PRESERVING FOSSILS IN THE NATIONAL PARKS: A HISTORY

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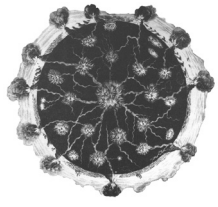

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ABSTRACT

The fossil record preserved throughout the National Park Service spans more than a billion years and is documented in at least 267 park units. The discovery, collection, study, and resource management of fossils from localities which are currently within parks sometimes predate the establishment of the National Park Service and many of the parks. Public education and interpretation at parks such as Agate Fossil Beds and Tule Springs Fossil Beds national monuments and many other designated areas include information on the rich history of paleontological field work by notable paleontologists undertaken prior to the areas being preserved as national park areas. Another important historical aspect for several dozen parks involves the conservation efforts undertaken by the public and interest groups to preserve and protect these important fossil localities. The evolution of the science and methodologies in paleontology is reflected in the resource management undertaken by the National Park Service and documented in park resource management records and archives, scientific publications, and agency policy. Today the National Park Service celebrates fossils by coordinating the National Fossil Day partnership which helps to promote the scientific and educational value of fossils.

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1. INTRODUCTION

The history of paleontology is filled with fascinating accounts of discovery and scientific inquiry, and an evolving understanding of ancient life forms preserved within Earth's geologic strata. A portion of this paleontological story is preserved within national parks, monuments and other administered areas under the care of the U.S. National Park Service. Collectively, at least 267 national park units have revealed fossilized remains and traces of prehistoric animals and plants as evidence of America's rich paleontological heritage. Seventeen National Park Service areas were established through authorizing legislation or proclamation that specifically references paleontological resources.

The history of paleontology associated with the National Park Service actually predates the establishment of the first federal parks and the creation of the bureau which administers these parks. Therefore, this publication considers many sources of historical information pertaining to fossils from either a geologic or cultural resource context to our national parks. This includes fossil occurrences from archeological sites which may date from hundreds to thousands of years ago. For example, projectile points produced from petrified wood have been documented from archeological sites in a number of parks, including Chaco Culture National Historical Park, New Mexico, and Petrified Forest National Park, Arizona. In addition to fossils that have been documented in archeological sites, fossils also occur within the building stones of historic structures, and in various historic or ethnographic contexts (Kenworthy and Santucci 2006).

The information presented in this publication is organized chronologically into six time periods reflecting the historic significance of the National Park Service paleontological resources. These divisions are: 1) 'Pre-Columbian Period' (pre-1492 AD); 2) 'Colonial & Early National Period' between first European settlement in the New World through the end of the eighteenth

century (1492–1800); 3) 'Antebellum through American Civil War Period' between the beginning of the nineteenth century to the end of the American Civil War (1800–1865); 4) 'Early National Parks & Monuments Period' between the end of the American Civil War through the establishment of the National Park Service (1865–1916); 5) 'First 50 Years of the National Park Service Period' between the establishment of the National Park Service and its 50th anniversary (1916–1966); and, 6) 'Second 50 Years of the National Park Service Period' between the 50th and the 100th anniversary (Centennial) of the National Park Service (1966–2016).

A long list of distinguished paleontologists, scientists and other notable figures accompanies the history of paleontology associated with the National Park Service. During the nineteenth century, Joseph Leidy (Academy of Natural Sciences and University of Pennsylvania), Othniel Charles Marsh (Yale University), Edward Drinker Cope (University of Pennsylvania), Spencer Baird (Smithsonian Institution), Charles Doolittle Walcott (Smithsonian Institution and U.S. Geological Survey), John Wesley Powell (U.S. Geological Survey), and others were involved in the field collection, scientific study, or curation of important fossils from areas now managed by the National Park Service. These paleontologists are just a small sample of the famous scientists who were directly involved with fossil research and discoveries from parks during the twentieth and early twenty-first centuries.

This summary represents the first attempt to compile the collective histories of paleontology for the U.S. National Park Service. Given the rich and extensive history of paleontology associated with at least 267 national parks, it is not possible to present in-depth discussions for any particular park, discovery, individual or historical event. The primary intent here is to provide a framework for organizing and presenting the extensive amount of historical information and to illustrate some of the significant paleontological history tied to National Park Service fossils.

2. PRE-COLUMBIAN PERIOD (LATE PLEISTOCENE TO 1492)

The question of how far back in time to begin a historical review of paleontology and the national parks is worth consideration. In the broadest sense and interpretation, the study of paleontology is a human undertaking involving fossils. In North America, there is evidence of human interactions with fossils that date back thousands of years. Archeological discoveries demonstrate and document the use of paleontological specimens by prehistoric Native Americans. Projectile points manufactured from petrified wood and tools fashioned from fossil bones or shells are not uncommon in the archeological record. Fossils used to produce what appears to be jewelry, effigies and spiritual objects are contained in archeological collections, including collections maintained by the National Park Service (Kenworthy and Santucci 2006).

This historical overview of National Park Service paleontology includes information which extends back to the earliest evidence of humans in North America during the Late Pleistocene. One of the oldest well-dated records of humans in North America, referred to as 'Arlington Springs Man', was found on Santa Rosa Island which is part of Channel Islands National Park, California (Orr 1962). There is a wealth of scientific literature concerning archeological sites in North America that yield evidence of interactions between Paleoindians and Late Pleistocene megafauna (Haynes 1966; Agenbroad 1980; Fisher 1984, 1987; Fox *et al*. 1992; Hoppe 2004). The decision to include fossils from archeological sites, exhibiting use or alteration by humans, in this paper is based on several factors. First, these specimens preserve interesting and important historic information pertaining to fossils which may be useful in research or public education. Additionally, the presentation of this information may result in other investigators recognizing, documenting and reporting on similar occurrences of fossils which show evidence of human use or alteration. Finally, the intent of this paper is to establish a comprehensive framework for future study related to the history of National Park Service paleontology and thus the widest scope of potential sources of data and information has been included. Therefore, this section titled 'Pre-Columbian Period' is inclusive of information which spans between the first

migrations of humans into the New World sometime during the Late Pleistocene until the arrival of European explorers in the late fifteenth century.

2.1 Fossils discovered in an archeological context

Kenworthy and Santucci (2006) presented an inventory of paleontological resources within cultural resource contexts documented from National Park Service areas. Relevant occurrences exist throughout the United States and take many forms. A number of parks in the Four Corners area of the American Southwest maintain collections of fossils, primarily petrified wood, which exhibit evidence of use or modifications by humans. Many of these specimens were obtained through archeological surveys undertaken in parks including: Canyon de Chelly National Monument and Petrified Forest National Park in Arizona; Mesa Verde National Park in Colorado; and Aztec Ruins National Monument, Bandelier National Monument, Chaco Culture National Historical Park and Salinas Pueblo Missions National Monument in New Mexico.

Humans have been present in the American Southwest for at least 12,000 years (Haynes 1969; Martin 1973; Meltzer 1983; Hurt 1990). Thousands of individual specimens of human-modified petrified wood have been collected from National Park Service areas in the Four Corners area. The National Park Service curatorial records associated with these collections identify the petrified wood artifacts as projectile points, scrapers, bifaces, knives, flakes, cores, gravers, burins, drills, hammerstones, choppers, pecking stones, abraders, polishing stones, and debitage (Tweet *et al*. 2009). A few ornamental or ceremonial objects made from fossils are also within the collections of the southwestern parks, including pendants from Aztec Ruins National Monument and Petrified Forest National Park, a bracelet from Chaco Culture National Historical Park; and effigies carved into fossil invertebrates including a bird effigy carved into a fossil brachiopod from Salinas Pueblo Missions National Monument (Hayes *et al*. 1981) (Figure 1).

Figure 1. Bird effigy carved into a fossil brachiopod from Salinas Pueblo Missions National Monument, New Mexico. Specimen in the National Park Service collections at the Western Archeological and Conservation Center. (Photograph by J. Tweet)

Similar pre-Columbian artifacts made from fossils have been documented from National Park Service areas in the central portion of the United States. Hopewell Culture National Historical Park, Ohio, has collections of fossil shark teeth and other fossils discovered in the mortuary offerings of prehistoric Native Americans. Thirteen fossil shark teeth are believed to have been incorporated into a necklace. Age dating of these archeological resources indicates these artifacts date between 200 BC to AD 500, during the Middle Woodland period. At Effigy Mounds National Monument, Iowa, a collection of crinoid columnals were discovered in a rockshelter. These fossil remains suggest the crinoids were used as jewelry objects by prehistoric Woodland Period Indians (Hunt *et al*. 2008).

George Washington Birthplace National Monument, Virginia, is an example of an eastern park which preserves pre-Columbian occurrences of fossils showing evidence of humans being aware of these resources and possibly handling or using them in some manner. Fossil shark teeth have been documented in direct association with shell middens at the monument. The middens date to the Late Archaic (approximately 5,000–3,200 years before present), Middle Woodland (approximately 2,500–1,100 years before present), and Late Woodland (approximately 1,100–400 years before present) periods. Fossil shark teeth are commonly found in the Calvert Formation (Miocene) which is exposed in the monument (R. Morawe, personal communication, 2005).

The documentation of fossils associated with pre-Columbian humans may provide evidence of long-distance transport and trade between prehistoric cultures. Many fossil taxa have limited geographic occurrences. The discovery of fossils in geographic areas which are far from the geologic strata in which the fossils were preserved may yield important historic and archeological information about ancient populations and their activities. Fossil *Glycymeris* (clam) shells found at Snaketown, an archeological site at Hohokam Pima National Monument, Arizona, are believed to have been procured from the Gulf of Mexico (Haury 1976).

3. COLONIAL AND EARLY NATIONAL PERIOD (1492–1800)

This period spans from the earliest sustained exploration of the New World by Europeans (1492) through the end of the eighteenth century. This portion of American history encompasses the exploration, colonialization, conflict, independence, birth and early organization of a new nation. This period extends up to the eve of the presidency of Thomas Jefferson and significant fossil discoveries on lands that would later be managed by the National Park Service.

3.1 The first published fossils from the New World

Long before the United States was an independent country and even longer before there was a US National Park Service, a remarkable fossil story was unfolding during the colonial period. During the late seventeenth century, fossils were collected from the bluffs and cliffs along the James and York rivers, lands which would later be included within Colonial National Historical Park. The fossils were shipped back to Europe for sale to collectors of natural history objects and some were eventually curated into European museums and other institutions. Information about this early fossil collecting was discovered while conducting research to gather baseline paleontological resource data for the national parks in the Eastern Seaboard states and the Atlantic Coastal Plain. These fossils hold an important place in the history of American paleontology.

The fossil-rich strata of the Virginia Coastal Plain and the shell beds along the cliffs of the James River, not far from colonial Jamestown, were well known to the local English settlers. These fossil beds (Pliocene Yorktown Formation) were a source of lime for producing mortar used in construction and are referenced in documents prepared by William Strachey, the first secretary of Jamestown, and by early naturalists John Banister and John Clayton (Ray 1983). Fossils and other natural history specimens were often collected by cartographers and seamen as objects to bring back to Europe to sell to naturalists or private collectors (Kenworthy and Santucci 2003).

The fossil mollusks from the Virginia coastline and James River came to the attention of English naturalist and physician Martin Lister. In 1687, Lister published an illustration of one of the Yorktown Formation bivalve fossils (*Pecten*) in *Historiae Conchyliorum* (Lister 1687; Ward and Blackwelder 1975; Ray 1987; Tweet *et al.* 2014). The significance of Lister's 1687 publication is likely more historic than scientific, as this work represents not only the first figured fossil specimen from a national park, but also the first figured fossil from America, the New World, and the Western Hemisphere (Figure 2)!

