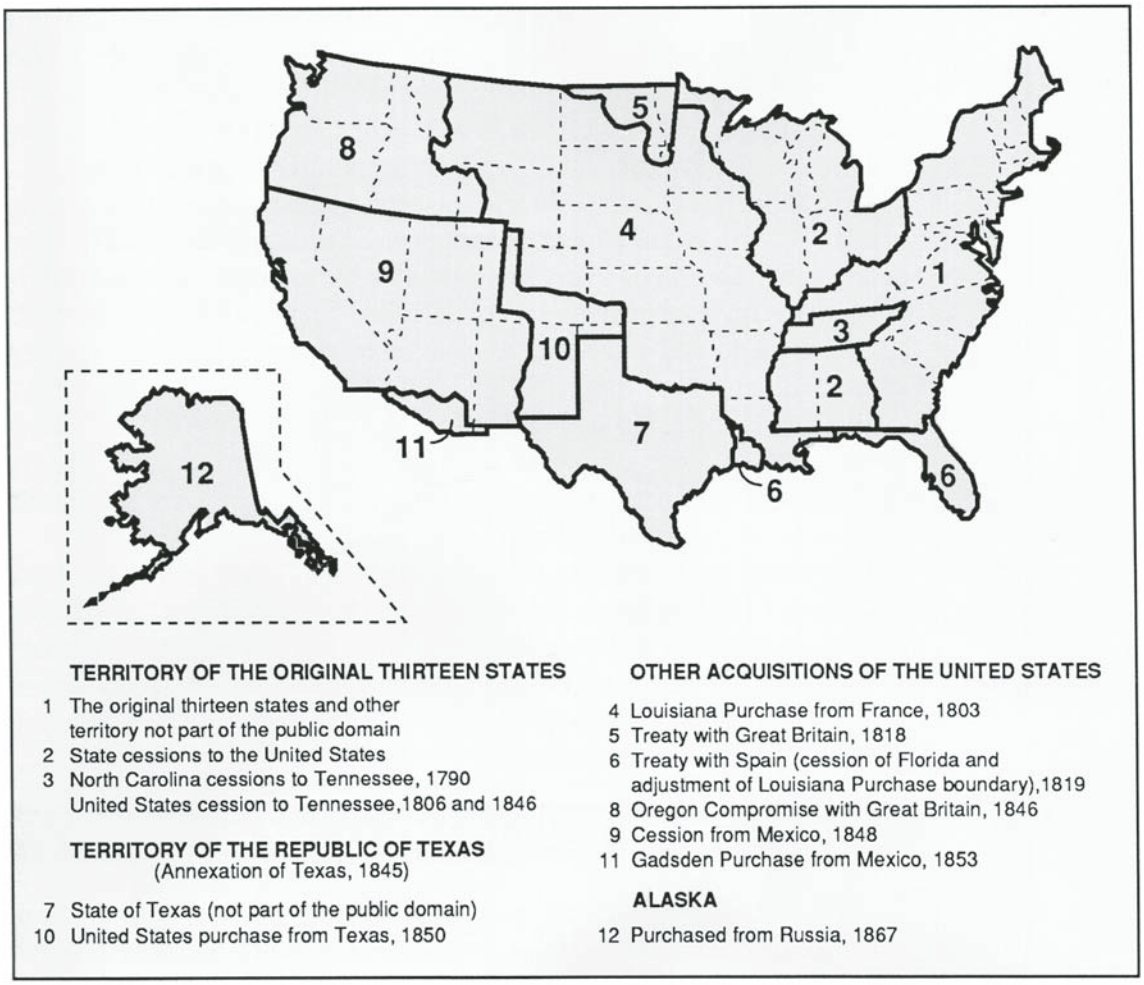

Figure 2. The acquisition of the U.S. lands occurred piecemeal and by a variety of actions. From Muhn and Stuart (1988).

both the "mammoth" and the *Megalonyx* living somewhere in the West, given his conviction that extinction was impossible (Ambrose, 1997; Semonin, 2000).

Whereas Lewis and Clark found many important species new to science, and sent evidence of them back east, they did not find a *Megalonyx* or a "mammoth" as Jefferson hoped. They did, however, find a few fossils, including a marine reptile in South Dakota and a fish fossil from Iowa or Nebraska (Chaky, 2015). Today the fish is in the collection of the Academy of Natural Sciences in Philadelphia, and is the only fossil known from the expedition still preserved (Simpson, 1942). One other fossil of note mentioned in their journals was a bone Clark described from along the banks of the Yellowstone River, several miles downstream from the landmark he named "Pompys Tower," now called Pompeys Pillar National Monument. The bone, which Clark described as a rib some 3 inches (7.6 cm) in diameter and 3 feet long (0.91 m), is likely the first notice made of a dinosaur fossil in the United States, foreshadowing the rich finds of fossils to be made in the West (Simpson, 1942). The first dinosaur fossils from America would not be recognized again and collected until 1855 when Ferdinand Hayden collected them from the banks of the Judith River in Montana (Leidy, 1856). That area is now part of the Upper Missouri River Breaks National Monument. Both Pompeys Pillar and the Upper Missouri River Breaks are managed today by the Bureau of Land Management (BLM).

Other early explorations authorized to study the continent included the Red River Expedition of 1806, which investigated the southwestern part of the continent, and Zebulon Pike's 1806–1807 expedition to examine the northern parts of Spain's territorial claims in what is now Colorado and New Mexico.

During the 1840s, the nation undertook another major growth spurt—annexing Texas in 1845; resolving the disputed boundary of Oregon with Britain in 1846; and with the end of the Mexican-American War, adding California, half of New Mexico, most of Arizona, all of Nevada and Utah, and parts of Wyoming and Colorado to the nation in 1848 (Fig. 2) (Utley and Mackintosh, 1989). The need for a consolidated department to manage domestic affairs was clear, and the DOI was created in 1849. The new department took on a wide variety of homeland tasks, including conducting a census of freed slaves moved to Haiti; exploring the West; overseeing the District of Columbia (D.C.) jail; regulating territorial governments; constructing the D.C. water system; managing hospitals and universities; managing parks and other public land; and taking responsibility for Native Americans. It is easy to see why the DOI has sometimes been called the "department of everything else" (Utley and Mackintosh, 1989).

Following the creation of the DOI, several independent surveys of the interior were authorized, including expeditions by John Wesley Powell (1869), Clarence King (1867–1872), Ferdinand Hayden (1869–1871), and George Wheeler (1872–1879). All these surveys of the West worked more or less in isolation from each other. Each contributed to the scientific understanding of the flora, fauna, geology, and paleontology of the United States. After Hayden's discovery of dinosaurs in Montana, many fossil remains were found throughout the West. These contributed to a colorful period in history sometimes called the "Great Dinosaur Rush," a period from ~1877–1892. This lust for fossils also forever linked the names of two rival scientists, Edward Drinker (E.D.) Cope and Othniel Charles (O.C.) Marsh. Each tried to outdo the other by possessing the best fossils in their own collections and rushing to publish new species faster than the other. The frontiers of the West were open for prospectors to roam freely, collecting fossils for wealthy scientists or for museums that could afford to fund their excavations or to outright purchase them. In this freewheeling period, thousands of fossils by count, and tons by weight, filled the museums of the nation, particularly in the East, mostly coming from public lands.

Paleontology played a central role in all the various surveys. Fossils are important indicators of geologic age, helping stratigraphers arrange the rocks they map into chronological sequence. Cope served as chief paleontologist during the Wheeler survey of the territories in 1874. There was no pay for the position, but it allowed Cope to claim he was on official government business and to procure supplies from the army (Jaffe, 2000). Political reformers came to argue that all of the independent government-funded survey efforts were inefficient. With political maneuvers, Marsh and his allies worked two items into legislation: (1) merging the surveys; and (2) providing that material collected under the surveys would become national property and be deposited in the Smithsonian National Museum of Natural History (Jaffe, 2000). This last provision was aimed directly at making Cope turn over any collections he had made under official government business. In 1879, the new United States Geological Survey (USGS) was formed (Muhn and Stuart, 1988). In 1882, Marsh himself was appointed as chief paleontologist with the USGS, which made him the nation's first paid government paleontologist. These two brilliant scientists apparently felt that, vast as it was, North America was not big enough for them to coexist, and the Cope and Marsh feud is now legendary (Lanham, 1973; Colbert, 1984; Jaffe, 2000).

Land Policy and Legislation

The history of land policy, the various related laws, and the many competing interests of the past provide a basis for understanding modern aspects of public land (see Gates, 1976). At the beginning, the United States was "land rich and cash poor," and the nation repeatedly turned to its land assets. For example, soldiers in the Continental Army were promised land as payment, as were soldiers in several subsequent national wars. There was also much debate about the best land policy. The two earliest broad notions that arose were either to have the government manage the selling of the land to individuals in an orderly fashion, or to wholesale the land to wealthy speculators with deep pockets who would then develop the land. The first view was espoused by Thomas Jefferson, and the second by Alexander Hamilton. The Public Land Act of 1796 took Hamilton's approach, and small farmers had to buy their farms from larger real estate interests.

However, this angered farmers, which brought about the Land Act of 1800. It reduced the minimum size of parcels that could be purchased and created a system to extend government credit to purchasers (Muhn and Stuart, 1988).

An essential development was a system to survey and divide land. Early on, claims to land were disorderly, leading to multiple disputes over land boundaries that burdened the court system. What was needed was an unambiguous system for subdividing land into unique parcels, and what emerged was the Rectangular Survey System, or the Public Land Survey System. Once a baseline was established for a region, rectangles of 36 square miles, 6 miles to a side, were measured out, and called townships. Each township contained 36 square parcels, or sections, which were numbered in an orderly fashion. Subparts, or aliquot parts (such as "northeast quarter"), could be further defined, creating a unique reference to any parcel of land within the system. This greatly improved land description and disposal. The task of mapping and recording the land ultimately fell to the General Land Office (GLO) of the federal government (White, 1991).

Ultimately, after a variety of other schemes were tried for selling land to citizens, the Homestead Act of 1862 opened public land to settlement without cash purchase. Settlers were required to apply for a patent to the land, improve the land through their own labor for five years, and pay fees. Although there was no cost for the land itself, there were still costs to build homes and develop crops, as well as sometimes to deal with the harsh and arid environments of the West. Of the more than 1.3 million homestead entries filed before 1900, only about half went to patent, in which the new owners gained title (Muhn and Stuart, 1988). (See Edwards [2008] for a discussion on the difficulty of compiling exact homestead numbers.) At least one homestead claim was made to secure the protection of fossils (see the example of Fossil Cycad National Monument).

In addition to encouraging settlement, the nation was eager to develop laws and policies to encourage exploitation of its mineral wealth. However, at the time of the discovery of gold in California in 1848 and the subsequent gold rush, the nation was not adequately prepared to oversee mining. This led to ad hoc rules, titles, and claims being devised by the miners themselves. After several initial attempts to get a handle on the issue, Congress passed the General Mining Law of 1872, which established that public lands were to be "free and open to exploration and purchase" (Muhn and Stuart, 1988, p. 19). Individuals and companies could apply for mining claims on public land, which made the development of minerals a priority over other uses (Muhn and Stuart, 1988). Mining claims were also tried as a tool to secure fossil collecting rights (see the example of *Diplodocus carnegii* in a following section).

Another use of public lands that helped encourage national development involved land grants made by Congress to encourage public education. In 1862, the Morrill Act granted to each state having federal public land 30,000 acres of that land from within its boundaries. This land was used to create land grant college campuses and research farms and for generating funds through such means as mining and grazing, or the land was sold outright to raise funds to support education. States without public lands were granted scrip to land elsewhere, issued in 160-acre increments that could be sold to raise funds for state colleges. In addition, one section of every township, section 16, was given to the states to help support education. After 1848, states received two sections of every township, and with the admission of Utah, Arizona, and New Mexico, the number of sections increased to four (Muhn and Stuart, 1988).

Land grants were also made to railroad companies to encourage transcontinental rail development, making travel and commerce easier across the nation, which now spanned the continent. Alternating mile-square sections of public land on either side of the railroad right-of-way were given to the railroad companies, as much as 40 sections of land for each mile across the territories. Even today, the public land has a noticeable "checkerboard" pattern of public and private ownership along the course of rail lands in western states.