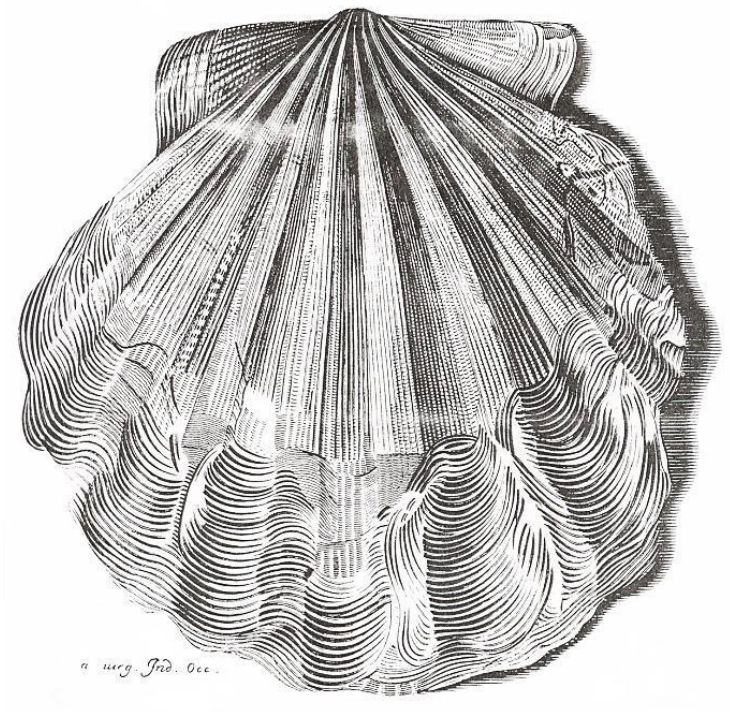

Figure 2. Martin Lister's 1687 illustration of a fossil shell later known as Chesapecten jeffersonius*, as reproduced in Ward and Blackwelder (1975).*

During the aftermath of the American Revolution, the fossils from along the James River and the Yorktown Battlefield area (later to become part of Colonial National Historical Park) continued to draw the attention of scientifically minded soldiers on both sides of the conflict. American General Benjamin Lincoln, who served at the siege of Yorktown, reported the presence of fossilized cockles (bivalves), clams, and other shells in several different layers exposed in the steep banks (Lincoln 1783). The German naturalist Johann David Schöpf, who served as a physician for the British Hessian troops, visited Yorktown in 1783 and noted the shell beds and probable fragments of whale bones (Ray 1983).

An additional note of interest related to the history of paleontology is tied to Colonial National Historical Park. Thomas Say described and published on a number of invertebrate fossils from the Yorktown Formation near Colonial National Historical Park (Say 1822, 1824). In 1824 Thomas Say formally described, named and published on Lister's fossil *Pecten* originally published in 1687, and assigned the genus and species *Pecten jeffersonius* in recognition of President Thomas Jefferson's great interest in fossils (Say 1824). The genus was renamed *Chesapecten* approximately 150 years later (Ward and Blackwelder 1975), and in 1993 the Commonwealth of Virginia designated *Chesapecten jeffersonius* as the state fossil.

3.2 Mastodon tooth mystery from Ben Franklin's home in Philadelphia

A single fossil specimen in the museum collections of Independence National Historical Park, Pennsylvania, represents a little-known history about our founding fathers and their interests in fossils. Ben Franklin, Thomas Jefferson and some of their contemporaries found fossilized remains of ancient animals to be fascinating natural history curiosities during a period of intellectual enlightenment. In 1767, Benjamin Franklin received some fossilized mastodon bones and teeth collected by a western lands speculator and Indian Agent named George Groghan.

In 1953, a mastodon molar was discovered in the basement of Franklin's home on Market Street in Philadelphia. The home was built by Franklin in 1786 and today is part of the area referred to as Franklin Court within Independence National Historical Park. Franklin lived in Philadelphia while serving in the Continental Congress and the Constitutional Convention and used the home as a rental property. The mastodon tooth is the only fossil within the large museum collection for Independence National Historical Park.

4. ANTEBELLUM THROUGH THE AMERICAN CIVIL WAR PERIOD (1800–1865)

Prior to the American Civil War (1861–1865), dreams of western expansion and the vast resources west of the Mississippi River motivated the people and leaders of the young nation. The Lewis and Clark Expedition, Louisiana Purchase, Mexican War and first migrations of pioneers across the western plains were collectively part of a manifest destiny shaping America during the nineteenth century. This was a formative period for the science of paleontology with early fossil discoveries capturing the attention of naturalists, geologists, political leaders and the public. Early fossil collections were routed to the handful of notable paleontologists and were directed to early museum and university collections for study and display.

4.1 Establishment of Peale's Museum in Philadelphia

The first recognized natural history museum in the United States was established by artist and naturalist Charles Willson Peale in Philadelphia. Originally known as the Philadelphia Museum, and later named Peale's American Museum, the museum collection was located on the second floor of Independence Hall (known at the time as the Pennsylvania State House) between 1802 and 1827 (Schofield 1989). Peale's museum exhibited his paintings of political and military leaders, as well as a large collection of natural history objects including fossils and a mastodon skeleton. This is an interesting footnote in the history of National Park Service paleontology, since Independence Hall is administered by the National Park Service as part of Independence National Historic Park.

4.2 Lewis and Clark Expedition discovers fossils:

President Thomas Jefferson may well have had the Peale mastodon in mind when he commissioned Captain Meriwether Lewis and Second Lieutenant William Clark to lead the first American expedition to explore the western territories. The Lewis and Clark Expedition, also known as the Corps of Discovery, was sanctioned shortly after the Louisiana Purchase in 1803. Among Jefferson's instructions was a request to keep alert for mammoths, living or dead. The perilous journey began in May 1804 and lasted through September 1806. The expedition passed through a number of important fossil localities including Big Bone Lick, Kentucky, and the Falls of the Ohio fossil site, Indiana. Although no living mastodon was encountered, one important fossil specimen was collected from lands which would later be part of the National Park Service. This discovery was a fossilized jaw with teeth from a Cretaceous fish collected on August 1804 by a member of the Lewis and Clark Expedition. The fossil fish was discovered near Soldier's River (Harlan 1824), a tributary of the Missouri River and now a landmark along the Lewis and Clark National Historic Trail.

By the 1820s, the scientific understanding and acceptance of fossils had become more widespread and some of the first scientific descriptions of fossils from future National Park Service lands were emerging. The fossil fish jaw discovered in 1804 during the first months of the Lewis and Clark Expedition was described twenty years later and named *Saurocephalus lanciformis* in 1824 (Harlan 1824). Today this holotype fossil specimen is in the collections of the Academy of Natural Sciences in Philadelphia. This is the only known surviving fossil collected by the Corps of Discovery and is also the oldest fossil that can be reliably attributed to an area administered by the National Park Service.

4.3 Early fossil discoveries at Vicksburg

French naturalist Charles A. Lesueur is credited for the first scientific documentation of fossils from Vicksburg National Military Park, Mississippi, in 1829, but his observations were not published until after his death (Dockery 1982; Kenworthy *et al*. 2007). British geologist Charles Lyell also collected fossil shells and corals from the Vicksburg Group from an area now within Vicksburg National Military Park on 19 March 1846 (Lyell 1849).

4.4 Mountain man Jim Bridger's claims of "peetrified trees" in Yellowstone

It has been proposed that mountain man Jim Bridger's report of the fossil forests of Yellowstone during the 1830s represents the first encounters of these resources by an American explorer. Bridger's accounts of Yellowstone's fossil forest were embellished by him and others as they were passed down over the years, but they provided an interesting example of the cultural history associated with these paleontological resources. According to one version of Bridger's tale,

> . . . peetrified birds a sittin' on peetrified trees a singin' peetrified songs in the peetrified air. The flowers and leaves and grass was peetrified, and they shone in a peculiar moonlight . . . that was peetrified too (Chapman and Chapman 1935, p. 383).

These colorful legends captured the attention of other explorers who journeyed into Yellowstone later in the century.

4.5 Early fossil discoveries in the White River Badlands

One of the most important and interesting historical stories tied to National Park Service paleontology involves early collecting of fossils in the '*mauvaises terres*' or 'badlands' of the Dakota Territory starting in the 1840s. The area is also referred to as the White River Badlands and has come to be known for the globally significant paleontological resources from the Eocene and Oligocene epochs of North America. The report and publication of fossil vertebrates from these prehistoric hunting grounds are linked to the birth of vertebrate paleontology as a science in North America. Some of the historically and scientifically important fossil localities in the White River Badlands are found today within Badlands National Park, South Dakota.

In 1843, a fossilized lower jaw with molars was collected in the badlands by a fur trader named Alexander Culbertson of the American Fur Company. This fossil specimen was transported back to St. Louis and into the hands of a physician named Dr. Hiram A. Prout (Figure 3). In 1846, Prout published a description and illustration of the jaw in the *American Journal of Science*, referring to the specimen as '*Palaeotherium*' based on a European fossil mammal which appeared similar (Prout 1846). The publication of 'Prout's specimen' captured the attention of the small community of paleontologists in the United States at that time, including Joseph Leidy (Academy of Natural Sciences, Philadelphia) and Spencer Baird (Dickinson College and Smithsonian Institution), prompting the first wave of a 'fossil rush' in the American west.

Figure 3. Lower jaw referred to as 'Prout's Palaeotherium Specimen' collected by fur trader Alexander Culbertson from the White River Badlands in 1843. USNM 21820. (Photo – Vincent Santucci).

Additional fossils collected by Alexander Culbertson were studied and described by Dr. Joseph Leidy including the skull of the camel *Poebrotherium* (Leidy 1847). Leidy has been considered the 'Father of Vertebrate Paleontology in North America' and studied White River Badlands fossils early in his career. A series of geology and paleontology surveys ventured into the Dakota Badlands beginning with John Evans's scientific expedition in 1849. Alexander Culbertson's brother Thaddeus was hired by Spencer Baird to collect White River Badlands fossils for him while he was a professor at Dickinson College in Pennsylvania. With Baird's move to the Smithsonian, the fossils were also forwarded to Washington, D.C. Field parties led by Ferdinand Vandiveer Hayden and Fielding Bradford Meek during the 1850s resulted in additional collections of fossil vertebrates (O'Harra 1920; Benton *et al*. 2015).

Joseph Leidy described many of the new fossils coming out of the Dakota Territory, (O'Harra 1920; Benton *et al*. 2015). By 1854, Joseph Leidy had named 84 new species of fossil vertebrates from North America; all but seven were based on fossils collected in the White River Badlands (Leidy 1853, 1869; Benton *et al*. 2105).

Faculty and students from the South Dakota School of Mines and Technology in Rapid City, South Dakota, have a long history of geology and paleontology field work in the White River Badlands dating back to 1899, and its Museum of Geology maintains one of the largest and most diverse collections of fossils from the Badlands acquired over more than a century of fieldwork. Similar fossils of mammals and turtles were observed by pioneers traveling the emigrant trail passing Scott's Bluff (today within Scotts Bluff National Monument, Nebraska) during the middle 1840s.

4.6 Reports of fossils during surveys in the southwestern territories

The first expeditions in the southwestern part of America began shortly after the end of the Mexican-American War of 1846–1848. The first plant fossil collected for scientific purposes in the Southwest was recovered from Canyon de Chelly by a military expedition led by Lieutenant J. H. Simpson on 5 September 1849 (Simpson 1852), likely within the modern boundaries of Canyon de Chelly National Monument. The expedition led by Captain Lorenzo Sitgreaves is credited with the first documentation of the petrified wood from within a few miles of the 'Arizona Petrified Forest' on 9 September 1851. A federal government expedition led by

Lieutenant Amiel W. Whipple named Lithodendron Creek in December 1853 (located today within Petrified Forest National Park) (Ash 1972).

4.7 Reports of fossils from Alaska

One of the earliest historical accounts of fossil collecting in Alaska dates back to the 1850s, prior to the United States' purchase of Alaska from Russia on 30 March 1867. Russian explorer and mining engineer Peter Doroschin made significant collections of fossils from a locality in south-central Alaska along the coast near Tuxedni Bay. This important locality was later named Fossil Point and today is within the boundaries of Lake Clark National Park & Preserve. Doroschin's fossil collections were shipped to the Russian capital at St. Petersburg where they were ultimately studied, described and illustrated by Russian paleontologist Eduard von Eichwald (Eichwald 1871). The rich and well-preserved Middle Jurassic marine invertebrate fauna from Fossil Point, recognized during the mid-nineteenth century when the area was part of Russian America, has continued to be the focus of scientific evaluation (Stanton and Martin 1905; Martin 1926; Imlay 1964; Detterman and Hartsock 1966; Blodgett and Santucci 2014; Blodgett *et al*. 2015).

4.8 Report of fossils from the western territories

Benjamin Franklin Shumard, like Hiram Prout, was another prominent member of the St. Louis scientific circle. He is noted for his geological publications during the 1850s. Shumard worked in several areas now designated as national parks including: Santa Fe National Historic Trail, Guadalupe Mountains National Park, and Mississippi National River & Recreation Area. Shumard was one of the organizers involved with the first government-sponsored geological surveys, at the state, territory, and federal levels. This group also included David Dale Owen, James Hall, Fielding Bradford Meek, and Ferdinand Vandiveer Hayden, and were particularly active during the 1850s. These geologists documented the rocks and fossils of many midwestern and southwestern parks. In addition to Badlands National Park, Guadalupe Mountains National Park, Mississippi National River & Recreation Area, and Santa Fe National Historic Trail, they worked in the Missouri National Recreational River, Niobrara National Scenic River, and St. Croix National Scenic River during the pre-Civil War expeditions. Owen and Shumard died during the 1860s, but the others remained active into the 1870s.

4.9 Early dinosaur discovery at Springfield Armory

The first report of a dinosaur fossil associated with a National Park Service unit dates to the 1850s. In 1855, blasting for the Water Shops at Springfield Armory in Massachusetts (now Springfield Armory National Historic Site) uncovered the remains of a small Lower Jurassic dinosaur (Santucci 1998a). The remains were sent to Edward Hitchcock, the pioneering paleoichnologist and president of Amherst College, and were described by his son Edward Jr. as *Megadactylus polyzelus* in 1865 (Hitchcock 1865). Taxonomic revision of the specimen from Springfield Armory resulted in the assignment of the genus *Anchisaurus* (Tweet and Santucci 2011).

4.10 Mammoth remains discovered on the Channel Islands

A single mammoth tooth and a poorly preserved tusk were discovered on Santa Rosa Island, California, by W. G. Blunt in 1856 (Stearns 1873). Blunt was involved with a geodetic survey of the Channel Islands between 1853 and 1856 (Roth 1996). This represents the earliest report of mammoth remains from the Channel Islands, which is now a unit of the National Park Service. The mammoth tooth was given to the California Academy of Sciences and it was determined later that the mammoth remains on the Channel Islands were pygmy mammoths (Agenbroad 1998).

4.11 Reports of fossils on the southern Colorado River

During the 1857–1858 J. C. Ives expedition along the Colorado River, John Strong Newberry discovered the first fossils from the area which is now within Lake Mead National Recreation Area, Nevada. Newberry (1861) reported finding a single mammoth tooth at the base of a hill on the east side of the Colorado River (today the locality is along the Lake Mohave arm below Hoover Dam). The hill is now known as 'Elephant Hill' in reference to the mammoth tooth discovery. Newberry also reported reworked Paleozoic fossils in rocks observed along the Colorado River.

4.12 Union soldiers collect fossils during the Civil War

By 1861, the country was embroiled in a civil war and the focus of the people was redirected towards the national crisis and military conflict. There are a few interesting historical accounts of fossils during the American Civil War. Fort Washington Park is situated along the bank of the Potomac River south of Washington, D.C. The fort was one of the federal defenses of the capital city where Union soldiers were stationed during the war. One of the soldiers, named Valentine Sticher, wrote about life at the fort between April and July 1861, the first months of the war. There are two entries in Sticher's diary which refer to fossil collecting at Fort Washington (Thompson 1910):

> June 10, 1861, Lieutenant Nagle, Wallace, and myself went up to ravine to look for petrified shells. . . . July 11, 1861, Cambell, Atkins, and Hartz started for Washington. Weather fine. Went up ravine again; found turtle heads (folk name for *Cucullaea gigantae* fossils). [H]ard work to dig them out. Dobson, Esterly, and Judge Foster came. (Thompson 1910, p. 105).

One final Civil War period historical note involving National Park Service fossils is linked to the western explorer and U.S. Geological Survey director, John Wesley Powell. During the siege at Vicksburg, Powell collected fossils from earthworks on the battlefield (now within Vicksburg National Military Park) in 1863 while serving for the Union Army (Moring 2002).

5. EARLY NATIONAL PARKS AND MONUMENTS PERIOD (1865–1916)

This period spans from the end of the American Civil War in 1865 through the creation in 1916 of the National Park Service as a bureau within the Department of the Interior. The period is marked by a renewed interest in westward expansion and exploration of new resources and opportunities. With increasing visitation and settlement in the west, the natural landscape was becoming more modified by development, exploitation of resources and conflict with Native Americans and earlier settlers. The voices of conservation and preservation of natural and cultural resources recognized the need to protect sensitive archeological sites and natural wilderness. The establishment of Yellowstone National Park in 1872 gave birth to an idea that flourished during the beginning of the twentieth century with the passage of the Antiquities Act (1906) and the creation of the National Park Service (1916).

This post-Civil War period is a colorful time for American paleontology with some academic rivalries and competition pertaining to the new fossil discoveries from the western territories. The famous 'Bone Wars' waged between Edward Drinker Cope and Othniel Charles Marsh have become legendary tales based upon the bitter scientific feud. Other individuals worked more independently in more remote locations of the western frontier to uncover the fossilized remains of ancient organisms previously unknown. Thomas Condon is one of the pioneer paleontologists who searched for fossils in the John Day Basin (later established as John Day Fossil Beds National Monument, Oregon) beginning in the 1860s.

The history of paleontology associated with the National Park Service during this period often includes stories which predate the concept of the Service and the establishment of specific

areas as national parks. However, it is important to remember that on some occasions scientifically significant fossil localities in the American West are part of areas later designated as national parks or monuments. Once a fossil locality is transferred and incorporated into lands administered by the National Park Service, the management, protection and stewardship of the paleontological resources becomes its responsibility.

5.1 The Great Surveys of the western territories yield fossils and inspire 'America's Best Idea'

After the American Civil War, there was a renewed focus by the United States government directed towards the resources of the western territories. Congress supported the funding of a series of scientific surveys to map and document the west between 1867 and 1879. The four 'Great Surveys' of the American West were primarily focused on the territories west of the 100th meridian and were led by Dr. Ferdinand V. Hayden, Clarence King, Major John Wesley Powell, and Lt. George Wheeler (Bartlett 1980).

The U.S. Geological and Geographical Survey of the Territories was led by geologist and surgeon Dr. Ferdinand V. Hayden between 1867 and 1878. The 'Hayden Survey' was a scientific expedition which explored northwestern Wyoming including the Yellowstone region and the headwaters of the Missouri and Yellowstone rivers. Hayden recruited artist Thomas Moran and photographer William Henry Jackson to accompany the survey team into Yellowstone and visually document the resources and landscapes. These images and illustrations complemented the scientific reports and descriptions of the flora, fauna and geology of Yellowstone. In December 1871, bills were introduced in the U.S. Congress to preserve Yellowstone as a national park. On 1 March 1872, President Ulysses S. Grant signed into law the Yellowstone National Park Protection Act (17 Stat. 32) creating the world's first national park and what is considered by some 'America's Best Idea'.

The first fossil collections from the area now within Yellowstone National Park, in Wyoming, Montana and Idaho, are attributed to the Hayden Survey of 1871. The fossil leaves obtained during the expedition were studied and described by paleobotanist Leo Lesquereux (Lesquereux 1872). William Henry Holmes accompanied the Hayden Survey and was the first to report the occurrence of petrified wood near Junction Butte and in the cliffs of the Lamar River Valley, the first to interpret the existence of successively buried fossils forests in Yellowstone, and the first to report invertebrate fossils from Yellowstone (Holmes 1878, 1879). In 1878 Holmes accompanied cartographer Henry Gannett to the summit of the peak now named Mount Holmes, where they found marine fossils, including trilobites, on a ridge just below the summit that was later named Trilobite Point (Santucci 1998b).

The U.S. Geological Exploration of the Fortieth Parallel was led by civilian scientist Clarence King between 1867 and 1878. This survey was sponsored by the U.S. Army and focused on producing maps and scientific reports on the resources along the fortieth parallel from northeastern California, through Nevada, and into the eastern Wyoming Territory. King also evaluated mineral resource potential during mapping and evaluation of resources.

The U.S. Geographical Survey West of the 100th Meridian was led by First Lieutenant George Montague Wheeler between 1869 and 1879. The 'Wheeler Survey' was administered under the U.S. Army Corps of Engineers. In 1869, Wheeler's expedition visited the area now within Great Basin National Park, Nevada, and in 1871 visited areas now part of Grand Canyon National Park, Arizona, and Lake Mead National Recreation Area, Arizona and Nevada, but only small collections of fossils were made.

The U.S. Geographical and Geological Survey of the Rocky Mountain Region was led by Major John Wesley Powell between 1869 and 1879. During the Civil War Powell was involved at the siege at Vicksburg and documented fossils from some exposed strata in the fortifications trenches. Powell would become the second Director of the U.S. Geological Survey and served between 1881 and 1894.

The 'Powell Survey' was a legendary adventure down the Green and Colorado rivers and through the Grand Canyon. In 1870 Powell obtained funding from Congress to support his river

trip which started in Green River, Wyoming Territory. Powell is credited with the collection of a fossil coral specimen near Echo Park and Split Mountain Canyon, an area which is now within Dinosaur National Monument. The specimen represents the holotype specimen for the fossil coral *Amplexus zaphrentiformis* (White 1876), and it was discovered nearly half a century before the first dinosaurs were reported from the area now within Dinosaur National Monument.

5.2 Excavation of Ice Age fossils from Port Kennedy Bone Cave

Port Kennedy Bone Cave is an important Pleistocene fossil locality which was uncovered and excavated in 1870 and again in 1896. The 'cave', likely representing a sinkhole that many animals fell into, is located within what is now Valley Forge National Historical Park, Pennsylvania. More than 1,200 fossil specimens were collected during the quarrying of Port Kennedy Bone Cave and they are curated into the collections at the Academy of Natural Sciences in Philadelphia and the American Museum of Natural History in New York (Daeschler *et al*. 1993). The fossils were originally studied and described by paleontologist Edward Drinker Cope (Cope 1871, 1899; Mercer 1899). Cope named 39 species of Pleistocene vertebrates collected from Port Kennedy Bone Cave, including several well-known taxa such as *Smilodon gracilis* (saber tooth cat) and several species of *Megalonyx* (ground sloth).

5.3 Early fossil discoveries from the Florissant Fossil Beds

The diverse and exceptionally well-preserved plant and insect fossils of Florissant (the area later designated as Florissant Fossil Beds National Monument) in Colorado came to light during the early scientific surveys of the American West. In 1873, Arthur C. Peale, the geologist for the Hayden Survey, wrote

> When the mountains are overthrown and the seas uplifted, the universe at Florissant flings itself against a gnat and preserves it. (Peale 1873).

The early collections of fossils from Florissant for Princeton University in 1877 and the government surveys resulted in many scientific publications describing the fossil plants (Lesquereux 1878, 1883), fossil insects (Scudder 1890, 1900), and fossil vertebrates (Cope 1875). Between 1906 and 1908, Theodore Dru Alison Cockerell made fossil collections that resulted in nearly 130 publications on the paleontology of the Florissant Fossil Beds (Cockerell 1908a, 1908b).

5.4 Fossils discovered in the Big Bend area

The Trans-Pecos area of Texas, which would later become part of Big Bend National Park, has a long and rich history of paleontological exploration, collecting, and research. Reports of fossils from the area date back to the late 1880s with collections of fossil invertebrates and invertebrates made by the 'Dumble Survey' of 1888 (Dumble 1895). Geologist John Udden mapped, studied, and described the Cretaceous strata of the Big Bend region in 1907 (Udden 1907). Udden reported the occurrence of petrified logs and the remains of what he referred to as 'saurian bones' from the Rattlesnake Beds.

5.5 Investigation of the Bone Bed at Agate Ranch

A rich paleontological history is associated with the Agate Springs Ranch, which would later be preserved as Agate Fossil Beds National Monument, Nebraska. The ranch has sometimes been referred to as the 'Great Bone Bed at Agate' where the fossils were discovered in the 1880s by James H. Cook and his wife Kate (Cockrell 1986). The locality was visited by some of the most notable paleontologists during the late nineteenth and early twentieth centuries and helped define

the understanding of Miocene fossil vertebrates in North America. James Cook invited many paleontologists to the ranch to dig and study the fossils, including Othniel Charles Marsh (Yale University) and Edward Drinker Cope (from Philadelphia) (Vetter 2008).

James and Kate's first son, Harold James Cook, was born in 1887 and exhibited great interest in fossils from an early age. In 1892 Harold assisted paleontologist Erwin Barbour (University of Nebraska) excavate a large fossil burrow referred to as *Daemonelix*, now known to have been produced by ancient rodents (Figure 4).