Public projects were undertaken to harness the rivers in the arid West, both to generate electrical power and to provide for irrigation to increase the productivity of otherwise marginal lands. Federal lands were also set aside for wildlife preservation and for hunting, and to preserve ancient Native American ruins.

Policy related to public land evolved over the first two centuries of the nation's history. Public land served many roles. It was used early on to help pay national debt, encourage westward expansion, provide for private land ownership, and encourage the development of mining and mineral production, as well as to fund major infrastructure projects such as the railroads. However, the policy of land disposal was revised with the passage of the Federal Land Policy and Management Act (FLPMA) of 1976. That act consolidated several federal bureaus, including the GLO and the General Grazing Service, into the BLM. It also set a policy for public lands to be retained by the federal government rather than disposed of. The lands were to be managed for multiple use and sustainable yield to serve present and future generations. Today, the BLM administers more surface land (248.3 million acres) and subsurface minerals (700 million acres) than any other agency of the government (Bureau of Land Management, 2015, 2016).

DEVELOPMENT OF THE MODERN MUSEUM

Peale's Museum

Charles Willson Peale founded one of America's first museums, the Peale Museum in Philadelphia, which opened to the public in 1786 (Rainger, 2001). Peale's vision for the museum was as a public resource that would improve visitors' moral character through lessons in science. The exhibits of mammals, birds, and plants were arranged following the *scala naturae,* or the great chain of being. One of his prize exhibits was the skeleton of a mastodon discovered in 1799 on the property of John Masten outside of Newburgh, New York. Peale visited Masten with the

hope of securing the fossil for his museum. After the two reached an agreement, Peale returned to Masten's farm with a crew and $500 in funding from the American Philosophical Society. Parts of the mastodon were missing, so Peale's workers explored a few other nearby farms that summer, including the farms of Captain J. Barber and Peter Millspaw.

Once all the mastodon bones were collected, they were transported to Philadelphia. There was enough material to attempt two mounts (Peale, 1803). Mounting the skeletons was done by Peale's son, Rembrandt, and Moses Williams, an enslaved man who worked for the Peales. Articulating the skeleton took three months. Initiating a practice that continues today for most mounted fossil skeletons, a composite of several individuals was made, and Rembrandt filled in missing parts of the skeleton (the top of the cranium and the tail) with sculpted elements. Wooden discs were placed between vertebrae to simulate the missing cartilage but their thickness slightly exaggerated the animal's length. The first completed mastodon mount was initially shown to the public in 1802, in the main hall of the American Philosophical Society in Philadelphia, because they had provided the funding for the excavation. The second mount was eventually displayed in the Peale Museum in Baltimore (Simpson and Tobien, 1954).

Lewis and Clark's Corps of Discovery was the first government-sponsored expedition for making scientific collections, beginning a long-standing tradition of federal museum property management. Acting as perhaps the earliest non-federal museum partner to the federal government, Peale's museum took in many of the American Indian artifacts and natural history specimens from the Lewis and Clark expedition because no one else could take them (Semonin, 2000). However, after Peale's death in 1827, his museum floundered. Rembrandt and his brother, Rubens Peale, struggled for years seeking support for the museum. They opened museums in New York and Baltimore trying to expand their audience and attendance, always hoping for some public support. In many ways, the Peale museums' issues were not dissimilar to those of modern museums, struggling with the balance between education and entertainment, and always short of funds. The Peale museums were eventually reduced from educational institutions to cheap sideshows when Phineas Taylor (P.T.) Barnum acquired the contents of Peale's New York museum in 1842, leased the Baltimore museum in 1845 and 1846, and purchased a portion of the contents of the Philadelphia museum in 1850 (Alderson, 1992). The Peale mastodons were put up for auction.

This illustrates another modern museum problem, that of federal collections orphaned when a museum or repository can no longer care for its collections. Orphaned collections are a problem for museums, and when federal collections are involved, for the DOI as well. Orphaned collections can languish without care, and deteriorate. When DOI collections are involved, the collections need to be moved, sometimes at great expense, to another repository that can properly care for them. Finding the funds to move and rehouse orphaned collections can be a problem. Some of the Peale collection, such as the fish fossil from the Lewis and Clark expedition, was transferred to the Academy of Natural Sciences in Philadelphia. The Academy, founded in 1812, also served an early non-federal repository for the various other government surveys until the establishment of the Smithsonian Institution on 10 August 1846. Fortunately, Peale's mastodons do survive to the present. The Philadelphia mastodon, the more complete of the two, was shopped around museums in Europe by speculators. The specimen was eventually purchased by Johann Jakob Kaup for the Dessischen Landesmuseum in Durmstadt, Germany (Simpson and Tobien, 1954). The Baltimore mastodon was purchased by John C. Warren (Warren, 1852), and is today at the American Museum of Natural History, disassembled (Simpson and Tobien, 1954).

Diplodocus carnegii

Many of the nation's most prestigious museums were stocked with paleontological material from public land during the "Great Dinosaur Rush." These included the Smithsonian National Museum of Natural History, the Yale Peabody Museum, the American Museum of Natural History, the Carnegie Museum of Natural History, and the Academy of Natural Sciences in Philadelphia. Peale's Philadelphia mastodon may have been the first mount, but the mounting of skeletons of ancient life was repeated many times by other museums. The first mounted dinosaur skeleton in the United States was a hadrosaur, which was erected in 1868 at the Academy of Natural Sciences in Philadelphia (Warren, 1998). Perhaps a bit ironically, the dinosaur mount was so popular that in the summer of 1870 the museum initiated an admission charge to reduce public attendance (Rainger, 2001). As more dinosaurs were discovered in the West, the public presentation of articulated, mounted skeletons gradually became more common.

One illustrative example is the story of *Diplodocus carnegii* (Rea, 2001). In 1898, the *New York Journal and Advertiser* ran a full page of stories and photographs under the headline "Most colossal animal ever on Earth just found out west" (Library of Congress, 2017) (Fig. 3). Andrew Carnegie wanted such a dinosaur for his namesake museum in Pittsburgh, and he dispatched the museum's director, William Jacob Holland, to obtain one. Obtaining enough fossilized skeletal elements for a complete mount was not a simple endeavor. Holland met with many setbacks and struggled with the strong personalities of Wyoming politicians, dinosaur hunters, and researchers. One of the issues that Holland and his collectors dealt with was the fact that their productive bone quarries were on public land, and it was feared that someone else might swoop in and collect from them first. Holland and his compatriots contemplated filing formal mineral claims for the area of their quarries in order to have a legal claim on the fossils. However, for whatever reason, they did not carry through with that while in Wyoming.

Eventually, Holland met the order for a complete dinosaur. By 1901, John Bell Hatcher put together a composite skeleton at the museum, mostly from the wild lands of Wyoming. He published his description of the animal with an illustration of

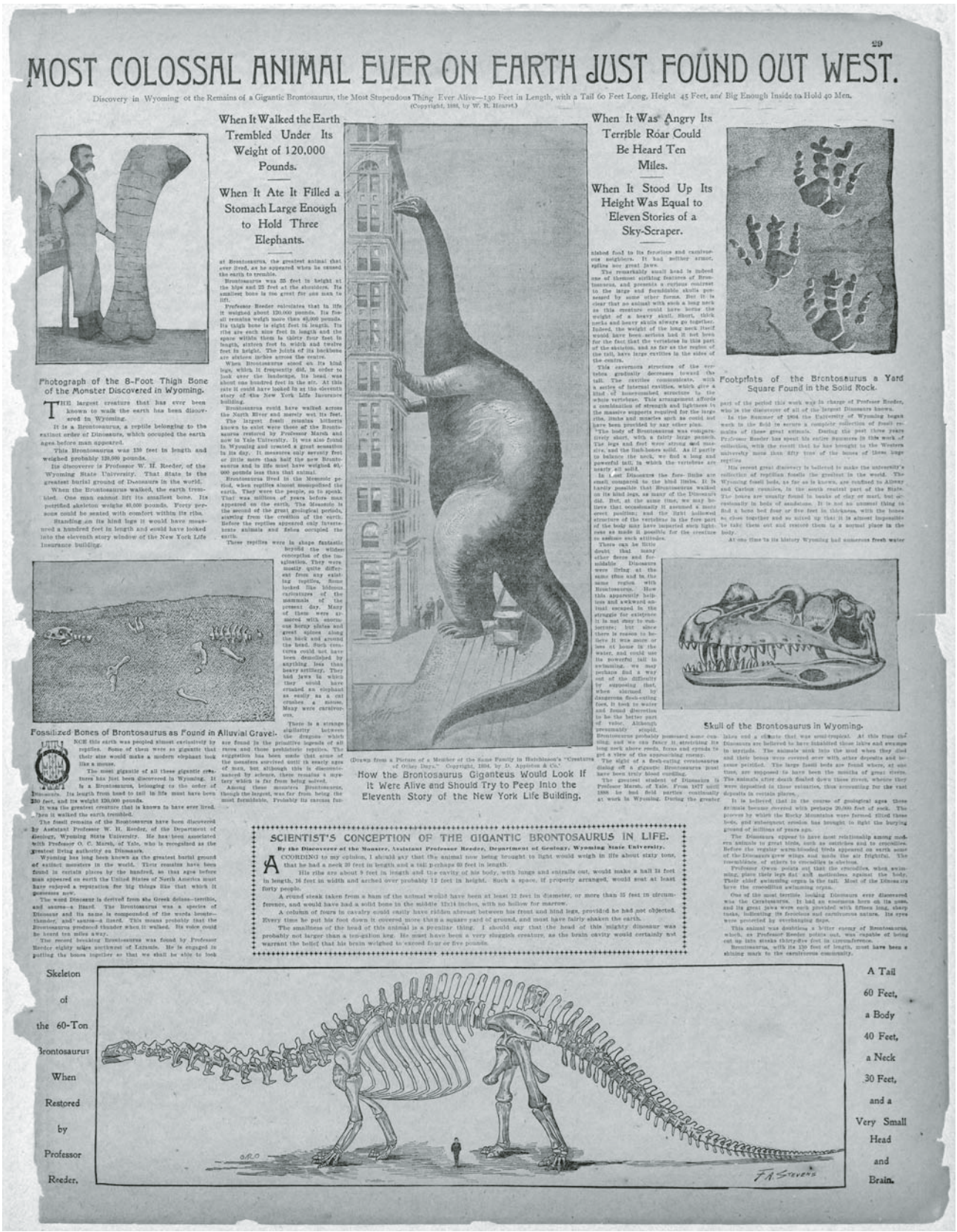

Figure 3. Page from the New York Journal and Advertiser dated 11 December 1898 discussing, and exaggerating, news of a newly discovered sauropod dinosaur found in Wyoming. From Library of Congress (2017).

the articulated skeleton (Hatcher, 1901) and named it *Diplodocus carnegii* for the museum's benefactor. The illustration was framed and sent to Carnegie at his home in Scotland. The illustration caught the eye of King Edward VII while visiting Carnegie, and the King requested a similar specimen for The Natural History Museum. This royal request thrilled Carnegie, who financed the casting and mounting of another full skeleton.

On 12 May 1905, the newly installed skeleton was dedicated in the halls of the British Museum, complete with speeches by Carnegie, Holland, the museum director, and British nobility. This was the first of many gifts by Carnegie to museums around the world. He was eager to show off "his" dinosaur[1], and with a sense of great national pride, to promote the wealth of the American fossil beds. All of these early museums, with their obligatory mounts of extinct skeletons, created the iconic impression of what a museum is in the public mind: a sanctuary of knowledge, public education, and research.

Throughout the period of the "Great Dinosaur Rush," the United States government seemed to take little notice of those riches coming from the public land. Another telling incident can be related on this point. Earl Douglass, another paleontologist working for the Carnegie Museum in 1913, did file a mineral claim for fossils. The claim was at what would become Dinosaur National Monument in Utah, today managed by the National Park Service (NPS). Attempting the ploy contemplated by Holland before him in Wyoming, Douglass filed his mineral claim to secure the area for the museum. The case was reviewed by the DOI, and it was ruled in 1915 that "[f]ossil remains of dinosaurs and other prehistoric animals are not mineral within the meaning of the United States mining laws, and lands containing such remains are not subject to entry under such laws" (Department of the Interior, 1916, p. 325). With this ruling, the use of mineral claims to reserve fossil rights was shut down. However, before the ink was dry on the DOI ruling, President Woodrow Wilson proclaimed the area as Dinosaur National Monument in 1915.