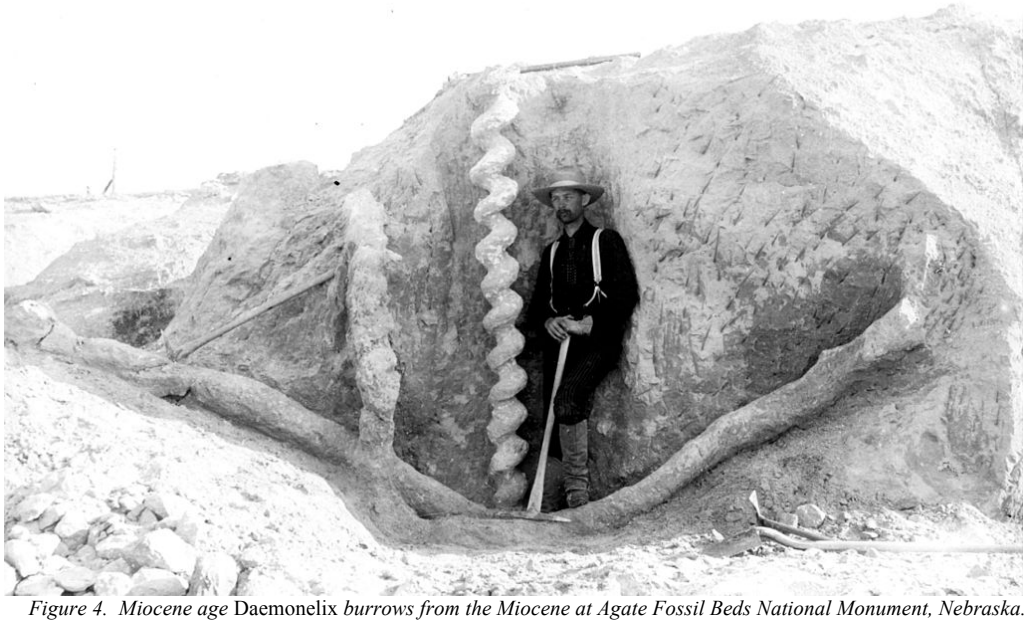

Figure 4. Miocene age Daemonelix *burrows from the Miocene at Agate Fossil Beds National Monument, Nebraska. (Photograph by James St. John - Public Domain, https://commons.wikimedia.org/w/index.php?curid=37027739. With permission from the Archives and Special Collections of the University of Nebraska-Lincoln Libraries)*

Between 1904 and 1925, the fossil hills and quarries of Agate Ranch were visited by field crews from the American Museum of Natural History, Amherst College, Carnegie Museum, University of Nebraska and Yale University (Peterson 1906; Loomis 1910; Matthew 1923). Fossil excavations yielded thousands of mostly mammal bones. Eventually, the increasing number of paleontologists working at the ranch led to some rivalry between the institutions. Harold enjoyed working with everyone and in 1905 began to work closely with Olaf Peterson from the Carnegie Museum in Pittsburgh. Harold also continued to work with Erwin Barbour from the University of Nebraska and was accepted as a student in their Geology Department in 1908 (Cockrell 1986).

In 1909, Harold was visited by paleontologist Henry Fairfield Osborn from the American Museum of Natural History in New York. Osborn offered the young Cook a research assistant position at Columbia University to study under Osborn, as well as vertebrate paleontologists William King Gregory and William Diller Matthew. In addition, Cook also met and corresponded with other distinguished paleontologists including Walter Granger, Frederic Brewster Loomis, Richard Swann Lull and William John Sinclair. The National Park Service maintains an extensive collection of archives associated with the Cook family including correspondence between the family and many of the paleontologists who visited and worked at Agate Springs Ranch.

5.6 Congress authorizes the Antiquities Act

On 8 June 1906, the Antiquities Act (Public Law 59–209) was signed into law by President Theodore Roosevelt. The law was enacted in response to the widespread looting and vandalism of

archeological sites in the American Southwest. One of the provisions of the Antiquities Act provided the president of the United States with the authority to proclaim national monuments (Santucci 2006). This authority to create national monuments does not require the support from Congress and has been used over 100 times including when Waco Mammoth National Monument was proclaimed in 2015.

5.7 Saving the Petrified Forest of Arizona

Several attempts to protect the Arizona petrified forest were undertaken by Congress during the 1890s. In 1900, Smithsonian paleobotanist Lester F. Ward published a 'Report on the Petrified Forests of Arizona' and recommended that the area needed to be protected (Ward 1900). During 1904 and 1905 conservationist John Muir traveled into the Arizona Territory with his daughter and ventured into the 'Petrified Forest' near the town of Adamana (Figure 5). Muir was both inspired by the fossil locality known as 'Chalcedony Forest' and unsettled by the wagon loads of petrified wood being hauled out. It is believed that John Muir communicated his observations and concerns about the petrified forest to his friend President Theodore Roosevelt (Lubick 1996).

Figure 5. John Muir and group examining petrified logs in an area referred to as 'First Forest' which would later be protected when Petrified Forest National Monument was established in 1906. (National Park Service photograph).

On 8 December 1906, President Theodore Roosevelt established Petrified Forest National Monument (Proclamation 697), one of the first monuments established using the Antiquities Act (Santucci 2006). The proclamation stated

> . . . the mineralized remains of Mesozoic forests, commonly known as the "Petrified Forest," in the Territory of Arizona . . . are of the greatest scientific interest and value and it appears that the public good would be promoted by reserving these deposits of fossilized wood as a national monument with

> as much land as may be necessary for the proper protection thereof . . . (Theodore Roosevelt, Presidential Proclamation 697).

5.8 Paleontologist Charles Walcott studies fossils from several national parks

One of the most famous American paleontologists is Charles Doolittle Walcott. Walcott joined the U.S. Geological Survey (USGS) in 1879 and in 1894 became its third Director, a position he held until 1907. In 1907 Walcott became the fourth Secretary of the Smithsonian Institution and served in that position until 1927. During his career, Charles Walcott either conducted fieldwork in or studied fossils which were collected from areas that would become national parks, including Death Valley National Park, Glacier National Park, Grand Canyon National Park, Grand Teton National Park, Great Smoky Mountains National Park, Ozark National Scenic Riverways, Saint Croix National Scenic Riverway, and Yellowstone National Park (Walcott 1883, 1890, 1899, 1901, 1902, 1906, 1914a, 1914b). Walcott was a strong advocate and supporter of the National Park Service during the early years of the new bureau, and in 1917 was an invited speaker at the Fourth National Park Conference (Walcott 1917).

5.9 World renowned dinosaur discoveries and the establishment of Dinosaur National Monument

During 1908 the Carnegie Museum in Pittsburgh, Pennsylvania, applied for and was granted an Antiquities Act Permit from the Secretary of the Interior to prospect and collect fossils from federal lands in Uintah County, Utah. This was the first such permit issued for fossils under the authority of the Antiquities Act, two years after the passage of the legislation by Congress. After the permit was issued in 1908, Carnegie Museum director William Holland discovered the femur of a sauropod dinosaur from the Morrison Formation near Jensen, Utah. The following year, Holland sent paleontologist Earl Douglass to continue paleontological field work in the dinosaur producing beds of northeastern Utah (Holland 1915a, 1915b, 1924; McIntosh 1977; Chure and McIntosh 1990). Excavations at the Dinosaur Quarry, sometimes referred to as the 'Douglass Quarry', continued until 1922, resulting in the collection of one the most important assemblages of dinosaur skeletons in the history of paleontology (Figure 6).

Figure 6. Carnegie Museum field crew collecting a dinosaur femur from the Douglass Quarry, which was incorporated into Dinosaur National Monument established in 1915. (National Park Service photograph).

On 4 October 1915, Dinosaur National Monument was established by President Woodrow Wilson as the second fossil park (the first was Petrified Forest National Monument) proclaimed by the Antiquities Act. According to the proclamation the monument was established to preserve

> . . . an extraordinary deposit of Dinosaurian and other gigantic reptilian remains of the Jurassic period, which are of great scientific interest and value, and it appears that the public interest would be promoted by reserving these deposits as a National Monument, together with as much land as may be needed for the protection thereof. (Woodrow Wilson, Presidential Proclamation 1313).

5.10 Discovery and excavation of the Cumberland Bone Cave

During 1912, an important fossiliferous cave deposit was discovered during construction of the Western Maryland Railway. Excavation of a cut in a ridge near Cumberland, Maryland, exposed fossil bones which were brought to the attention of a local naturalist named Raymond Armbruster. Paleontologist James Gidley at the Smithsonian Institution was notified and visited this fossil locality, given the name Cumberland Bone Cave. Gidley supervised excavation of Cumberland Bone Cave between 1912 and 1916. Forty-one genera of mammals were originally identified from within the cave deposits, many representing extinct Pleistocene fauna including saber-tooth cat and cave bear specimens (Gidley 1913; Gidley and Gazin 1938). Today the area which was part of the Cumberland Bone Cave is along the Potomac Heritage National Scenic Trail near Cumberland, Maryland.

6. FIRST 50 YEARS OF THE NATIONAL PARK SERVICE PERIOD (1916–1966)

This historic period begins with the establishment of the National Park Service in 1916 through the 50th anniversary of the bureau in 1966. The National Park Service Organic Act was signed into law by President Woodrow Wilson on 25 August 1916, creating the National Park Service, as a new federal bureau in the Department of the Interior. The legislation included the following language which serves as the purpose of the National Park Service:

> . . . to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. (National Park Service Organic Act, 54 U.S.C. § 100101 *et seq*.).

In addition to the creation of the National Park Service and its first 50 years, this historic period included two world wars, the Great Depression and post-war globalization extending to the 50th anniversary of the National Park Service in 1966.

6.1 Establishment of Zion National Monument recognized fossils

On 18 March 1918, Zion National Monument, Utah, was proclaimed by President Woodrow Wilson. According to the proclamation the significance of Zion was described by the following text:

> The geologic features include craters of extinct volcanoes, fossiliferous deposits of unusual nature, and brilliantly colored strata of unique composition, among which are some believed to be the best representatives in the world of a rare type of sedimentation . . . the features of geographic interest include a labyrinth of remarkable canyons with highly ornate and beautifully colored walls, in which are plainly recorded the geologic events of past ages . . . (Woodrow Wilson, Proclamation 1435).

The monument was redesignated a national park on 19 November 1919 through a complex series of legislative actions.

6.2 Charles Sternberg visits Chaco Canyon National Monument

During June 1921, the famous commercial fossil collector Charles Sternberg and his assistant John Bender visited Chaco Canyon National Monument (proclaimed in 1907). The monument was redesignated Chaco Culture National Historical Park in 1980. Sternberg discovered and collected some large fossil bivalves known as inoceramids. Sternberg unsuccessfully tried to sell the fossils to Dr. Carl Wiman at the University of Uppsala in Sweden. In a letter written by Sternberg to Dr. Wiman on 11 July 1921, referencing specimens for sale, he stated, "I found a fine locality at Pueblo Bonita [in the monument], where I got some fine *Inoceramus* shells" (Hunt *et al*. 1992, letter 2 appendix 1—Sternberg 1932). Wiman declined to purchase the shells as he apparently was only interested in vertebrate fossils.

6.3 Establishment and deauthorization of Fossil Cycad National Monument

On 21 October 1922, President Warren G. Harding proclaimed Fossil Cycad National Monument in the Black Hills of South Dakota (Proclamation 1641) as the third national monument established based on its fossil resources. The fossil locality preserved hundreds of Cretaceous cycadeoid specimens, possibly the world's greatest concentrations of these fossil plants (Figure 7). Although established as a unit of the National Park Service, the monument was not actively managed. Years of negligent management at the monument resulted in irreparable impacts on the finite and scientifically significant paleobotanical resources. Fossils exposed on the monument's surface were collected faster than erosion could expose other specimens from beneath. The loss of the exposed petrified plant remains eventually left the site devoid of fossils and ultimately without a purpose to justify its existence as a unit of the National Park Service. On 1 September 1957, the U.S. Congress voted to deauthorize Fossil Cycad National Monument (Santucci and Hughes 1998; Santucci and Ghist 2014).

Figure 7. Yale paleobotanist George Wieland supervising the excavation of fossil cycads by members of the Civilian Conservation Corps at Fossil Cycad National Monument. (National Park Service photograph).

6.4 Charles Gilmore documents fossil vertebrate tracks at Grand Canyon National Park

In 1924, the National Park Service invited Smithsonian paleontologist Charles Gilmore to examine Upper Paleozoic vertebrate tracks at Grand Canyon National Park, Arizona. Gilmore documented and collected fossil tracks from the Wescogame Formation of the Supai Group (Pennsylvanian), the Hermit Shale (Permian) and Coconino Sandstone (Permian). These fossil tracks were described by Gilmore in a series of publications during the late 1920s (Gilmore 1926, 1927, 1928). Gilmore also assisted with the design and construction of an *in situ* fossil track exhibit along the Hermit Trail which is no longer maintained.

6.5 Establishment of Badlands National Monument

After a decade-long effort, Badlands National Monument, South Dakota, was authorized on 4 March 1929 as a unit of the National Park Service. The authorizing act (Public Law 1021, codified at 16 U.S.C. § 441 - 441o) was signed by President Calvin Coolidge on the last day of his term as President of the United States. The area included in the monument preserved extremely fossiliferous strata from the Eocene and Oligocene epochs commonly referred to as the White River Badlands by early explorers and fossil collectors. The monument was not officially established until 25 January 1939 and was later redesignated as a national park in 1978. Section 4.5 of this paper provides additional historical information pertaining to the paleontology of Badlands National Park.

6.6 Paleontological localities evaluated as potential national monuments but never authorized

During the first 50 years of the National Park Service's history, many natural and cultural areas were evaluated as potential national parks or monuments. The list of proposed new areas included a number of paleontological localities, such as: Mastodon National Monument, New Mexico; Red Rock Canyon (including the Petrified Cocoanut Grove) National Monument, California; States Red Mountain Coal Mine (dinosaur tracks) National Monument, Colorado; Glen Rose Dinosaur Tracksite National Monument, Texas; Irvington Fossil Deposit National Monument, California; Rancho La Brea (Tar Pits) National Monument, California; Sharktooth Hill National Monument, California; Gingko Petrified Forest National Monument, Washington; Esmeralda Petrified Forest National Monument, Nevada; and Calistoga Petrified Forest National Monument, California. Although these proposed fossil monuments were never authorized as National Park Service Areas, many would later be established as National Natural Landmarks.

6.7 Civilian Conservation Corps supports paleontology projects in national parks

President Franklin D. Roosevelt's New Deal included a public work relief program known as the Civilian Conservation Corps that existed between 1933 and 1942. The Civilian Conservation Corps was designed to create jobs during the Great Depression in the United States which involved the conservation and development of natural resources and it played an important role in the development of many early national parks and monuments (Paige 1985). Civilian Conservation Corps workers assisted with paleontology projects in several National Park Service areas including Badlands National Park, Big Bend National Park, Grand Canyon National Park, Fossil Cycad National Monument and several other parks. The projects included the development of interpretive exhibits and support for fossil excavations, collection, and research.

6.8 Donald Curry and fossil discoveries at Death Valley National Monument

On 11 February 1933, President Herbert Hoover, the only U.S. president formally trained as a geologist, proclaimed Death Valley as a national monument (Proclamation 2028). A year later in 1934, Donald Curry was hired as the first Ranger Naturalist at Death Valley National Monument.

Curry is possibly the first professional geologist to wear the ranger uniform (Figure 8). He conducted geologic research during the day and presented interpretive programs to the public in the evenings. Curry is credited with the discovery of titanothere remains in Titus Canyon, fossil plant material from the Furnace Creek Formation, several new Tertiary fish fossils, and three fossil vertebrate track localities, most notably at the Copper Canyon tracksite. In his honor, two fossil species have been designated with the species name *curryi* including: *Fundulus curryi* (fish) and *Protitanops curryi* (mammal) (Santucci and Nyborg 1999).

Figure 8. Geologist Donald Curry and Ranger Doudna mapping in Gold Canyon at Death Valley National Monument. (National Park Service photograph).

6.9 Myrl Walker promotes paleontology at Petrified Forest National Monument

Between 1934 and 1938, Park Naturalist Myrl Walker was stationed at Petrified Forest National Monument. Although Walker was assigned to provide interpretation of park resources, he coordinated paleontological surveys, collected fossils, wrote reports, and even published a paper (Walker 1938) on some of the park fossils (Parker 2006). Walker was trained in paleontology and hosted Charles Gilmore and George Sternberg during field work in the park. Myrl Walker is considered to be the first paleontologist who worked for the National Park Service at Petrified Forest National Monument. Section 5.7 provides additional information pertaining to the history of paleontology at Petrified Forest National Monument.

6.10 Establishment of Big Bend National Park and early fossil discoveries

Between 1929 and 1936, Yellowstone Superintendent Roger Wolcott Toll would assist National Park Service Director Horace Albright during the winter months by evaluating proposed additions to the National Park System. During 1934, Toll traveled to the Big Bend region of Texas to visit the newly designated Texas State Park. In Toll's Big Bend Trip Report, he described the "outstanding scenic area". The recommendations made by Toll were instrumental in

the 20 June 1935 authorization of Big Bend National Park by Congress as a unit of the National Park Service (Public Law 74-157, codified at 16 U.S.C. § 156 - 158). Within this legislation is specific language which references that the park will be established upon the conveyance of lands from the State of Texas to the federal government.

In February 1936, Toll and biologist George Melendez Wright visited Big Bend as participants in an International Park Commission to evaluate the area for possible designation of a transboundary park with Mexico. Tragically, on 25 February 1936, both Toll and Wright were killed in an automobile accident after their visit to Big Bend.

A young geologist named Ross Maxwell was hired by the National Park Service to survey the area of the proposed new national park. Maxwell and the Regional Geologist, Charles Gould, quickly recognized the important fossil vertebrates which occurred in the Cretaceous strata in the Big Bend area. Maxwell and Gould recruited help from the Civilian Conservation Corps to collect fossils and to construct a small museum in the Chisos Basin in a barracks at the Civilian Conservation Corps camp (Gould 1936) (Figure 9). Unfortunately, a fire on 24 December 1941 destroyed the geology and fossil museum.

Figure 9. Rocks and fossils on display at the museum set up by the Civilian Conservation Corps in a camp barracks in the Chisos Basin. (National Park Service photograph).

A crew from the Works Progress Administration (WPA) helped to develop three fossil quarries in Big Bend during 1938 and 1939. The WPA crew worked under the supervision of William Strain from the Texas College of Mines and Mineralogy in El Paso, Texas. More than 500 fossil bones were collected under Strain's supervision (Wick and Corrick 2015). The success of the WPA quarries drew several notable paleontologists into the field at Big Bend during 1940, including Charles Gilmore (Smithsonian) and Barnum Brown and Roland T. Bird (American Museum of Natural History). Brown and Bird collected a variety of dinosaur bones and partial jaws of the giant crocodilian which was later named *Deinosuchus* (Baird and Horner 1979).

A deed of conveyance was completed in 1944 and Big Bend National Park was officially established on 12 June 1944, nine years after the authorization. Geologist Ross Maxwell was appointed the first superintendent and served from 1944 to 1952 (Maxwell 1985). During Maxwell's tenure, he fostered a long-term relationship with paleontologists Wann Langston and Jack Wilson, and students from the Vertebrate Paleontology Laboratory at the University of Texas at Austin (later named the Texas Memorial Museum). Section 5.4 of this paper provides additional information on the history of paleontology in the Big Bend area.

6.11 Discovery of fossils during the construction of Boulder Dam

On 13 October 1936, Boulder Dam National Recreation Area (Public Law 88-639, codified at 16 U.S.C. §§ 460n – 460n-9) was established as a unit of the National Park Service to administer the reservoir lake and adjacent lands formed by the construction of Boulder Dam, known today as Hoover Dam. In 1947 the name was changed to Lake Mead National Recreation Area and was established as the first national recreation area in 1964. Geologist Edward Schenk was hired by the National Park Service to describe the geology and paleontology of the new recreation area. Schenk collected hundreds of fossil specimens from within and around Lake Mead National Recreation Area. A portion of this collection is maintained in the Lake Mead National Recreation Area park museum collection. Some of Schenk's fossil collection may have been sent to the U.S. Geological Survey in Reston, Virginia. A series of unpublished reports, prepared by Schenk regarding his work at Lake Mead during 1936 through 1938, are maintained in the Lake Mead National Recreation Area archives in Boulder City, Nevada (i.e. Schenk 1936, 1938).

6.12 Establishment of Channel Islands National Monument recognizes fossils

On 26 April 1938, Channel Islands National Monument, California, was proclaimed by President Franklin D. Roosevelt (see Davis and Kimball 2017). According to the proclamation, the Channel Islands

> . . . lying off the coast of Southern California contain fossils of Pleistocene elephants and ancient trees, and furnish noteworthy examples of ancient volcanism, deposition, and active sea erosion, and have situated thereon various other objects of geological and scientific interest. (Franklin D. Roosevelt, Proclamation 2281).

The monument was designated a national park on 5 March 1989 (Public Law 96-199, codified at 16 U.S.C. § 410ff-410ff-7) and the islands of San Miguel, Santa Cruz and Santa Rosa were added to the park.

6.13 Discovery and early fossil collecting at Rampart Cave

In April 1942, Remington Kellogg from the Smithsonian led a party, including members of the Civilian Conservation Corps, to Rampart Cave to excavate Pleistocene fossils. Rampart Cave is formed in the Cambrian Muav Limestone and was discovered in 1936 by a National Park Service employee named Willis Evans (Santucci *et al*. 2001). The cave preserved extensive deposits of Pleistocene ground sloth dung which contain the bones of ice age mammal fossils. Rampart Cave was originally within the boundaries of Lake Mead National Recreation Area, but was later incorporated into Grand Canyon National Park when that park's boundaries were expanded in January 1975.

6.14 Commercial development of the petrified forests of Florissant

By the 1920s, early discussions began about preservation of the Florissant Fossil Beds in Colorado, which had long been known to paleontologists and fossil collectors. Two privately owned petrified forest attractions existed at this time, less than a mile apart, and the owners eventually engaged in a competitive commercial rivalry resulting in a feud. The first was opened in 1890 under the name Coplen Petrified Forest and was later sold in 1926 to P. J. Singer. The name was changed to Colorado Petrified Forest in 1932. The second petrified forest, originally named the New Petrified Forest, was opened in 1920 and operated as a commercial quarry selling fossils. This operation changed its name initially to Henderson Petrified Forest and then to Pike Petrified Forest in 1950. The Pike Petrified Forest included the famous trio of petrified stumps

and eventually closed to the public in 1961, but later was to be included within the boundaries of Florissant Fossil Beds National Monument (Leopold and Meyer 2012).

While traveling in Colorado with his wife Lillian, cartoonist and producer Walt Disney visited the Pike Petrified Forest on 11 July 1956. Walt's recognizable signature inscribed in the Pike Petrified Forest registry book for this day confirms his visit. The accounts of Disney's visit to this tourist attraction vary slightly, but the important fact that Walt purchased a petrified stump that day is substantiated. The 7.5 foot (2.29 meters) tall Florissant stump can be viewed today on exhibit in Frontierland at Disneyland, California (Figure 10). One account associated with Disney's purchase of the petrified stump suggests the fossil was purchased as a gift to his wife for their thirty-first wedding anniversary.

Figure 10. Walt and Lillian Disney stand in front of the petrified tree exhibit in Frontierland in Disneyland, California. The fossil was purchased by Disney from the Pike Petrified Forest in Colorado, a locality that was later preserved within Florissant Fossil Beds National Monument. (With permission of the The Walt Disney Company, © Disney).

According to an interpretive sign with the petrified tree at the theme park, the specimen was presented to Disneyland by Mrs. Walt Disney in September 1957. However, in a letter dated 19 July 1956, from Walt Disney to Jack Baker, owner of the Pike Petrified Forest, the instructions were to deliver the petrified stump directly to Disneyland. Disney paid $1,650 for the stump and some smaller pieces of petrified wood.

6.15 Scientific study of the Yellowstone petrified forests

Paleobotanist Erling Dorf and students from Princeton University conducted paleontological and geological field investigations in Yellowstone between 1955 and 1959 (Dorf 1960, 1964). This work involved mapping and field collection of plant fossils from a sequence of Eocene volcanoclastic deposits exposed along Specimen Ridge in the Lamar Valley of Yellowstone. Dorf concluded there were at least twenty-seven distinct petrified forests preserved at Specimen Ridge (Dorf 1964).

6.16 National Historic Landmarks and National Natural Landmarks programs established

In 1960 the National Park Service began to administer the National Historic Landmarks Program. The National Historic Landmarks Program supports the designation of nationally significant historic places by the Secretary of the Interior. National Historic Landmarks are sites and properties which possess exceptional value or quality in illustrating or interpreting the heritage of the United States. More than 2,500 historic places are designated as National Historic Landmarks, including five which are associated with famous paleontologists or historically important fossil localities (Figure 11).