HOW THE DOI CAME TO MANAGE MUSEUM PROPERTY

A New Conservation Ethic

As Americans developed their vast country, little thought was initially given to conservation. The resources and extent of the land seemed limitless. Forests were something to clear to make room for grazing and agricultural production, and good new land was always just over the horizon. However, it was obvious that timberlands were disappearing by late in the nineteenth century. Many areas around the Great Lakes had been clear-cut. Fear arose that the nation would soon have no more forests, so calls began for conserving and managing forest lands (Muhn and Stuart, 1988; Williams, 2005).

As early as 1876, Congress appropriated funding to study the nation's forest health, which resulted in the creation of forest reserves, and ultimately the United States Department of Agriculture Forest Service (USFS) in 1905 (Williams, 2005). Another sign of the emerging conservation ethic was the establishment of the world's first national park with the creation of Yellowstone National Park in 1872 (Utley and Mackintosh, 1989). The remarkable scenery, wildlife, and geologic wonders such as geysers and thermal pools were set aside in perpetuity after Ferdinand Hayden reported the results of his survey to Congress.

It was significant to science and the burgeoning museum profession when the federal government finally took notice of the scientific resources on the land it managed. Fossils had been collected from public lands for decades, but the first assertion of ownership by the federal government was to claim the fossils collected by Cope while he was with the geological surveys. Other than that, little notice was taken of all the fossils collected from federal public land and mounted in the nation's museums. However, in 1906 that situation changed.

The Antiquities Act

With the growing conservation ethic, the desire to set aside national parks, and a desire to manage resources for the future, Congress became alarmed at the looting by private collectors of archaeological resources from the southwest. Congress passed the Antiquities Act of 1906 to punish anyone who "… shall appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity …" on federal public land. Enactment of the Antiquities Act was a watershed moment for science and for resource management. For the first time, the government asserted a blanket claim to the historic and scientific resources on the public lands of the United States. The Antiquities Act also required that the government regulate, through a system of permits, who was authorized to collect, and directed what would happen to the collections made: Those resources would remain available to the public, under public ownership and control.

There was difficulty, however, in enforcing the Antiquities Act. For one thing, it was not entirely clear if the act applied to fossil resources—were they correctly seen as "objects of antiquity"? Legal opinions on that differed (Sakurai, 1994; Kuizon, 2006). Even for the archaeological resources to which the law more obviously applied, violations of the Antiquities Act were inconsistently prosecuted and often hard to win in court. In the case of the *United States v. Diaz*, argued before the Ninth Circuit Court of Appeals, it was ruled in 1974 that the law was vague, and therefore unconstitutional (United States v. Ben Diaz, 1974). However, the Tenth Circuit Court ruled in 1979 that the law was not vague, and that a person of ordinary intelligence would be able to ascertain that excavating a prehistoric Native American burial ground is prohibited (United States v. Smyer and May, 1979). Thus, this part of the Antiquities Act potentially faced a ruling in the United States Supreme Court. However, it was not

[1]Still making an impact today, the Carnegie specimen, now called "Dippy" by the museum, will tour the United Kingdom from 2018–2020.

appealed to that level, and that court did not get a chance to hear it. In effect, it remains law, but subsequent legislation has clarified the government's policy on historic and scientific resources from public land.

Fossil Cycad National Monument

This national monument was one of the first established under the authority of the Antiquities Act and can be viewed as a negative example of the management of fossil resources on public lands. It illustrates that, even with the best intentions of managing the fossil resource in perpetuity, maladroit scientific and political management can unravel those intents.

Along the flank of the Black Hills in South Dakota are exposures of the Lower Cretaceous Lakota Formation. The area came to the attention of scientists around 1890, when fossil plants called cycadeoids (Fig. 4) were found in abundance. The first scientific publication on the fossils was produced by a University of Iowa professor, Thomas MacBride (1893). The paleobotanist at the Smithsonian, Lester Ward, also obtained and published on specimens from the site (Ward, 1899). By 1896, O.C. Marsh had acquired a very large collection of the cycadeoids for the Yale Peabody Museum.

A paleontology student, George Wieland, who was working with Marsh at Yale, collected the majority of the cycadeoids for Marsh, and devoted his entire career to these fossil plants. He lobbied for the protection of the rich collecting site and dreamed of making it a public attraction, complete with a visitor center and in situ fossil displays (Wieland, 1937). In 1919, concerned because exposed fossils were being carried off, Wieland applied for a homestead patent to protect the parcel of land where he and others had excavated hundreds of fossil specimens. He happily renounced his patent claim when President Woodrow Wilson signed an executive order in 1920 to withdraw the land from homestead claims so the case for a national monument could be studied. Two years later, President Warren G. Harding signed a proclamation establishing Fossil Cycad National Monument, and the management of the monument was passed to the NPS. It had taken decades of lobbying and two presidential actions for Wieland's dream to come to fruition.

Figure 4. A fossil cycadiod, *Cycadeoidea furcata,* a species of uncertain status from the now-decommissioned Fossil Cycad National Monument in South Dakota. From Wieland (1916, p. 296).

Long after its establishment as a national monument, Wieland continued to lobby for the site's development. He led an excavation at the site in 1935, likely to prove to detractors that in situ fossils were still there, and reported collecting another ton of fossil material (Wieland, 1937). He publicly shamed the NPS for dragging its feet, and proposed additional congressional action to force it to act (Wieland, 1938, 1945). That strategy may not have furthered his cause. The NPS was not enthusiastic about the monument and its development, and years of fossil collecting by museums and fossil poaching by locals eventually resulted in all visible fossils being removed. The passage of time, the death of the monument's advocates, and the visible absence of the fossils for which the monument was established were all ammunition that the NPS used to lobby to have the monument decommissioned. In 1957, they got their wish. The monument returned to general federal land management under the BLM. The monument and dreams for its future faded. More detail on this interesting story can be found in Santucci and Ghist (2014).

Today, the NPS and the BLM are working in collaboration to preserve the historical record of the former monument. There is rich archival material, including publications, newspaper stories, photographs, and letters all related to the site. There also exists a wealth of fossils that were collected, many of which are preserved in the Yale Peabody Museum. Many also found their way around the nation and around the world to several other museums. The BLM recognizes the site with the designation of an Area of Critical Environmental Concern (ACEC) in management plans, ensuring that its unique history will be considered in future decisions.

Additional Preservation Laws

Given the legal uncertainty of whether the Antiquities Act actually protected antiquities and other scientific objects, other laws were passed by Congress to clarify the situation. For archaeological resources, clear protections were accomplished with the Archaeological Resources Protection Act (ARPA) of 1979. The National Environmental Policy Act (NEPA) of 1969 also outlined the policy of the nation to evaluate potential impacts of federal projects upon all natural resources and the human environment on public land.

Paleontological resources were generally managed by federal agencies under the authority of the Antiquities Act, even though that law's application to fossils was unclear. The Act was, until recently, the primary authority cited for requiring and issuing permits to collect fossils on public land. The professional paleontological community recognized the need for clear legislation related to the status of fossils on public land, as had been passed for archaeology with ARPA. An extensive record of legal and policy actions related to fossils on federal land was summarized by Kuizon (2006). Legislation was finally passed in the Omnibus Public Land Management Act of 2009 in a section that is cited as the Paleontological Resources Preservation Act (PRPA). Key provisions in PRPA include the following:

- Fossils from these lands shall be managed and protected using scientific principles and expertise.
- Casual collection of a reasonable amount of common invertebrate and plant fossils is allowed for personal noncommercial use on lands administered by the BLM, the Bureau of Reclamation (BOR), and the USFS.
- Paleontological resources may not be collected from the specified federal lands without a permit, except as allowed for casual collection.
- An applicant for a permit must be qualified to conduct the permitted activity.
- Fossils collected under permit from public land will remain the property of the United States, and specimens and related records must be preserved and made available to the scientific community.
- Certain acts are prohibited, and criminal and civil penalties are established for violations. Such acts include unauthorized collecting, damaging, defacing, or selling of fossils from federal land.
- Information about the locality and nature of fossil resources on or collected from the specified federal lands must be held as confidential to protect those resources, unless disclosure is judged by the government to cause no potential harm.

PRPA reasserts or establishes several key points. Prior to PRPA, most land management agencies by policy focused on vertebrate fossils as a management priority, and generally only required authorization (by permit) for collecting vertebrate fossils. This focus on vertebrate fossils, however, gave many people the impression that other groups of fossils, such as plants and non-vertebrates, could be collected on federal land without any restrictions. That notion was incorrect. While agencies may not have required a permit to collect plants and non-vertebrates, any ground disturbance on federal land has required assessment under NEPA since its enactment in 1969. This unfortunate misunderstanding in some cases led to rather large areas of ground-disturbing work with the excuse that "it is ok, we are not collecting vertebrates."

PRPA established clearly that it is the policy of the government to manage all paleontological resources, not just vertebrates. Whereas plant and non-vertebrate researchers collected without a permit in the past (but could not cause ground disturbances), they too now need to apply for authorization for collection. This allows land managing agencies to have a better handle on the range and extent of research across the taxonomic spectrum that originates on public land. And PRPA unambiguously establishes that fossil material collected from the public domain must be reposited in public museums.

Another point to be made is that requiring curation of material in museums demands responsible collection and acquisition policies. This is true across the board, including federal and non-federal researchers working on public land. Museum storage space is always at a premium, and additions to any collection should be purpose and mission driven. All of the provisions of PRPA, the authorization and tracking of research on public land, and best collection and museum management policies will result in a benefit for the American people. There will be a better understanding of the value of public land to science, better accountability for the resources that come from public lands, and assurance that those resources are used for the benefit of all people, through research and educational opportunities.

MANAGING LANDSCAPES AND FOSSILS

Millions of fossils have come from public lands, both before and after Congress expressed a desire to manage the resource. Whereas Section 1 of the Antiquities Act outlined resources to be protected and punishments for violations, Section 2 gave the President of the United States the authorization to designate national monuments. It allowed the creation of national monuments to protect "… historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest…." Almost immediately after the passage of the Act, paleontological resources were deemed significant when in 1906 President Theodore Roosevelt created one of the first monuments, Petrified Forest National Monument, later designated Petrified Forest National Park in 1962. Either through presidential proclamation or through legislation, at least 23 national parks and monuments have been created with the authorization explicitly mentioning their fossil resources (Table 2). In addition to those places, the NPS has documented fossils in more than 260 additional NPS-managed units (National Park Service, 2017).

One recent publication documented holotype specimens from within (or likely collected within) NPS areas. Including microfossils and fossil plants, invertebrates, vertebrates, and ichnotaxa, over 4850 holotype specimens were documented (Tweet et al., 2016). The NPS manages ~80 million acres of public land, about 16% of the total land managed by the DOI. Recognition that many DOI-managed public lands are rich in fossils creates opportunities for research and public education, as well as challenges for land and resource management. Following are some focused case studies highlighting different geologic eras, different agencies, and different management issues.