A similar natural resource-focused program is the National Natural Landmarks Program which was established on 18 May 1962 by Secretary of Interior Stewart Udall (see Eggleston and Connors 2017). The program is administered by the National Park Service and promotes conservation and voluntary preservation of outstanding natural resources. A thematic inventory of ecological and geological sites throughout the United States was conducted between 1970 and 1987, including an inventory of significant Mesozoic fossil vertebrate sites for possible inclusion in the National Natural Landmarks Program (Ostrom 1985). As of the date of this publication, 45 National Natural Landmarks were established primarily based on the significant paleontological resources (Figure 11).

6.17 A really 'Big Dig' at Tule Spring Fossil Beds

Between October 1962 and February 1963, a team of geologists, paleontologists and archeologists converged in an area north of Las Vegas known as Tule Springs. This scientific undertaking, later referred to as the 'Big Dig', was an intensive effort to find evidence suggesting early humans and ice age mammals co-existed along the Las Vegas Wash during the Late Pleistocene. The first remains of extinct mammoths, camels, bison, sloths and horses were discovered at Tule Springs several decades earlier. The documentation of charcoal and the discovery of a few potentially 'human modified' objects presented hope that Tule Springs may shed light on the discussion of human antiquity in North America.

The expedition at Tule Springs was led by geologist C. Vance Haynes from the University of Arizona (Wormington and Ellis 1967). The scientific team included Willard Libby from the University of California at Los Angeles who was the recipient of the Nobel Prize in chemistry for his pioneering work on radiocarbon dating. Libby's analysis of Carbon 14 (^{14}C) samples from Tule Springs represented the first field testing of his new age-dating technique. Although the results of the 'Big Dig' were not able to conclusively determine the co-existence of humans and ice age megafauna, the significance of the Late Pleistocene fossil locality resulted in the area being designated as the Tule Springs Fossil Beds National Monument approximately 50 years after the 'Big Dig'.

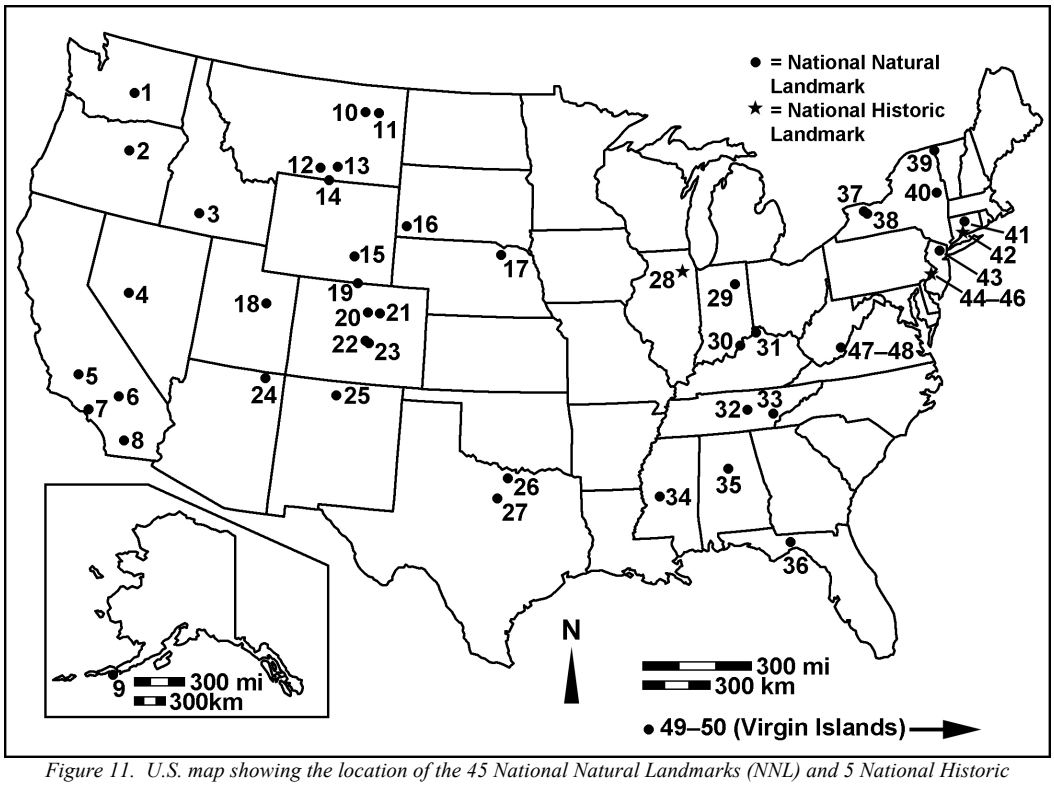

Figure 11. U.S. map showing the location of the 45 National Natural Landmarks (NNL) and 5 National Historic Landmarks (NHL) that are recognized based on the significant paleontological resources or history. The location of the NHLs and NNLs are presented on the map and include: 1. Ginkgo Petrified Forest NNL, WA; 2. John Day Fossil Beds NNL, OR; 3. Hagerman Fauna Sites NNL, ID; 4.Ichthyosaur Site NNL, NV; 5. Sharktooth Hill NNL, CA; 6. Rainbow Basin NNL, CA; 7. Rancho La Brea NNL, CA; 8.Anza-Borrego Desert State Park NNL, CA; 9. Unga Island NNL, AK; 10. Hell Creek Fossil Area NNL, MT; 11. Bug Creek Fossil Area NNL, MT; 12. Bridger Fossil Area NNL, MT; 13. Cloverly Formation Site NNL, MT; 14. Crooked Creek Natural Area NNL, WY; 15. Como Bluff NNL, WY; 16. Mammoth Site of Hot Springs NNL, SD; 17. Ashfall Fossil Beds NNL, NE; 18. Cleveland-Lloyd Dinosaur Quarry NNL, UT; 19. Sand Creek NNL, WY; 20. Morrison-Golden Fossil Areas NNL, CO; 21. West Bijou Site NNL, CO; 22. Garden Park Fossil Area NNL, CO; 23. Indian Springs Trace Fossil Site NNL, CO; 24.Comb Ridge NNL, AZ; 25. Ghost Ranch NNL, NM; 26. Greenwood Canyon NNL, TX; 27. Dinosaur Valley NNL, TX; 28. Mazon Creek Fossil Beds NHL, IL; 29. Hanging Rock and Wabash Reef NNL, IN; 30. Ohio Coral Reef (Falls of the Ohio) NNL, IN & KY; 31. Big Bone Lick NNL, KY; 32. Big Bone Cave NNL, TN; 33. Lost Sea (Craighead Caverns) NNL, KY; 34. Mississippi Petrified Forest NNL, MS; 35. Red Mountain Expressway Cut NNL, AL; 36. Wakulla Springs NNL, FL; 37. Fossil Coral Reef NNL, NY; 38. Fall Brook Gorge NNL, NY; 39. Chazy Fossil Reef NNL, NY & VT; 40. Petrified Gardens NNL, NY; 41. Dinosaur Trackway NNL, CT; 42. Othniel Charles Marsh House NHL, CT; 43. Riker Hill Fossil Site NNL, NJ; 44. Charles Willson Peale NHL, PA; 45. Edward Drinker Cope House NHL, PA; 46. Hadrosaurus Foulki Leidy Site NHL, NJ; 47. Organ Cave System NNL, WV; 48. Lost World Caverns NNL, WV; 49. Coki Point Cliffs NNL, Virgin Islands; 50. Vagthus Point NNL, Virgin Islands.

6.18 Resdesignation of Petrified Forest National Monument to National Park

On 9 December 1962, Congress established Petrified Forest National Park by redesignating and expanding the 1906 national monument. The original park legislation (Public Law 85-358) was first approved by President Dwight D. Eisenhower in 1958, but President John F. Kennedy signed the final legislation in 1962. Sections 5.6 and 6.8 in this publication present earlier historical information pertaining to Petrified Forest National Park.

6.19 Authorization of Agate Fossil Beds National Monument

On 5 June 1965, Agate Fossil Beds National Monument, Nebraska, was created as a unit of the National Park Service. According to the enabling legislation, the monument was created

> . . . to preserve for the benefit and enjoyment of present and future generations the outstanding paleontological sites known as the Agate Springs Fossil Quarries, and nearby related geological phenomena, to provide a center for continuing paleontological research and for the display and interpretation of the scientific specimens uncovered at such sites, and to facilitate the protection and exhibition of a valuable collection of Native American artifacts and relics that are representative of an import phase of Native American history. (Public Law 89-33).

Although the monument was authorized in 1965, it was not established until 14 June 1997. Section 5.5 in this publication presents additional historical information pertaining to Agate Fossil Beds National Monument.

7. SECOND 50 YEARS OF THE NATIONAL PARK SERVICE PERIOD (1966–2016)

The period represents the fifty years between the 50th and 100th anniversaries for the National Park Service, and is punctuated by the establishment of several National Park Service areas recognized in part for their significant paleontological resources. Perhaps this trend in the conservation of paleontological resources is a reflection of evolving societal values or human dimensions pertaining to fossils during this period (Santucci *et al*. 2016). This period includes a program called Mission 66, in which the National Park Service undertook a ten-year effort to dramatically expand visitor services by 1966, in time for the 50th anniversary of the agency. There were National Park Service paleontology-focused exhibits which were developed as part of Mission 66. During the second half of the twentieth century, an escalating commercial market for fossils sparked a corresponding public and political debate involving our paleontological heritage in the United States.

This period also marks the creation of the first service-wide National Park Service paleontologist position, the development of National Park Service policies pertaining to paleontology, and the recruitment of more than 200 paleontology interns to support fossil-related projects in parks. Additionally, the Paleontological Resource Preservation Act was signed into law in March 2009, the National Park Service Junior Paleontologist Program was created, and National Fossil Day was established as part of Earth Science Week.

7.1 Establishment of Florissant Fossil Beds National Monument

On 20 August 1969, Florissant Fossil Beds National Monument, Colorado, was established as a unit of the National Park Service. According to the authorizing legislation the monument was established

> in order to preserve and interpret for the benefit and enjoyment of present and future generations the excellently preserved insect and leaf fossils and related geologic sites and objects at the Florissant lakebeds . . . (Public Law 91-60).

The monument preserves abundant and diverse paleontological resources from the Eocene Florissant Formation. Fossil remains include incredibly well-preserved leaves, fruits, insects, fishes, birds, and small mammals that originally came to scientific attention in the early 1870s. Additionally, Florissant Fossil Beds National Monument contains impressive standing stumps of petrified redwood trees. Leopold and Meyer (2012) present a detailed historical account of the preservation movement which advanced to protect the Florissant Fossil Beds and creation of the national monument. Section 5.3 presents additional historical information pertaining to the Florissant Fossil Beds.

7.2 New paleontological discoveries at Big Bend National Park

Big Bend National Park was a 'hot spot' for paleontological field work and discoveries during the 1970s. Judith A. Schiebout uncovered Paleocene mammals during her dissertation field work that spanned the Cretaceous–Paleogene boundary in Big Bend National Park (Schiebout 1973). In 1971, the remains of the largest known flying animal, a pterosaur named *Quetzalcoatlus northropi*, were uncovered by Doug Lawson (Lawson 1972, 1975). Lawson is also credited with describing ceratopsian and tyrannosaurid fossils from the park, and documenting a variety of paleobotanical specimens from Big Bend National Park (Lawson 1972, 1976). During the late 1970s, James and Margaret Stevens and Tom Lehman began their paleontological work in Big Bend National Park which spanned four decades and included many important fossil discoveries (Stevens 1977; Lehman 1985). Sections 5.4 and 6.10 provide additional information pertaining to the history of paleontology in the Big Bend area of Texas.

7.3 Establishment of Guadalupe Mountains National Park

On 30 September 1972, Guadalupe Mountains National Park, Texas, was established as a unit of the National Park Service. According to the authorizing legislation:

> In order to preserve in public ownership an area in the State of Texas possessing outstanding geological values together with scenic and other natural values of great significance. (Public Law 89-667, codified at 16 U.S.C. § 283-283e).

Although fossils are not specifically mentioned, they are certainly part of the park's "outstanding geological values". The Permian Reef Complex preserved within and around Guadalupe Mountains National Park represents one of the largest fossil reefs and the most complete Permian marine sequences in the world (Newell *et al*. 1953). The diverse marine fauna associated with the ancient reef ecosystem includes algae, fusulinids, sponges, corals, bryozoans, brachiopods, trilobites, ostracods, gastropods, cephalopods, scaphopods, pelecypods, crinoids, echinoids, conodonts and a few rare fish. A network of more than two dozen caves at Guadalupe Mountains National Park preserves Pleistocene and Holocene vertebrate fossils (Santucci *et al*. 2001).