TABLE 2. LIST OF PARKS AND NATIONAL MONUMENTS CREATED AT LEAST IN PART FOR THEIR PALEONTOLOGICAL RESOURCES

Bureau	Unit	Description of fossils	Year	State
NPS	Petrified Forest National Park	Late Triassic trees and other fossils	Monument in 1906; Park in 1962	Arizona
NPS	Zion National Park	Triassic plant and vertebrate remains	Monument in 1909; Park in 1919	Utah
NPS	Dinosaur National Monument	Dinosaurs	1915	Utah
NPS	Fossil Cycad National Monument	Fossil plants	1922; subsequently Monument status revoked 1957	South Dakota
NPS	Death Valley National Park	Precambrian through Paleozoic fossils, Paleogene and Neogene body and traces	1933	California
NPS	Joshua Tree National Park	Paleontology resources	Monument in 1936; Park in 1994	California
NPS	Channel Islands National Park	Dwarf mammoths	1938	California
NPS	Agate Fossil Beds National Monument	Miocene mammals	Authorized in 1965; established 1997	Nebraska
NPS	Florissant Fossil Beds National Monument	Eocene to Oligocene plants, insects, and vertebrates	1969	Colorado
NPS	Fossil Butte National Monument	Eocene plants, insects, and vertebrates	1972	Wyoming
NPS	John Day Fossil Beds National Monument	Eocene to Miocene plants and animals	Authorized in 1974; opened in 1975	Oregon
NPS	Bering Land Bridge National Preserve	Pleistocene megafauna	1978	Alaska
NPS	Yukon Charley National Preserve	Paleontology resources	Monument in 1978; Preserve in 1980	Alaska
NPS	Hagerman Fossil Beds National Monument	Pliocene vertebrates	1988	Idaho
BLM	Grand Staircase–Escalante National Monument	Dinosaurs	1996	Utah
BLM and NPS	Grand Canyon–Parashant National Monument	Paleozoic invertebrates	2000	Nevada
FWS	Hanford Reach National Monument	Mammalian fossils from the Miocene to Pliocene Ringold Formation	2000	Washington
BLM	Prehistoric Trackways National Monument	Paleozoic reptile tracks	2009	New Mexico
NPS	Tule Springs Fossil Beds National Monument	Pleistocene fossils	2014	Nevada
BLM and USFS	Browns Canyon National Monument	Pennsylvanian non-vertebrates	2015	Colorado
NPS	Waco Mammoth National Monument	Mammoths	2015	Texas
NPS	Katahdin Woods and Waters National Monument	Paleozoic fossils	2016	Maine
BLM and USFS	Bears Ears National Monument	Paleozoic and Mesozoic marine and terrestrial fossils	2016	Utah

Note: BLM—Bureau of Land Management; FWS—Fish and Wildlife Service; NPS—National Park Service; USFS—United States Forest Service.

Grand Staircase–Escalante National Monument

When Grand Staircase–Escalante National Monument (GSENM) was created and assigned to the BLM to manage, the Late Cretaceous fossil record of the Kaiparowits Plateau region was listed as one of the primary resources worthy of protection (Clinton, 1996). The BLM assigned a full-time paleontologist to focus on the resource and to promote research.

The Kaiparowits Plateau, in south-central Utah, is underlain by ~2100 m of lower Cenomanian to upper Campanian (and possibly early Maastrichtian) strata (dated 100–70 Ma) that is mostly terrestrial, although marine beds do occur in the lower half of the section (Titus et al., 2013). Vertebrate fossils occur throughout the entire section, with a general trend toward better preservation and higher abundance up-section (Titus et al., 2017). The units yielding the highest numbers of terrestrial vertebrate fossils are the Wahweap and Kaiparowits formations, both of which occur at the top of the sequence. Largely paralic and marine units in the lower half (Naturita, Tropic Shale, and Straight Cliffs formations) have much lower fossil abundances overall, and macrovertebrate remains are much less common. However, locally spectacular exceptions are present, especially in the fully marine Tropic Shale, where articulated sharks, fishes, marine reptiles, and dinosaurs occur (Albright et al., 2013).

The significance of the monument's "world class" Late Cretaceous record was largely based on the study of the abundant

vertebrate microfauna (Titus et al., 2017). With the monument's designation, interest in macrovertebrate remains began to build. Numerous macroskeletal sites had been previously documented during microvertebrate surveys, although very little diagnostic material had been collected as of 1996. In fact, only two individual dinosaurs had been described in the literature as identifiable to genus (Weishampel and Jensen, 1979; DeCourten and Russell, 1985). Between 1998 and 2000, the Utah Geological Survey was permitted by the BLM to conduct fieldwork to document known sites and provide a basis for planning decisions related to fossil resources (Foster et al., 2001). Relatively few new sites were documented, however, because the focus of this field effort was to verify and assess sites known from previous literature. The BLM's Monument Management Plan (MMP) was signed and implemented in 2000. The planning process did identify the Kaiparowits region as having tremendous potential for significant macrofauna even though almost nothing was known about it. Key decisions in the MMP (SCI-7 and PAL-1) provided the basis for establishing a program of fossil inventory, collection, and research to fill in this key knowledge gap.

Thus, every year since 2000, the monument's in-house paleontology program, along with a handful of other partner institutions (e.g., the Natural History Museum of Utah, the Utah Geological Survey, the Denver Museum of Nature & Science, and the Museum of Northern Arizona), have conducted inventories and excavations to broaden the scientific understanding of the Late Cretaceous fossil ecosystems and to preserve some of the priceless fossils. One of the key partnerships in this endeavor is with the Natural History Museum of Utah, which not only conducts fieldwork and collecting each year, but also permanently curates large Kaiparowits collections. The Natural History Museum of Utah currently houses ~20,000 Kaiparowits fossil objects, many of which are type and figured specimens of new dinosaurs and other vertebrate taxa. The Denver Museum of Nature & Science, the other major partner in the current inventory and collection effort, houses ~27,000 GSENM Cretaceous fossil objects, over half of which are paleobotanical specimens. From these and other collections, a whole new North American Late Cretaceous flora and fauna are being cataloged.

Since 2005, 12 new genera of Kaiparowits dinosaurs, such as *Nasutoceratops titusi* (Fig. 5), have been named (Titus et al., 2017). Numerous other taxa are currently under study for publication. The Kaiparowits dinosaur assemblage contains the oldest named members of the tyrannosaurid and lambeosaurine dinosaur clades, *Lythronax argestes* and *Adelolophus hutchisoni,* respectively (Loewen et al., 2013b; Gates et al., 2014), as well as the highest ceratopsid diversity (minimum of five genera) for a single faunal zone in the world (Loewen et al., 2013a). It has also yielded the most complete Late Cretaceous terrestrial bird fossil from North America (*Avisaurus* sp.) and numerous specimens of hadrosaurs, ceratopsids, and maniraptorans retaining evidence of soft tissue (Zanno and Sampson, 2005; Gates et al., 2013; Sampson et al., 2013; Zanno et al., 2013). The near total uniqueness of the late Campanian (ca. 75 Ma) Kaiparowits dinosaur assemblage, in concert with turtle, mammal, crocodyle, and squamate evidence, has made it clear that the Kaiparowits Plateau represents a previously unrecognized, higher-diversity biogeographic realm (Roberts et al., 2013) distinct from that which characterizes the northern Great Plains (Montana and Alberta, Canada). Overall, the region can claim to hold one of the most complete Late Cretaceous terrestrial vertebrate fossil successions in the world. With ~25% of the entire plateau region surveyed, additional important future discoveries are assured.

Charles M. Russell National Wildlife Refuge

The Charles M. Russell National Wildlife Refuge (CMRNWR) surrounds Fort Peck Reservoir in Montana and is the second-largest National Wildlife Refuge in the lower 48

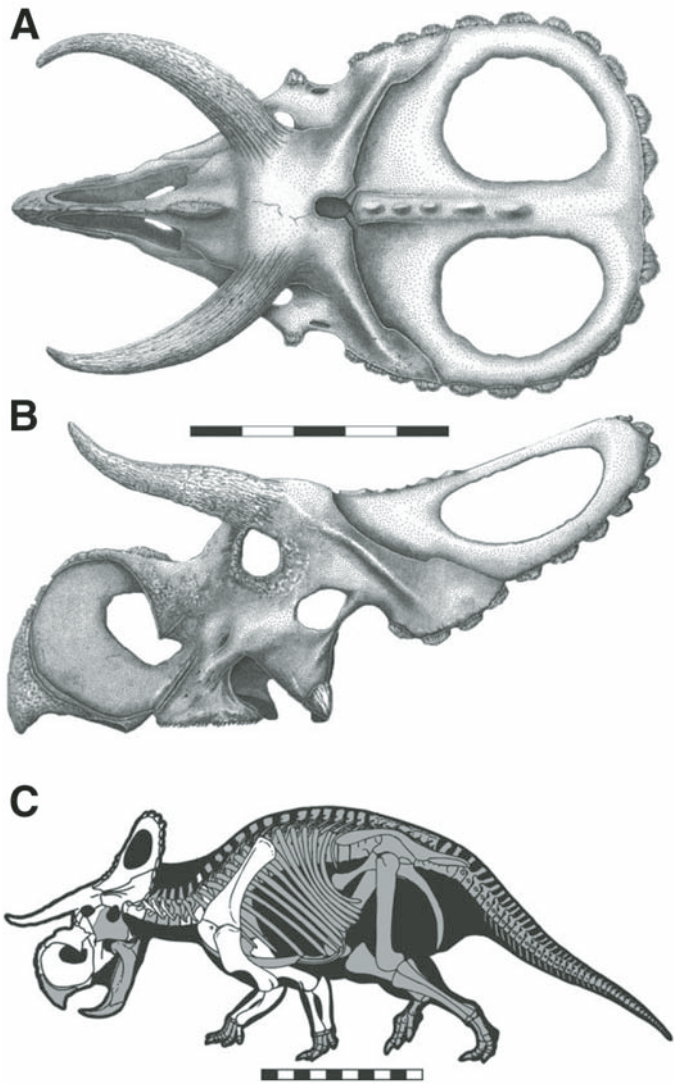

Figure 5. *Nasutoceratops titusi,* a newly identified ceratopsian species from Grand Staircase–Escalante National Monument. Scale bars in (A) and (B) are 50 cm, and in (C) 1 m. From Sampson et al. (2013).

states. The refuge, managed by the U.S. Fish and Wildlife Service (FWS), protects ~125 linear miles (not river miles) of the Missouri River ranging from the Fort Peck Dam west to the boundary of the Upper Missouri River Breaks National Monument (UMRBNM). The latter is managed by the BLM and protects another 80 plus linear miles of the river to the west. The CMRNWR was created in 1936 as a "range" and officially became a refuge in 1976. This area is significant for discoveries made in the early years of paleontology, as well as intensive ongoing modern research.

Fossils from this area came to light in 1901, when William T. Hornaday, then director of the New York Zoological Society, was exploring the area. He picked up three fragments of *Triceratops* nasal horn (Clemens and Hartman, 2014). He showed the bones to H.F. Osborn at the American Museum of Natural History, who dispatched Barnum Brown to the area to prospect the next year. Brown later recounted that soon after arriving in the area indicated by Hornaday, while the cook prepared supper, he walked up the drainage and located bones running into a hillside. This discovery would forever change paleontology and the imaginations of children everywhere—it became the type specimen of *Tyrannosaurus rex* (Osborn, 1905) (Fig. 6). The type locality today is just outside the modern boundaries of the refuge, and on private land. However, in 1902, the land was under federal management.

The formation in which the *Tyrannosaurus rex* and several *Triceratops* skulls were collected in 1902 now takes its name from a small drainage flowing north into the Missouri River—it is known as the Hell Creek Formation. From this early success, fossil hunters have been drawn to the Hell Creek badlands ever since. Paleontologists have amassed extensive floral and faunal lists. The depositional setting for the shales and sands of the Hell Creek Formation was a low-lying, low-relief margin of the Cretaceous Interior Seaway, with fluctuating fluvial channels, deltas, and peaty swamps (Clemens and Hartman, 2014). The general area of the Hell Creek Formation and the overlying Tullock Member of the Fort Union Formation is of intense interest because it is one of the few places in the world to preserve a terrestrial record of the Cretaceous–Paleogene (K–Pg) boundary.

During the 1970s, the discovery of anomalously high concentrations of iridium in marine formations at the K–Pg boundary led to the advancement of the asteroid extinction hypothesis (Alvarez et al., 1980). Soon thereafter, samples were taken at a site dubbed "Iridium Hill" (Clemens and Hartman, 2014) on BLM-managed land outside the preserve. The iridium layer represents an isochron that marks the end of the Cretaceous. Using lithological, geochemical, palynological, and geochronological analyses, the layer was located at other areas across Montana and North Dakota. Hell Creek fossils include invertebrates, diverse plant macrofossils, fishes, amphibians, lizards, dinosaurs, and mammals (Clemens and Hartman, 2014). The overlying Tullock Member also preserves flora and fauna. Together these units provide excellent information about the final years of the Cretaceous Period and the Paleogene recovery within the ecosystem after the end-Cretaceous extinction. Because of this, the formations have consistently attracted multidisciplinary researchers who work on both the CMRNWR and surrounding BLM land. Partner museums with significant Hell Creek and Tullock collections from public land include the Museum of the Rockies, the Burke

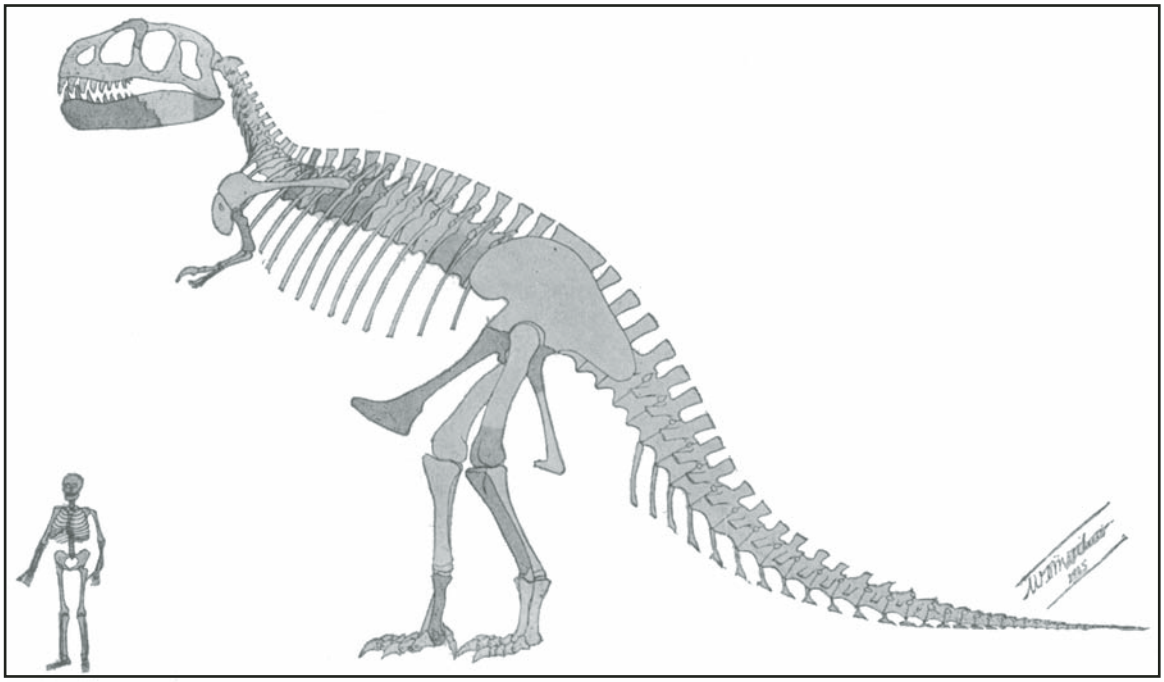

Figure 6. First published image of *Tyrannosaurus rex,* taken from Osborn's 1905 holotype description paper.

Museum, the Smithsonian National Museum of Natural History, and the Denver Museum of Nature & Science, among others.

American Falls Reservoir

The American Falls Reservoir was created when the Bureau of Reclamation (BOR) built the American Falls Dam on the Snake River in Idaho. The dam and reservoir were constructed as part of the Minidoka Project on the Snake River Plain to provide flood control, irrigation, and recreation. Construction of the original dam by the BOR began in 1925 and was completed in 1927. When a second dam was built in 1978, the original structure was demolished. Although the dam itself is located in Power County, the reservoir stretches northeastward into Bingham and Bannock counties. It is one of 348 reservoirs managed by the BOR (Stratton et al., 2014) and the largest in the upper Snake River Basin. The management of fossils along the shoreline of an active reservoir, combined with ongoing erosion, provides a challenge.

The American Falls fauna is recovered as float from the lower member of the American Falls Formation, which is exposed on the beach ringing the reservoir (Ridenour, 1969). The formation represents a floodplain of the ancestral Snake River and consists of sands, silty sands, silts, and a small proportion of clayey silt beds. Forming cliffs above the lower member are lacustrine sediments composed of clay, which are considered the upper member of the American Falls Formation. The upper member accumulated in a lake that formed when the Cedar Butte basalt flow impounded the Snake River. The two sedimentary units are separated by a distinct change in texture and an undulatory erosional surface. The upper member contains the Rainbow Beach fauna (McDonald and Anderson, 1975).

The first documented fossil vertebrate collected from the American Falls Formation was a partial cranium referred to as *Bison alaskensis,* collected in 1894 "from the banks of the Snake River, Idaho, about 9 miles above American Falls, in the gravel overlying the lava beds" (Lucas, 1899, p. 766). This general area is now inundated by the American Falls Reservoir. However, the composition and mineralogy of matrix adhering to the cranium is consistent with that of the basal sand and gravel of the lower member of the American Falls Formation. The skull was originally housed at Stanford University but was subsequently transferred to the Idaho Museum of Natural History on the Idaho State University campus in Pocatello (Pinsof, 1991).

The American Falls fauna is Sangamonian interglacial in age and the Rainbow Beach fauna is Wisconsinan. Both faunas have similar megafauna including the giant bison, *Bison latifrons* (Fig. 7), along with the horse *Equus scotti*; the extinct camel *Camelops hesternus*; two types of ground sloth, *Paramylodon harlani* and *Megalonyx jeffersonii*; the Columbian mammoth, *Mammuthus columbi*; and the American mastodon, *Mammut americanum* (McDonald and Anderson, 1975; Pinsof, 1998). The largest collection of fossil vertebrates of both the American Falls and the Rainbow Beach faunas is held in the John A. White Repository at the Idaho Museum of Natural History. The earliest collections made by the museum started in the 1930s and have continued uninterrupted to the present (Stratton et al., 2014). Over 17,000 vertebrate specimens from the American Falls fauna alone are recorded in the museum's database.

Figure 7. John White, former curator of vertebrate paleontology, Idaho Museum of Natural History, with skull of the giant bison, *Bison latifrons,* at American Falls Reservoir. The skull is part of a partial skeleton (IMNH 75002/27) collected in 1975. Photo courtesy of the John A. White Paleontological Repository, Idaho Museum of Natural History.

At the American Falls Reservoir, fluctuations in the water level occur both seasonally and in response to long-term changes in yearly precipitation in the region. The difference between the high and low stands in the reservoir is ~18 m, and the shoreline ranges from a minimum of 75 km at normal minimum elevation to 185 km at normal maximum elevation (Bureau of Reclamation, 1995). This results in constant erosion of both the lower member of the American Falls Formation along the beach and the cliff face of the upper member. Control of this erosion by the BOR through the installation of riprap rock barriers requires considering the impact to the fossil resources, and mitigation often involves their collection and documentation (Stratton et al., 2014). The continuous exposure of fossils also increases the potential for their illegal removal by individuals visiting American Falls Reservoir for recreation. Usually the fossils are found as float along the beach strandline, so articulated material is rare. Constant monitoring of the shoreline around the reservoir is needed. This is particularly important in the summer when the reservoir is heavily used for recreation and in the fall when the water level is at its lowest, which is when exposure of the fossil-bearing sediments is at its greatest. The ongoing partnership between the BOR and the Idaho Museum of Natural History has ensured that this paleontological resource is preserved for future generations and available for both scientific study and public interpretation in museum exhibits.

MANAGING MUSEUM PROPERTY

The DOI as Steward

The "treasure" of the nation is not only in the landscapes and resources utilized in some productive way, but also in the objects and specimens that have come from the land and are today curated as museum property. The museum property held by the DOI represents a significant prehistoric, historic, cultural, and scientific legacy for the nation. Collectively, it makes the DOI one of the largest managers of museum collections in the United States. The scope of the DOI collections includes objects from all scientific and cultural disciplines, including archaeology, archives, art, biology, ethnography, geology, history, and paleontology. Ten DOI bureaus and offices presently manage museum property (Table 3), and the total of all museum objects across all bureaus and offices and collection types is presently estimated at nearly 204 million objects. The largest single collection discipline is archives, representing over 131 million documents along with almost 3000 additional linear feet of archives (Table 4). The NPS, which has hundreds more museum staff than all other agencies combined (Table 5), is the largest collection holder in the DOI and manages an estimated 175 million objects (Table 1). (Readers interested in scientific collections held across the federal government beyond the DOI should refer to the Interagency Working Group on Scientific Collections, 2009).

When dealing with collections of this size and scope, challenges are inevitable. In 2009, the DOI Office of Inspector General (OIG) conducted an audit of the overall museum program and correctly noted a number of important deficiencies (Office of Inspector General, 2009). In broad terms, the audit found that the DOI lacked sufficient oversight of the bureau and office collections; had a very large backlog of objects that were not accessioned and/or cataloged; was not caring for some objects properly; was not conducting regular inventories for accountability purposes; and did not know where all its collections were housed, including those in non-federal museums and repositories. The OIG issued recommendations for the DOI to implement, which are being addressed. Each year one or more of the recommendations is completed.

The DOI provides oversight, policy direction, technical support, and training for all the bureaus and offices that manage museum collections. Department staff work closely with national curators of the bureaus and offices to write policy, address current issues and challenges, and cooperate on projects. One such project was a recent survey of ~200 non-federal repositories to find the DOI collections they possibly housed. The survey included questions about collections by discipline, so the hope was to

TABLE 3. BUREAUS WITHIN DEPARTMENT OF THE INTERIOR (DOI) RESPONSIBLE FOR MUSEUM PROPERTY AND A BRIEF OVERVIEW OF WHAT EACH BUREAU MANAGES

Bureau	Abbreviation	Acres or types of resources managed
Bureau of Indian Affairs	BIA	55.7 million acres of land held in trust for Native Americans
Bureau of Land Management	BLM	248 million surface, 700 million subsurface acres
Bureau of Reclamation	BOR	476 dams and 338 reservoirs
Bureau of Safety and Environmental Enforcement	BSEE	1.7 billion acres on the U.S. Outer Continental Shelf
Fish and Wildlife Service	FWS	150 million acres
Indian Arts and Crafts Board	IACB	Operates three regional museums
Department of the Interior Museum	IM	Houses a collection related to DOI and curates exhibits at the Main Interior Building in Washington, D.C., and online
National Park Service	NPS	80 million acres, including 56 national parks and 417 other units
Office of the Special Trustee for American Indians	OST	Manages assets for trust beneficiaries that the federal government holds in trust
U.S. Geological Survey	USGS	Conducts scientific research on a wide range of natural systems of national importance. Much of the resulting museum collections are curated by the Smithsonian Institution

TABLE 4. NUMBERS OF MUSEUM OBJECTS CURRENTLY IDENTIFIED UNDER DEPARTMENT OF THE INTERIOR MUSEUM PROGRAM MANAGEMENT IN FISCAL YEAR 2016

Discipline	Museum objects managed (millions)	Cubic feet	Linear feet
Archaeology	63.452	18,109	0
Archives	131.855	0	2992
Art	0.104	0	0
Biology	3.396	0	0
Ethnography	0.034	0	0
Geology	0.081	0	0
History	3.472	360	0
Paleontology	1.515	105	0
Totals	203.909	18,574	2992

TABLE 5. MUSEUM STAFF BY BUREAU FOR FISCAL YEARS 2014–2016

Bureau	2014	2015	2016
BIA	3	3	3
BLM	5	4	4
BOR	6	55	
BSEE	2	2	2
FWS	3	33	
IACB	5	5	5
IM	4	4	4
NPS	660	588	646
OST	1	11	
USGS	1	1	1

Note: BIA—Bureau of Indian Affairs; BLM—Bureau of Land Management; BOR—Bureau of Reclamation; BSEE—Bureau of Safety and Environmental Enforcement; FWS—Fish and Wildlife Service; IACB—Indian Arts and Crafts Board; IM—Department of the Interior Museum; NPS—National Park Service; OST—Office of the Special Trustee for American Indians; USGS—United States Geological Survey.

find fossils and other objects and specimens in repositories that bureaus did not know about. Another goal of the survey was to forge partnerships with the newly discovered repositories and strengthen relationships with known partner repositories.

DOI Repositories

Most bureaus and offices have few full-time staff dedicated to museum collection care (Table 5). The NPS is the exception to this rule with 646 museum staff members. The NPS operates 1469 museum repository facilities located at 329 units, where a unit is a park, monument, historic site, or historic house. Some of those units have multiple repositories that house collections, such as exhibits at visitor centers, museums, historic structures, and administrative or storage spaces. The other bureaus have far fewer bureau-run repositories. For example, the BLM has three repositories, whose scope of collections is limited to archaeological and historical objects. As a result, the BLM has 158 non-federal partner facilities housing the remainder of its museum objects. All DOI facilities must comply with DOI policy and procedures for the physical security and environmental conditions of museum collections to ensure their proper care. The DOI encourages non-federal partner facilities to also comply with DOI collection standards, which reflect best museum practices as promoted by the American Alliance of Museums.