7.4 Establishment of Fossil Butte National Monument

On 23 October 1972, Fossil Butte National Monument, Wyoming, was established as a unit of the National Park Service. According to the authorizing legislation the monument was established

> . . . in order to preserve for the benefit and enjoyment of present and future generations outstanding paleontological sites and related geological phenomena, and to provide for the display and interpretation of scientific specimens, the Fossil Butte National Monument. (Public Law 92-537).

Fossil Butte National Monument contains lacustrine deposits from Eocene Fossil Lake, one of three ancient lakes representing the extremely fossiliferous Green River Formation. The extraordinary preservation of the fossils, including Eocene vertebrates, invertebrates, plants and trace fossils, at the locality is recognized as a *Lagerstätten*. The wonderful fossil preservation of the Green River Formation fossils has resulted in intensive commercial collecting of fossils on private and State of Wyoming lands in Fossil Basin for more than a century (Grande 1980) (Figure 12).

7.5 Redesignation of Badlands National Monument to National Park

On 10 November 1978, Badlands National Monument was redesignated as a national park (Public Law 95-625, codified at 16 U.S.C. § 441 - 441o). This redesignation included the expansion of the park boundary to include the area referred to as the 'South Unit' which incorpor-

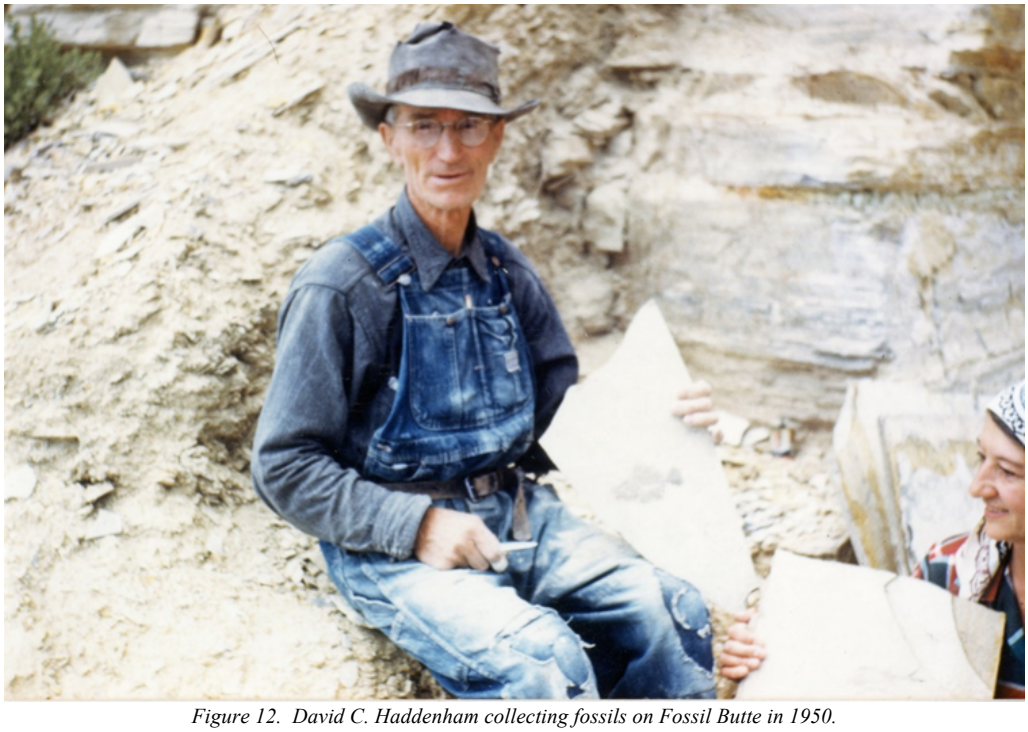

Figure 12. David C. Haddenham collecting fossils on Fossil Butte in 1950. (Photo by Walter Youngquist – FOBU 13666).

ates lands on the Pine Ridge Indian Reservation. According to the Badlands National Park General Management Plan for the South Unit (2012), the purpose of the park is to

> . . . preserve, interpret, and provide scientific research of the paleontological and geological resources of the White River Badlands . . . .

The history related to the expansion of lands to be incorporated into Badlands National Park is complex and extends back to World War II. In 1942, the United States acquired most of the area now encompassed within the South Unit of the park to be used as a U.S. Air Force gunnery range. The lands were acquired through condemnation, and Native American families who lived on the condemned lands were displaced.

Federal legislation signed in August 1968 (Public Law 90-468), and a Memorandum of Agreement between the Oglala Sioux and the National Park Service in 1976, paved the way for the redesignation of Badlands National Park of 1978 to include the addition of the South Unit on the Pine Ridge Indian Reservation. Sections 4.5 and 6.5 of this paper present additional historical information pertaining to the paleontology of the Badlands.

7.6 Enactment of the Archaeological Resources Protection Act

The Archaeological Resources Protection Act of 1979 (Public Law 96–95, as amended, codified at 16 U.S.C. § 470aa *et seq*.) is the primary legal authority pertaining to the management of archeological resources on federal and Indian lands in the United States. Although the focus of the Archaeological Resources Protection Act applies to archeological resources, there is a provision which specifically addresses the occurrence of paleontological resources within an archeological context (Kenworthy and Santucci 2006).

7.7 Establishment of Bering Land Bridge and Yukon-Charley Rivers national monuments recognizing fossils

Bering Land Bridge National Monument and Yukon-Charley Rivers National Monument were established as units of the National Park Service in Alaska on 1 December 1978. President Jimmy Carter proclaimed these monuments under the authority of the Antiquities Act (1906) and specifically referenced the paleontological resources of each monument. The Bering Land Bridge National Monument proclamation states

> paleontological sites providing abundant evidence of the migration of plants and animals onto the continent in the ages before the human migrations. The arctic conditions here are favorable to the preservation of this paleontological record from minute pollen grains and insects to the large mammals such as the mammoth. (Jimmy Carter, Proclamation 4614).

The Yukon-Charley Rivers National Monument proclamation references

> outstanding paleontological resources and ecologically diverse natural resources, offering many opportunities for scientific and historic study and research. [The proclamation further states] Geological and paleontological features within the area are exceptional, including a nearly unbroken visible series of rock strata representing a range in geologic time from pre-Cambrian to Recent. The oldest exposures contain fossils estimated to be 700 million years old, including the earliest forms of animal life. A large array of Ice Age fossils occurs in the area. (Jimmy Carter, Proclamation 4626).

7.8 Enactment of the Alaska National Interest Lands Conservation Act and recognition of scientific significance of Alaska parks

On 2 December 1980, the Alaska National Interest Lands Conservation Act was signed into law by President Jimmy Carter, and it redesignated both Bering Land Bridge National Monument and Yukon-Charley Rivers National Monument as national preserves and again reaffirmed the:

> protection of the geological, archeological, paleontological, biological and other phenomena (Public Law 96-487, codified at 16 U.S.C. §§ 3101 et seq.).

The Alaska National Interest Lands Conservation Act led to the large expansion of National Park Service lands in Alaska which preserve diverse and scientifically important paleontological resources.

7.9 Fossil theft investigation at Badlands National Park

During the summer of 1985, a law enforcement investigation at Badlands National Park, South Dakota, uncovered evidence involving long-term and systematic illegal collecting of fossils from within the park. This investigation yielded information indicating that some of the unauthorized fossil collecting in the park was potentially tied to commercial fossil dealers. Nearly a decade after the fossil theft investigation was initiated at Badlands National Park in 1985, the first felony conviction for fossil theft in U.S. history was issued to a commercial fossil business in 1995 for the theft of fossil fish from Badlands National Park (Fiffer 2000).

7.10 First National Park Service Fossil Resource Conference hosted at Dinosaur National Monument

In 1986, the first National Park Service Fossil Resources Conference was hosted at Dinosaur National Monument. The conference was hosted by Dan Chure, paleontologist at Dinosaur National Monument, and Ted Fremd, paleontologist at John Day Fossil Beds National Monument, in order to promote communication and collaboration between staff involved with the

management, protection, interpretation, curation and research of National Park Service fossils. Dan and Ted raised issues which contributed to development of service-wide policy and guidelines (NPS-77) pertaining to National Park Service fossils and led to the transfer of National Park Service paleontology from under the administration of the Cultural Resources Program to the Natural Resources Program. The birth of the fossil resource conference idea at Dinosaur National Monument in 1986 led to nine more similar conferences which expanded to involve other federal, state and local land managing agencies.

7.11 Establishment of Hagerman Fossil Beds National Monument

On 18 November 1988, Hagerman Fossil Beds National Monument, Idaho, was established as a unit of the National Park Service. According to the authorizing legislation the monument was established

> In order to preserve for the benefit and enjoyment of present and future generations the outstanding paleontological sites known as the Hagerman Valley fossil sites, to provide a center for continuing paleontological research, and to provide for display and interpretation of the scientific specimens uncovered at such sites, there is hereby established the Hagerman Fossil Beds National Monument. (Public Law 100-696).

Section 306 of the law states

> In order to provide for continuing paleontological research, the Secretary shall incorporate in the general management plan provisions for the orderly and regulated use of and research in the monument by qualified scientists, scientific groups, and students under the jurisdiction of such qualified individuals or groups. (Public Law 100-696).

Hagerman Fossil Beds National Monument preserves one of the world's richest fossil deposits from the late Pliocene epoch. Among the scientifically significant fossils from the monument is the largest concentration of 'Hagerman Horse' fossils in North America (Figure 13).

Figure 13. Smithsonian field crew jacketing fossils at the Hagerman Horse Quarry. (Smithsonian photograph).

7.12 First assessment of National Park Service paleontological resource crimes

In 1988 the Servicewide Natural Resources Assessment and Action Program recognized that the loss of paleontological resources through illegal collecting was a major resource issue facing the National Park System. A Paleontological Resources Protection Questionnaire was distributed to National Park Service areas in the spring of 1992. This survey was primarily designed to gather data regarding the extent and magnitude of illegal fossil collection in the parks. The initial survey identified 721 incidents of paleontological resource crimes in the National Park Service, resulting in 412 citations and six arrests. Based on the results of the initial survey, a series of recommendations were implemented to enhance the protection of non-renewable paleontological resources in the National Park Service. One of the recommendations called for the need to develop and present paleontological resource protection training to National Park Service staff and law enforcement rangers. Between 1993 and 1999 more than 200 National Park Service rangers participated in paleontological resource protection training.

In 1999, the National Park Service Ranger Activities Division and the Geologic Resources Division distributed a Geological, Paleontological & Cave Resources Protection Survey to the parks. This survey was expanded from the 1992 survey to include incidents related to the theft or vandalism of any geologic resources, including fossils and cave resources, in the parks. The results of the second survey led to recommendations to expand the training opportunities for National Park Service staff and for the development of paleontological resource protection training modules. An Albright Wirth Grant was presented to the author in 1998 to coordinate the development of paleontological resource protection training with the Federal Law Enforcement Training Center and the National Park Service Horace Albright Training Center. Three paleontological resource training modules were produced through this collaboration and have been presented to more than 1,200 National Park Service employees.

7.13 Federal paleontological resource crimes investigation – Tyrannosaurus rex *specimen 'Sue'*

One of the most well-known fossils in the world is a *Tyrannosaurus rex* named 'Sue'. This dinosaur skeleton is recognized as one of the largest, most complete and best-preserved specimens of the iconic *Tyrannosaurus rex* ever discovered and collected. 'Sue' was discovered during the summer of 1990 on the Cheyenne River Indian Reservation in South Dakota. The complex story involving 'Sue' has become highly publicized, controversial, sometimes clouded by misinformation, and often overshadowed by the dinosaur. The discussion of the 'Sue' investigation is presented here based on the fact that there were ties to illegal fossil collecting in Badlands National Park and National Park Service staff participated in the investigation. The investigation led to the seizure of the dinosaur skeleton on 14 May 1992 followed by both civil and criminal litigation (Fiffer 2000). The civil litigation involving 'Sue' determined ownership of the fossil and the specimen was eventually auctioned in October 1997 and sold for over $8 million dollars. Although the criminal portion of the case had almost nothing to do with the dinosaur 'Sue', media coverage has led to confusion about the criminal case by focusing on the dinosaur. In fact, the criminal portion of the case resulted in the first felony conviction for fossil theft through a trial in United States history. This portion of the case specifically involved catfish fossils stolen from Badlands National Park, an important historical fact which has largely been overshadowed by the media focus on the dinosaur.