John Day Fossil Beds National Monument

An example of a DOI repository can be found at the John Day Fossil Beds National Monument, the Thomas Condon Paleontology Center. Covering ~10,000 square miles, the John Day fossil beds contain one of the most complete terrestrial Cenozoic

stratigraphic sequences in the world. Agency boundaries and private lands are comingled in this fossil-rich landscape, lending a perfect opportunity for collaborative, interagency management (Fremd et al., 2009).

The fossils of the John Day Basin have been of interest to researchers for over 150 years, beginning with Thomas Condon, O.C. Marsh, and E.D. Cope and later followed by J.C. Merriam, Ralph Chaney, and many others. It was clear that the vertebrate and plant records in the region were a valuable resource to the scientific community. J.C. Merriam was one of the early proponents of protecting the fossil beds as public land, and by the 1930s, three state parks had been created: Thomas Condon–John Day Fossil Beds State Park, Clarno State Park, and Painted Hills State Park. With the support of the governor and legislature of the state of Oregon, the state parks were turned over to the NPS to manage (Enabling Legislation of 1974, Public Law 93-486). The modern 14,000 acre monument was authorized when the enabling legislation adopted by Congress was signed into law on 26 October 1974. The monument consists of three separate and distinct management units, corresponding to the original three state parks, as well as other federal land; however, the monument could not encompass all the important fossil sites within the John Day River valley. Agencies that also manage significant fossil localities in the region include NPS, BLM, FWS, Bureau of Indian Affairs (BIA), USFS, and the state of Oregon. In particular, the NPS and the BLM have formally been partners in the John Day region since at least 1987, and these agencies have worked collaboratively to preserve the paleontological resources of the region. BLM specimens comprise ~26% of the collections at the Paleontology Center.

The geologic layers at the John Day fossil beds represent ~40 million years, or nearly two-thirds of the Cenozoic Era (Fig. 8). The fossiliferous units are the Clarno, John Day, Mascall, and Rattlesnake formations. The history of evolution and changing climates is well preserved within rocks exposed on these public lands. The Eocene Clarno Formation (54–39 Ma) is ~1800 m thick and includes both volcanic and volcanogenic sedimentary rocks deposited by lava flows, ashfalls, lahars, and fluvial mechanisms (Bestland et al., 1999; Dillhoff et al., 2009; McClaughry et al., 2009). The most captivating NPS-administered sites from the Clarno Formation are the Hancock Mammal Quarry and the Clarno Nutbeds outcrops, representing a diverse flora and fauna.

The John Day Formation (39–18 Ma) is subdivided into seven members: Big Basin, Turtle Cove, Kimberly, Haystack Valley, Balm Creek, Johnson Canyon, and Rose Creek (Retallack et al., 2000; Hunt and Stepleton, 2004; Albright et al., 2008). A rich fossil record of plants and animals is preserved, as well as paleosols. Thirteen of the volcanic layers in the John Day

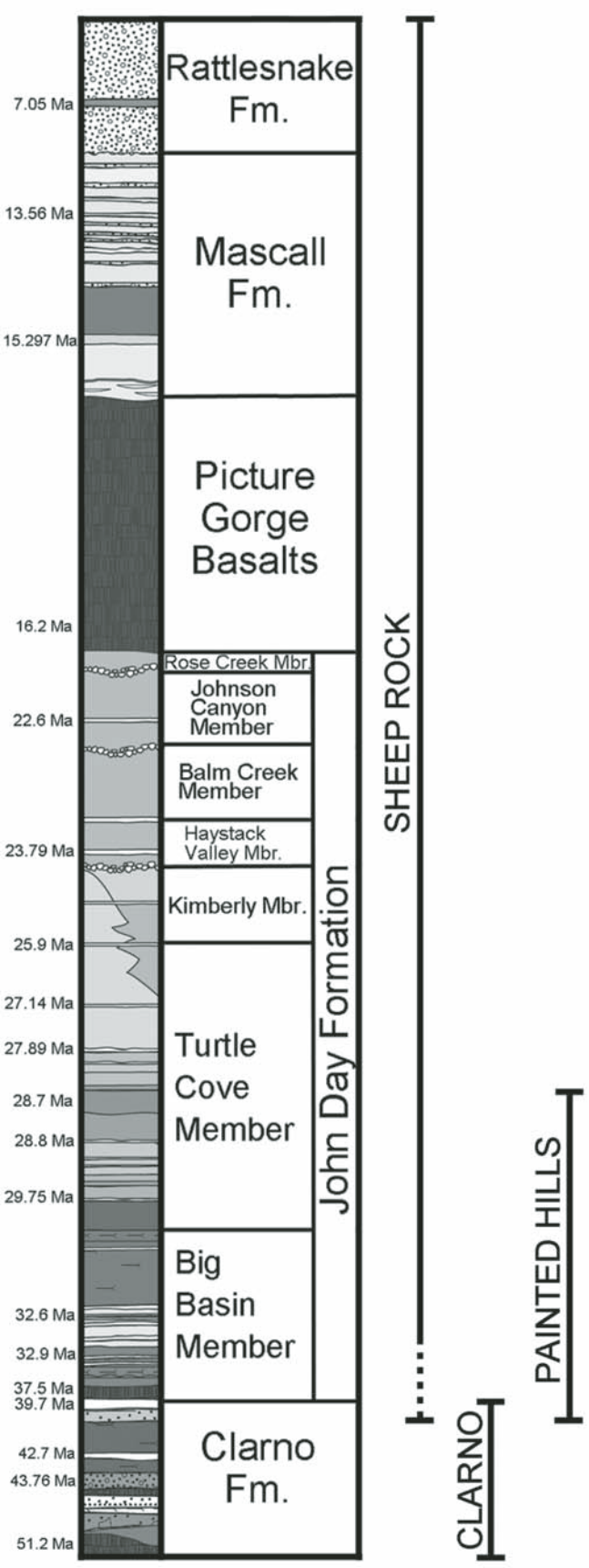

Figure 8. Composite stratigraphy of John Day Fossil Beds National Monument. The approximate stratigraphic ranges of the three units of the monument are indicated by black lines on the right. Courtesy of the National Park Service.

Formation are named and many of them have been radiometrically dated. One of the largest volcanic deposits is the Picture Gorge ignimbrite (28.7 Ma) in the Turtle Cove Member, which represents a large caldera eruption possibly associated with the Yellowstone hotspot (Seligman et al., 2014). The John Day Formation includes some rare and interesting taxa including one of the last North American primates before the arrival of humans, *Ekgmowechashala zancanellai* (Samuels et al., 2015).

The Mascall Formation (17–13 Ma) is composed of volcaniclastic sediment derived from the coeval volcanoes of Oregon, Washington, and Nevada (Rytuba and McKee, 1984; Bestland et al., 2008). Like the John Day Formation, several paleosols are preserved. A well-preserved floral assemblage (leaves and pollen) can be found in the lower diatomite layers, and there is a good record of extinct vertebrates throughout the entire Mascall Formation (Downs, 1956; Chaney, 1959).

The Rattlesnake Formation (7 Ma) is the stratigraphically highest geologic unit and comprises fluvial deposits (Enlows, 1976; Martin, 1983; Martin and Fremd, 2001). It is dissected by the Rattlesnake Ash Flow Tuff (7.05 Ma). Plant fossils are rare in the Rattlesnake Formation (Dillhoff et al., 2009), but there are numerous vertebrate fossils that were first described in 1925 and include the first occurrence of true beavers and fishers (Merriam et al., 1925; Samuels and Zancanella, 2011; Samuels and Cavin, 2013).

One fascinating story that is preserved at the John Day fossils beds is the evolution of the horse. Fossils of 24 species of horse can be found within the section. They chronicle the evolution of the family Equidae in the face of an environment changing from a closed forest to an open grassland (Fremd, 2010). Recently, the horse fossil record at the John Day fossil beds has been utilized in studies of the evolution of tooth morphology (Famoso et al., 2013; Famoso and Davis, 2014).

With 197 confirmed type specimens (Tweet et al., 2016), a relatively continuous section, abundant plant and animal fossils, and numerous volcanic layers (ashes, ignimbrites, and lava flows), the John Day fossil beds are a unique resource. The long history of collecting in the area has meant that fossil material can be found in many repositories across North America. The partnership of all the various public lands in the John Day region ensures that the rich 40-million-year record of plant and animal evolution and climate change is preserved for future generations.

Non-Federal Facilities

Whereas properly managing museum property within DOI facilities is challenging in itself, an entirely different set of issues arises when trying to manage and be accountable for federal property held in non-federal facilities. For example, unlike the NPS, which houses many fossil collections on-site at park units, almost all of the BLM's fossil resources are housed in non-federal partner repositories. The other bureaus are in a similar situation. The non-federal partners range from large public or private museums to small county museums, or even laboratories within university departments. More than 25 million museum objects managed by the DOI bureaus are housed in almost 900 non-federal partner facilities.

The DOI partnerships with all the non-federal facilities are an essential part of museum object care, and the DOI is grateful to its partner facilities for the work they do caring for public material in trust. Many of these collections were made by researchers at their own behest under permit, and some resulted in sizeable collections at their institutions. The non-federal facilities have taken on the task of documenting, curating, and housing these public materials in trust, preserving them for public benefit. All of the museum collections are available for exhibition and educational programming, and countless visitors to federal and non-federal museums are enriched by these objects.

Because the objects and specimens remain property of the federal government, each of the bureaus within the DOI is responsible to the American people to account for them. Sometimes records at both the bureaus and the repositories are inadequate (or otherwise unprocessed) to identify which objects are federally held. Backlogs of repository accessioning and cataloging; failure of the stewarding institution to note which objects were collected from public land; and old, lost, or incomplete records of permit authorizations by the bureaus (or cases where authorization was never sought) all contribute to the challenges of knowing what the DOI is responsible for, and where those collections are held.

In addition to discoveries of legacy collections (collections made historically, and newly discovered to be federal material), new collections are actively being made. This is especially true in paleontology. On BLM land, for example, the number of permits issued each year continues to rise. The BLM issued 440 paleontology research permits in fiscal year (FY) 2015, and 465 permits in FY2016, to researchers outside the federal government. Thousands of fossils are added annually to repository collections through researcher-driven efforts. This has led to many discoveries of scientific interest, including new species and other unique occurrences, but it also contributes to collection growth, backlogs, and more responsibilities to the public and researchers for access and use.

Despite these challenges, there has been considerable progress. Each year recommendations in the OIG report are completed. In recognition of the need to help support collections in non-federal partner facilities, the DOI has been able to offer some support for collection management improvements through project funding and internships. This support has successfully improved collection conditions and records across many non-federal partners. Strides have been made in identifying non-federal partners and developing working relationships and partnerships with repository staff. Outreach about the roles and responsibilities of the DOI in museum collection management is a continuing effort, of which this paper is a prime example.

The DOI systems for documenting and tracking collections are continuously being improved. A notable advancement being planned for the coming years is a complete upgrade to the DOI-wide computerized collection management system. The goal is to have an enterprise-wide solution for collection management that

will dramatically improve access to information about DOI collections to better serve researchers and the American public. This will augment all the work the bureaus are doing to develop online exhibits and share other information about the public's collections.

CONCLUSIONS

The young U.S. government documented its natural resources and utilized its wealth in many ways. Among the resources on the public land were fossils, which ignited scientific curiosity and facilitated addressing significant questions such as the reality of extinction and evolution, and helped to propel paleontology into its modern form. Land settlement was encouraged with a variety of schemes to transfer land into private ownership, making more than a million ordinary people into landowners. A conservation ethic slowly emerged in the late nineteenth century, particularly with the obvious loss of forest lands. The federal government established the USFS and the first national park. The federal government also exerted ownership of scientific and cultural resources on the public lands by the turn of the twentieth century, which is when the DOI's accountability to the public began for the museum objects that it managed. Systems for permits were developed to provide a mechanism for tracking public material into either federal or non-federal museums charged with holding the material in trust for the American public. The permits also allow land managers to account for the amount and scope of research being conducted on public land. More recent efforts to account for and track the nation's historic and scientific treasure from public lands have led to the recognition that the DOI is responsible for one of the largest collections of museum property in the nation. Land-managing bureaus and offices are charged with overseeing historic and scientific resources while they are in the field, inventorying them, and mitigating potential damage to resources not yet collected. The DOI museum staff is charged with accounting for and preserving museum collections in both DOI and non-federal facilities. There are several hurdles to overcome to be successful in these daunting tasks, and recent successes and improvements make the DOI better positioned than ever to do so.

Responsible collecting by researchers on public lands, proper issuance and recordkeeping of bureaus' authorizations to researchers to collect from public lands, and the cooperation of research professionals and non-federal museums are essential. Both DOI museums and non-federal museums have taken on a significant trust responsibility to care for the nation's heritage. The partnership between the DOI and non-federal facilities is critical, and wherever possible the DOI is offering resources to help with the burden. The natural and cultural heritage under DOI management is immense, and the DOI is striving to manage this treasure to protect it for future generations.

ACKNOWLEDGMENTS

Many people contributed toward this paper. Justin Tweet was helpful with information on fossils in the NPS. Robert Marcell from the NPS pointed out useful reference material on homesteads. The BLM paleontology team of Scott Foss, Phil Gensler, Brent Breithaupt, Harley Armstrong, Rebecca Hunt-Foster, and Neffra Mathews is always supportive. The USFS paleontologists, Bruce Schumacher and Barbara Beasley, provided insights about their agency. BOR staff Kathleen Hogue, Lynne MacDonald, George Shannon, Zac Nelson, and Bill Chada assisted with information about fossil resources on BOR-administered land. BLM colleagues Cyndi Eide and Debbie Sorg assisted with research related to land patents, and Jeff Erwin produced Figure 1. Gary Smith, also of the BLM, was extremely supportive of this effort as well. Mary Thompson from the Idaho Museum of Natural History provided the photo in Figure 7. Paula Gouse provided information about fossils on FWS-managed land. Shelley Hall and Chris Schierup from John Day Fossil Beds National Monument also provided support. The editors and reviewers of the paper provided valuable comments for improvement.

REFERENCES CITED

Albright, L.B., III, Woodburne, M.O., Fremd, T.J., Swisher, C.C., III, MacFadden, B.J., and Scott, G.R., 2008, Revised chronostratigraphy and biostratigraphy of the John Day Formation (Turtle Cove and Kimberly Members), Oregon, with implications for updated calibration of the Arikareean North American Land Mammal Age: The Journal of Geology, v. 116, p. 211–237, https://doi.org/10.1086/587650.

Albright, L.B., III, Gillette, D.D., and Titus, A.L., 2013, Fossil vertebrates from the Tropic Shale (Upper Cretaceous), southern Utah, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah: Bloomington, Indiana University Press, p. 536–562.

Alderson, W.T., 1992, Mermaids, Mummies, and Mastodons: The Emergence of the American Museum: Washington, D.C., American Association of Museums, 104 p.

Alvarez, L.W., Alvarez, W., Asaro, F., and Michel, H.V., 1980, Extraterrestrial cause for the Cretaceous–Tertiary extinction: Science, v. 208, p. 1095–1108, https://doi.org/10.1126/science.208.4448.1095.

Ambrose, S.E., 1997, Undaunted Courage: Meriwether Lewis, Thomas Jefferson, and the Opening of the American West: New York, Simon and Schuster, 528 p.

Bestland, E.A., Hammond, P.E., Blackwell, D.L.S., Kays, M.A., Retallack, G.J., and Stimac, J., 1999, Geologic framework of the Clarno Unit, John Day Fossil Beds National Monument: Central Oregon: Oregon Geology, v. 61, p. 3–19.

Bestland, E.A., Forbes, M.S., Krull, E.S., Retallack, G.J., and Fremd, T.J., 2008, Stratigraphy, paleopedology, and geochemistry of the middle Miocene Mascall Formation (Type area, central Oregon, USA): PaleoBios, v. 28, p. 41–61.

Boyd, J.P., 1958, The *Megalonyx,* the *Megatherium,* and Thomas Jefferson's lapse of memory: Proceedings of the American Philosophical Society, v. 103, no. 5, p. 420–435.

Bureau of Land Management, 2015, Public Land Statistics: Lakewood, Colorado, Government Printing Office, 261 p.

Bureau of Land Management, 2016, The Federal Land Policy and Management Act of 1976 as amended: Washington, D.C., U.S. Department of the Interior, Bureau of Land Management, 106 p.

Bureau of Reclamation, 1995, Bureau of Reclamation American Falls Resource Management Plan, Bureau of Reclamation, Pacific Northwest Region Boise, Idaho and Snake River Area Office Minidoka Project, 254 p.

Chaky, D., 2015, Fossils and the fur trade: The Chouteaus as patrons of paleontology: We Proceeded On: Lewis and Clark Trail Heritage Foundation, v. 41, no. 2, p. 12–23.

Chaney, R.W., 1959, Miocene floras of the Columbia Plateau. Part I, Composition and interpretation: Washington, D.C., Carnegie Institution of Publication, v. 617, p. 1–134.

Clemens, W.A., and Hartman, J.H., 2014, From *Tyrannosaurus rex* to asteroid impact: Early studies (1901–1980) of the Hell Creek Formation in its type area, *in* Wilson, G.P., Clemens, W.A., Horner, J.R., and Hartman, J.H., eds., Through the End of the Cretaceous in the Type Locality of the Hell Creek Formation in Montana and Adjacent Areas: Geological Society of America Special Paper 503, p. 1–87, https://doi.org/10.1130/2014.2503(01).

Clinton, W.J., 1996, Proclamation 6920—Establishment of the Grand Staircase–Escalante National Monument, *in* Peters, G., and Woolley, J.T., The American Presidency Project: Santa Barbara, California, http://www.presidency.ucsb.edu/ws/?pid=51948.

Colbert, E.H., 1984, The Great Dinosaur Hunters and Their Discoveries: New York, Dover Publications, 283 p.

Cuvier, G., 1799, Mémoire sur les espèces d'éléphans vivantes et fossiles: Mémoires de l'Institut National des Sciences et Arts, Sciences: Mathematics and Physics, v. 2, p. 1–22.

DeCourten, F., and Russell, D.A., 1985, A specimen of *Ornithomimus velox* (Theropoda, Ornithomimidae) from the terminal Cretaceous Kaiparowits Formation of southern Utah: Journal of Paleontology, v. 59, p. 1091–1099.

Department of the Interior, 1916, Earl Douglass, *in* Hesselman, G.J., ed., Decisions of the Department of the Interior in Cases Relating to the Public Lands, Volume 44: Washington, D.C., Department of the Interior, p. 325–326.

Dillhoff, R.M., Dillhoff, T.A., Dunn, R.E., Myers, J.A., and Strömberg, C.A.E., 2009, Cenozoic paleobotany of the John Day Basin, central Oregon, *in* O'Connor, J.E., Dorsey, R.J., and Madin, I.P., eds., Volcanoes to Vineyards: Geologic Field Trips through the Dynamic Landscape of the Pacific Northwest: Geological Society of America Field Guide 15, p. 135–164, https://doi.org/10.1130/2009.fld015(07).

Downs, T., 1956, The Mascall fauna from the Miocene of Oregon: University of California Publications in Geological Sciences, v. 31, p. 199–354.

Edwards, R., 2008, Why the homesteading data are so poor (and what can be done about it): Great Plains Quarterly, v. 28, p. 181–190.

Enlows, H.E., 1976, Petrography of the Rattlesnake Formation at the type area, central Oregon: Department of Geology and Mineral Industries, State of Oregon: Oil and Gas Investigations, v. 25, p. 1–34.

Famoso, N.A., and Davis, E.B., 2014, Occlusal Enamel Complexity in middle Miocene to Holocene Equids (Equidae: Perissodactyla) of North America: PLoS One, v. 9, no. 2, e90184, 11 p., https://doi.org/10.1371/journal.pone.0090184.

Famoso, N.A., Feranec, R.S., and Davis, E.B., 2013, Occlusal enamel complexity and its implications for lophodonty, hypsodony, body mass, and diet in extinct and extant ungulates: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 387, p. 211–216, https://doi.org/10.1016/j.palaeo.2013.07.006.

Foster, J.R., Titus, A.L., Winterfeld, G.F., Hayden, M.C., and Hamblin, A.H., 2001, Paleontological survey of the Grand Staircase–Escalante National Monument, Garfield and Kane counties, Utah: Utah Geological Survey Special Study, v. 97, p. 1–98.

Fremd, T.J., 2010, Guidebook: SVP Field Symposium 2010. John Day Basin Field Conference: Society of Vertebrate Paleontology, 153 p., https://scholarsbank.uoregon.edu/xmlui/handle/1794/12193.

Fremd, T.J., Foss, S.E., and Zancanella, J., 2009, Interagency management of fossil resources, *in* Foss, S.E., Cavin, J.L., Brown, T., and Kirkland, J.I., eds., Proceedings of the Eighth Conference on Fossil Resources: Salt Lake City, Bureau of Land Management, p. 29–31.

Gates, P.W., 1976, An overview of American land policy: Agricultural History, v. 50, p. 213–229.

Gates, T.A., Lund, E.K., Boyd, C.A., DeBlieux, D.D., Titus, A.L., Evans, D.C., Getty, M.A., Kirkland, J.I., and Easton, J.G., 2013, Ornithopod dinosaurs from the Grand Staircase–Escalante National Monument region, Utah, and their role in paleobiogeographic and macroevolutionary studies, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of southern Utah: Bloomington, Indiana University Press, p. 237–272.

Gates, T.A., Jinnah, Z., Levitt, C., and Getty, M.A., 2014, New hadrosaurid specimens from the lower middle Campanian Wahweap Formation of Utah, *in* Eberth, D.A., and Evans, D.C., eds., Hadrosaurs: Proceedings of the International Hadrosaur Symposium: Bloomington, Indiana University Press, p. 156–173.

Hatcher, J.B., 1901, *Diplodocus* (Marsh): Its osteology, taxonomy, and probable habits, with a restoration of the skeleton: Memoirs of the Carnegie Museum, v. 1, no. 1, p. 1–63.

Hedeen, S., 2008, Big Bone Lick: The Cradle of American Paleontology: Lexington, University Press of Kentucky, 182 p.

Hunt, R.M., and Stepleton, E., 2004, Geology and paleontology of the upper John Day beds, John Day River Valley, Oregon: Lithostratigraphic and biochronologic revision in the Haystack Valley and Kimberly areas (Kimberly and Mt. Misery quadrangles): Bulletin of the American Museum of Natural History, no. 282, p. 1–90, https://doi.org/10.1206/0003-0090(2004)282<0001:GAPOTU>2.0.CO;2.

Interagency Working Group on Scientific Collections, 2009, Scientific Collections: Mission-Critical Infrastructure of Federal Science Agencies: Washington, D.C., Office of Science and Technology Policy, 49 p.

Jaffe, M., 2000, The Gilded Dinosaur: The Fossil War between E.D. Cope and O.C. Marsh and the Rise of American Science: New York, Crown Publishers, 424 p.

Jefferson, T., 1788, Notes on the State of Virginia: Philadelphia, Prichard and Hall, 244 p.

Jefferson, T., 1799, A memoir on the discovery of certain bones of a quadruped of the clawed kind in the western parts of Virginia: Transactions of the American Philosophical Society, v. 4, p. 246–260, https://doi.org/10.2307/1005103.

Kuizon, L., 2006, Legislative and regulatory history of paleontological resources: New Mexico Museum of Natural History and Science Bulletin, v. 34, p. 102–108.

Lanham, U., 1973, The Bone Hunters: The Heroic Age of Paleontology in the American West: New York, Dover Publications, 285 p.

Leidy, J., 1856, Notices of remains of extinct reptiles and fishes, discovered by Dr. F.V. Hayden in the bad lands of the Judith River, Nebraska Territory: American Journal of Science and Arts, v. 22, p. 118–120.