7.14 California Desert Protection Act recognizes fossils at two parks

On 31 October 1994, the California Desert Protection Act was signed into law by President Bill Clinton. The law expanded the boundaries and redesignated two national monuments in California as national parks resulting in the establishment of Death Valley National Park and Joshua Tree National Park. The law referenced, for both national parks, the

> superlative natural, ecological, geological, archeological, paleontological, cultural, historical and wilderness values . . . (Public Law 103-433, codified at 16 U.S.C. § 410aaa et seq.).

7.15 Establishment of Grand Canyon-Parashant National Monument recognizes fossils

On 11 January 2000, Grand Canyon-Parashant National Monument, Arizona, was proclaimed by President Bill Clinton. According to the proclamation,

> The monument is a geological treasure. Its Paleozoic and Mesozoic sedimentary rock layers are relatively undeformed and unobscured by vegetation, offering a clear view to understanding the geologic history of the Colorado Plateau . . . Fossils are abundant in the monument. Among these are large numbers of invertebrate fossils, including bryozoans and brachiopods located in the Calville Limestone of the Grand Wash Cliffs, and brachiopods, pelecypods, fenestrate bryozoa, and crinoid ossicles in the Toroweap and Kaibab formations of Whitmore Canyon. There are also sponges in nodules and pectenoid pelecypods throughout the Kaibab formation of Parashant Canyon. (Bill Clinton, Proclamation 7265).

Grand Canyon – Parashant National Monument includes lands which are administered by both the Bureau of Land Management and National Park Service.

7.16 Publication of the Secretary of Interior 'Report to Congress' – Fossils on Federal and Indian lands

In May 2000, the Secretary of the Interior published a report titled Fossils on Federal and Indian Lands: Assessment of Fossil Management on Federal & Indian Lands. During the previous year Congress (Senate Appropriations Committee) requested information on the status and condition of paleontological resources and collections from federal lands in order to assess the need for a unified federal policy for fossils. In addition, during the previous two decades, a series of bills pertaining to paleontological resources were introduced to Congress, which resulted in some conflicting and confusing feedback from constituents. Eight consulting federal agencies participated in the development of the report to Congress including the Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, U.S. Forest Service, National Park Service, Smithsonian Institution and U.S. Geological Survey. A draft report was developed and a notice regarding the report was published in the Federal Register. The draft report was presented at a public hearing and public comments were obtained which were incorporated into the final 'Report to Congress' published in May 2000.

7.17 Initiation and completion of fossil resource summaries for National Park Service inventory and monitoring networks

In order to better understand the scope, significance, distribution and management issues associated with National Park Service fossils, a strategy was established in 2001 to compile baseline paleontological resource data for parks. The strategy aligned with the recently created organization of the National Park Service into inventory and monitoring networks, a system in which 270 parks were grouped into thirty-two ecoregions based on similarities in natural resources. The Northern Colorado Plateau Inventory and Monitoring Network was selected as the prototype paleontological resource inventory network for the National Park Service (Koch and Santucci 2002). Between 2002 and 2012, paleontological resource inventories were systematically completed for all thirty-two National Park Service inventory and monitoring networks, expanding the number of parks identified with fossils from 135 in 1999 to 243 in 2014 (today there are 267 parks identified with fossils). The project also provided an excellent foundation for the ongoing National Park Service Paleontology Synthesis Project which compiles the bureau's paleontological resource data by geologic time, taxonomy, museum repositories and other important data.

7.18 Petrified Forest National Park Expansion Act adds important fossil beds to Park

On 3 December 2004, President George W. Bush signed The Petrified Forest National Park Expansion Act of 2004 (Public Law 108-430, codified at 16 U.S.C. §§ 119) to authorize an expansion of the park boundaries identified in the park's General Management Plan initiated during 1991. The park expansion more than doubled the size of the park, from 93,533 acres to 218,533 acres, which included highly fossiliferous Late Triassic deposits. Sections 4.6 and 6.8 of this paper provide additional historical information pertaining to Petrified Forest National Park. Sections 5.7 and 6.9 of this article include additional information on the history of paleontology at Petrified Forest National Park.

7.19 First 'Fossil Preparation and Collections Symposium' convened

In 2008, the Petrified Forest Museum Association hosted the first annual Fossil Preparation and Collections Symposium, an international conference that brought together forty-five professional and avocational laboratory and collections specialists at Petrified Forest National Park. The success of this event led to increasingly larger meetings each year, eventually spawning the Association for Materials and Methods in Paleontology. Meetings sponsored by the Association for Materials and Methods in Paleontology have routinely featured strong National Park Service support, including hosting, collection tours, field trips, and continued participation from Petrified Forest National Park, Fossil Butte National Monument, Hagerman Fossil Beds National Monument, Dinosaur National Park, John Day Fossil Beds, Florissant Fossil Beds National Monument, Waco Mammoth National Monument, and the National Park Service Museum Management Program (M. Brown, personal communication, 2017).

7.20 Paleontological Resources Preservation Act of 2009 signed into law

On 30 March 2009, President Barack Obama signed the Paleontological Resource Preservation Act into law. Approximately thirty years after the Archaeological Resources Protection Act was signed into law on 31 October 1979, an equivalent federal authority was promulgated for paleontological resources. The Paleontological Resource Preservation Act is authorized for five federal land managing agencies including the: Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, National Park Service, and U.S. Forest Service. The law includes mandates pertaining to the

> inventory, monitoring, and the scientific and educational use of paleontological resources . . . (Public Law 111-011).

The legislation also contains language pertaining to paleontological resource permits, museum collections, criminal and civil penalties, and confidentiality of sensitive resource information.

7.21 Paleontological resource monitoring strategy developed and piloted

The National Park Service pioneered some of the first discussions and strategies devoted to the monitoring of *in situ* paleontological resources (Santucci and Koch 2003; Santucci *et al*. 2009). In 2009, Glen Canyon National Recreation Area, Arizona and Utah, was selected as the prototype paleontological resource monitoring park for the National Park Service. Glen Canyon National Recreation Area was selected based on the continuous fluctuations of water levels on Lake Powell, which intermittently submerged or exposed the abundant fossils which occur along the lake shoreline. Low lake water levels, related to droughts in the western United States, exposed many new fossil track sites which were submerged for many decades. The methods employed for paleontological resource monitoring at Glen Canyon National Recreation Area captured baseline data to measure changes in the stability and condition of the fossils over time (Kirkland *et al*.

2010). The monitoring strategy evaluates both natural and human factors contributing to the condition of *in situ* paleontological resources. Paleontological resource monitoring continues at Glen Canyon National Recreation Area and has been initiated in several other National Park Service areas.

7.22 Establishment of National Fossil Day as a nationwide partnership

The Paleontological Resource Preservation Act states "The Secretary shall establish a program to increase public awareness about the significance of paleontological resources." In response to this provision in the law, the National Park Service and American Geosciences Institute proposed a partnership called 'National Fossil Day' to promote the scientific and educational values of fossils. The first National Fossil Day was hosted on 13 October 2010, during Earth Science Week, with a public event celebrating fossils on the National Mall in Washington, D.C. More than 500 children participated in the National Park Service Junior Paleontologist Program, a fossil-themed educational activity which premiered in June 2010 to promote interest in science and stewardship among children. By 2016, the National Fossil Day partnership had expanded to include more than 350 partners across the United States and in every state providing fossil-focused educational activities for children, families and others at the local level. Additionally, during this time period, the National Park Service developed the Junior Paleontologist Activity Booklet to promote interest in science and stewardship among children.

7.23 Establishment of Tule Springs Fossil Beds National Monument

On 19 December 2014, Tule Springs Fossil Beds National Monument, Nevada, was established as a unit of the National Park Service. According to the authorizing legislation the monument was established

> In order to conserve, protect, interpret, and enhance for the benefit of present and future generations the unique and nationally important paleontological, scientific, educational, and recreational resources and values . . . (Public Law 113-291).

The monument consists of lands transferred to the National Park Service from the Bureau of Land Management. Pleistocene sedimentary deposits in the upper Las Vegas Wash have yielded abundant ice age megafauna fossils (mammoths, camels, sloths, etc.) and have been the focus of field collecting and research (Springer *et al*. 2017). Additional historical information pertaining to Tule Springs Fossil Beds is presented in Section 6.17 of this publication.

7.24 Establishment of Waco Mammoth National Monument

On 10 July 2015, Waco Mammoth National Monument, Texas, was established as a unit of the National Park Service by President Barack Obama. According to the proclamation, the monument was created as a

> partnership between the City of Waco, Baylor University, and the Waco Mammoth Foundation, Inc., . . . [to] maintain the Waco Mammoth Site and expand the partnership to include the National Park Service [and] to preserve and protect the scientific objects at the Waco Mammoth Site. (Barack Obama, Proclamation 9299).

The history of the fossil locality dates back to the discovery of a fossil bone during the spring of 1978 by Paul Barron and Eddie Bufkin. The two men collected the bone and took it to Baylor University's Strecker Museum (now Mayborn Museum) where it was identified as a femur from a Pleistocene Columbian mammoth (*Mammuthus columbi*). To date, the site has yielded the remains of twenty-five mammoths, which represent the largest known concentration from a single herd dying during the same event, along with the remains of camel, dwarf antelope, American

alligator, giant tortoise, and the tooth of a juvenile saber-toothed cat (Bongino 2007; Nordt *et al*. 2015; Weist *et al*. 2016).

7.25 First National Park Service PaleoBlitz hosted

As part of the National Park Service Centennial Celebration, more than 100 Bioblitz events were hosted in parks throughout the country. On 20–21 May 2016, the first official National Park Service PaleoBlitz was hosted at Chickasaw National Recreation Area, Oklahoma. The PaleoBlitz consisted of two components including field paleontological resource inventories conducted by a team of paleontologists, and a fossil education and outreach event for the public.

7.26 Establishment of Katahdin Woods and Waters National Monument recognizes fossils

On 24 August 2016, Katahdin Woods and Waters National Monument, Maine, was established as a unit of the National Park Service by President Barack Obama. According to the proclamation the significance of the monument includes

> bedrock spanning over 150 million years of the Paleozoic era, revealing a remarkably complete exposure of Paleozoic rock strata with well-preserved fossils. (Barack Obama, Proclamation 9476).

Fossils were first reported from the area now within Katahdin Woods and Waters National Monument during the American Civil War (Hitchcock 1861). Extensive fossil collections have been obtained from the monument including at least four holotype fossil specimens (Clarke 1907; Elias 1982).

8. PALEONTOLOGY AND THE SECOND CENTURY FOR THE NATIONAL PARK SERVICE (BEYOND 2016)

The organization of this publication includes the history of paleontology associated with the national parks to the 100th anniversary (centennial) of the National Park Service in 2016. The collective history, involving fossils in at least 267 parks, is the foundation upon which a paleontology program can grow during the second century for the National Park Service.

The Paleontological Resources Preservation Act regulatory process will have a profound influence over the direction of paleontology for the National Park Service and other bureaus in the Department of Interior. The Paleontological Resources Preservation Act mandates for inventorying, monitoring, educational outreach, permitting, curation and resource protection, all of which will enhance the stewardship of fossils on federal lands. New partnerships are being formed between the primary paleontology-focused professional organizations and the National Park Service to create opportunities to promote public engagement to support the management of fossils in parks. It is anticipated that dozens of paleontology students will be recruited annually to help parks with projects and outreach involving park fossils.

In addition to preserving fossils in the parks, the preservation of historic and scientific archives and data associated with National Park Service fossils is critical. An organizational framework for the National Park Service Paleontology Archives & Library has been developed and will serve as an important repository for both digital and hardcopy documents, maps, photos and other information pertaining to National Park Service fossils. This will be an extremely important source for paleontology information for future National Park Service managers, paleontologists, researchers and others.

The National Park Service will continue to coordinate the National Fossil Day partnership and outreach activities to promote the scientific and educational values of fossils throughout the United States. During 2017, the number of children who have taken the Junior Paleontologist pledge will reach 100,000. A Spanish-language version of the Junior Paleontologist booklet is

being developed and will be available in late 2017 to expand opportunities to reach Spanish-speaking children.

The next chapters for the history of paleontology in the National Park Service will be written in the upcoming years, decades and beyond. As the Junior Paleontologists grow up, the paleontology interns complete their education, and the public and professional support for fossils in parks expands, there will be many new stories to add to this rich history of National Park Service paleontology. This journey has only begun and the future will most certainly help us to better understand the past.

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