Library of Congress, 2017, Most colossal animal ever on Earth just found out west: https://www.loc.gov/resource/sn83030180/1898-12-11/ed-1/?sp=33 (accessed February 2017).

Loewen, M.A., Farke, A.A., Sampson, S.D., Getty, M.A., Lund, E.K., and O'Connor, P.M., 2013a, Ceratopsid dinosaurs from the Grand Staircase of southern Utah, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah: Bloomington, Indiana University Press, p. 488–503.

Loewen, M.A., Irmis, R.B., Sertich, J.J.W., Currie, P.J., and Sampson, S.D., 2013b, Tyrant dinosaur evolution tracks the rise and fall of Late Cretaceous oceans: PLoS One, v. 8, no. 11, p. e79420, https://doi.org/10.1371/journal.pone.0079420.

Lucas, F.A., 1899, The fossil bison of North America: Proceedings of the United States National Museum, v. 21, p. 755–771, https://doi.org/10.5479/si.00963801.21-1172.755.

MacBride, T.H., 1893, A new cycad: Bulletin from the Laboratories of Natural History of the State University of Iowa, v. 2, p. 391–393.

Martin, J.E., 1983, Additions to the early Hemphillian (Miocene) Rattlesnake Fauna from central Oregon: Proceedings of the South Dakota Academy of Science, v. 62, p. 23–33.

Martin, J.E., and Fremd, T.J., 2001, Revision of the lithostratigraphy of the Hemphillian Rattlesnake units of central Oregon: PaleoBios, v. 21, p. 89.

McClaughry, J.D., Ferns, M.L., Streck, M.J., Patridge, K.A., and Gordon, C.L., 2009, Paleogene calderas of central and eastern Oregon: Eruptive sources of widespread tuffs in the John Day and Clarno Formations, *in* O'Connor, J.E., Dorsey, R.J., and Madin, I.P., eds., Volcanoes to Vineyards: Geologic Field Trips through the Dynamic Landscape of the Pacific Northwest: Geological Society of America Field Guide 15, p. 407–434, https://doi.org/10.1130/2009.fld015(20).

McDonald, H.G., and Anderson, E., 1975, A late Pleistocene vertebrate fauna from southeastern Idaho: Tebiwa, v. 18, no. 1, p. 19–37.

Merriam, J.C., Stock, C., and Moody, C.L., 1925, The Pliocene Rattlesnake Formation and fauna of eastern Oregon, with notes on the geology of the Rattlesnake and Mascall deposits: Carnegie Institution of Washington: Contributions to Palaeontology, v. 347, p. 43–92.

Muhn, J., and Stuart, H.R., 1988, Opportunity and Challenge: The Story of BLM: Washington, D.C., U.S. Department of the Interior, Bureau of Land Management, 301 p.

National Park Service, 2017, Preserving our rich fossil heritage: https://www.nps.gov/subjects/fossils/index.htm (accessed February 2017).

Office of Inspector General, 2009, Department of the Interior Museum Collections: Accountability and Preservation: Washington, D.C., Office of Inspector General, 20 p.

Osborn, H.F., 1905, *Tyrannosaurus* and other Cretaceous carnivorous dinosaurs: Bulletin of the American Museum of Natural History, v. 21, p. 259–265.

Peale, R., 1803, An Historical Disquisition on the Mammoth, or Great American Incognitum, an Extinct, Immense, Carnivorous Animal, Whose Fossil Remains Have Been Found in North America: London, E. Lawrence, 91 p.

Pinsof, J.D., 1991, A cranium of *Bison alaskensis* (Mammalia: Artiodactyla: Bovidae) and comments on fossil *Bison* diversity in the American Falls area, southeastern Idaho: Journal of Vertebrate Paleontology, v. 11, no. 4, p. 509–514, https://doi.org/10.1080/02724634.1991.10011418.

Pinsof, J.D., 1998, The American Falls local fauna: Late Pleistocene (Sangamonian) vertebrates from southeastern Idaho, *in* Akersten, W.A., McDonald, H.G., Meldrum, D.J., and Flint, M.E.T., eds., And Whereas…Papers on the Vertebrate Paleontology of Idaho Honoring John A. White, Volume 1, Idaho Museum of Natural History Occasional Paper 36, p. 121–145.

Rainger, R., 2001, The museum in America: Historical and cultural perspectives, *in* Mares, M.A., ed., The Sam Noble Oklahoma Museum of Natural History: A University Natural History Museum for the New Millennium: Norman, Oklahoma, Sam Noble Oklahoma Museum of Natural History, p. 9–26.

Rea, T., 2001, Bone Wars: The Excavation and Celebrity of Andrew Carnegie's Dinosaur: Pittsburgh, Pennsylvania, University of Pittsburgh Press, 276 p.

Retallack, G.J., Bestland, E.A., and Fremd, T.J., 2000, Eocene and Oligocene Paleosols of Central Oregon: Geological Society of America Special Paper 344, 196 p.

Ridenour, J., 1969, Depositional environments of the late Pleistocene American Falls Formation, southeastern Idaho [M.S. thesis]: Pocatello, Idaho State University, 82 p.

Roberts, E.M., Sampson, S.D., Deino, A., and Bowring, S., 2013, The Kaiparowits Formation: A remarkable record of Late Cretaceous terrestrial environments, ecosystems and evolution in western North America, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah: Bloomington, Indiana University Press, p. 85–106.

Rudwick, M.J.S., 1972, The Meaning of Fossils: Episodes in the History of Paleontology: Chicago, University of Chicago Press, 287 p.

Rytuba, J.J., and McKee, E.H., 1984, Peralkaline ash flow tuffs and calderas of the McDermitt: Journal of Geophysical Research, v. 89, p. 8616–8628, https://doi.org/10.1029/JB089iB10p08616.

Sakurai, D.S., 1994, Animal, mineral, or cultural antiquity: The management and protection of paleontological resources: Loyola of Los Angeles International and Comparative Law Review, v. 17, p. 197–243.

Sampson, S.D., Lund, E.K., Loewen, M.A., Farke, A.A., and Clayton, K.E., 2013, A remarkable short-snouted horned dinosaur from the Late Cretaceous (late Campanian) of southern Laramidia: Proceedings of the Royal Society: Biological Sciences, v. 280, https://doi.org/10.1098/rspb.2013.1186.

Samuels, J.X., and Cavin, J.L., 2013, The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon: Journal of Vertebrate Paleontology, v. 33, no. 2, p. 448–454, https://doi.org/10.1080/02724634.2013.722155.

Samuels, J.X., and Zancanella, J., 2011, An early Hemphillian occurrence of *Castor* (Castoridae) from the Rattlesnake Formation of Oregon: Journal of Paleontology, v. 85, p. 930–935, https://doi.org/10.1666/11-016.1.

Samuels, J.X., Albright, L.B., III, and Fremd, T.J., 2015, The last fossil primate in North America, new material of the enigmatic *Ekgmowechashala* from the Arikareean of Oregon: American Journal of Physical Anthropology, v. 158, p. 43–54, https://doi.org/10.1002/ajpa.22769.

Santucci, V.L., and Ghist, J.M., 2014, Fossil Cycad National Monument: A history from discovery to deauthorization: Dakoterra, v. 6, p. 82–93.

Scharf, J.T., 1879, History of Maryland from the Earliest Period to the Present Day: Hatboro, Pennsylvania, Tradition Press, 635 p.

Seligman, A.N., Bindeman, I.N., McClaughry, J., Stern, R.A., and Fisher, C., 2014, The earliest low and high $\delta^{18}O$ caldera-forming eruptions of the Yellowstone plume: Implications for the 30–40 Ma Oregon calderas and speculations on plume-triggered delaminations: Frontiers in Earth Science, v. 2, p. 1–9, https://doi.org/10.3389/feart.2014.00034.

Semonin, P., 2000, American Monster: How the Nation's First Prehistoric Creature Became a Symbol of National Identity: New York, New York University Press, 482 p.

Simpson, G.G., 1942, The beginnings of vertebrate paleontology in North America: Proceedings of the American Philosophical Society, v. 86, no. 1, p. 130–188.

Simpson, G.G., 1943, The discovery of fossil vertebrates in North America: Journal of Paleontology, v. 17, no. 1, p. 26–38.

Simpson, G.G., and Tobien, H., 1954, The rediscovery of Peale's Mastodon: Proceedings of the American Philosophical Society, v. 98, no. 4, p. 279–281.

Stratton, A.E., Tapanila, L., and Stratton, J.H., 2014, Collecting history of vertebrate fossils at American Falls, Idaho: A reservoir of data to inform land-use policy: Palaios, v. 29, p. 393–400, https://doi.org/10.2110/palo.2013.131.

Titus, A.L., Roberts, E.M., and Albright, L.B., III, 2013, Geologic overview, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah: Bloomington, Indiana University Press, p. 13–41.

Titus, A.L., Eaton, J.G., and Sertich, J., 2017, Late Cretaceous stratigraphy and vertebrate faunas of the Markagunt, Paunsaugunt, and Kaiparowits plateaus, southern Utah: Geology of the Intermountain West, v. 3, p. 229–291.

Turner, G., 1799, Memoir on the extraneous fossils, denominated mammoth bones: Principally designed to shew, that they are the remains of more than one species of non-descript animal: Transactions of the American Philosophical Society, v. 4, p. 510–518, https://doi.org/10.2307/1005126.

Tweet, J.S., Santucci, V.L., and McDonald, H.G., 2016, Name-bearing fossil type specimens and taxa named from National Park Service areas: New Mexico Museum of Natural History and Science Bulletin, v. 73, p. 277–288.

United States v. Ben Diaz, 1974, United States Ninth Circuit Court of Appeals: 499 F2d 113 74-1177.

United States v. William R. Smyer and Byron R. May, 1979, United States Tenth Circuit Court of Appeals: 596 F2d 939 78-1134, 78-1135.

Utley, R.M., and Mackintosh, B., 1989, The Department of Everything Else: Highlights of Interior History: Washington, D.C., United States Department of the Interior, 57 p.

Ward, L.F., 1899, Cretaceous formation of the Black Hills as indicated by the fossil plants: U.S. Geological Survey Annual Report, v. 19, p. 521–958.

Warren, J.C., 1852, The Mastodon Giganteus of North America: Boston, John Wilson and Son, 219 p., https://doi.org/10.5962/bhl.title.62016.

Warren, L., 1998, Joseph Leidy: The Last Man Who Knew Everything: New Haven, Connecticut, Yale University Press, 303 p.

Weishampel, D.B., and Jensen, J.A., 1979, *Parasaurolophus* (Reptilia: Hadrosauridae) from Utah: Journal of Paleontology, v. 53, no. 6, p. 1422–1427.

White, C.A., 1991, A History of the Rectangular Survey System: Washington, D.C., Bureau of Land Management, 774 p.

Wieland, G.R., 1916, American Fossil Cycads: Volume 2 Taxonomy: Carnegie Institute Publication, v. 34, 407 p.

Wieland, G.R., 1937, Fossil Cycad National Monument: Science, v. 85, no. 2203, p. 287–289, https://doi.org/10.1126/science.85.2203.287.

Wieland, G.R., 1938, Our national monuments: Science, v. 87, no. 2246, p. 37–39, https://doi.org/10.1126/science.87.2246.37.

Wieland, G.R., 1945, The Yale cycadeoids: Science, v. 102, no. 2655, p. 513–514, https://doi.org/10.1126/science.102.2655.513-a.

Williams, G.W., 2005, The USDA Forest Service—The First Century: Washington, D.C., U.S. Department of Agriculture Forest Service Office of Communication, 156 p.

Zanno, L.E., and Sampson, S.D., 2005, A new oviraptorosaur (Theropoda, Maniraptora) from the Late Cretaceous (Campanian) of Utah: Journal of Vertebrate Paleontology, v. 25, no. 4, p. 897–904, https://doi.org/10.1671/0272-4634(2005)025[0897:ANOTMF]2.0.CO;2.

Zanno, L.E., Loewen, M.A., Farke, A.A., Kim, G., Claessens, L.P.A.M., and McGarrity, C.T., 2013, Late Cretaceous theropod dinosaurs of southern Utah, *in* Titus, A.L., and Loewen, M.A., eds., At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah: Bloomington, Indiana University Press, p. 504–525.

Manuscript Accepted by the Society 21 November 2017
Manuscript Published Online 6 July 2018