Lucas, S.G. and Sullivan, R.M., eds., 2018, Fossil Record 6. New Mexico Museum of Natural History and Science Bulletin 79.

THE PALEONTOLOGY SYNTHESIS PROJECT AND ESTABLISHING A FRAMEWORK FOR MANAGING NATIONAL PARK SERVICE PALEONTOLOGICAL RESOURCE ARCHIVES AND DATA

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Abstract—The National Park Service Paleontology Program maintains an extensive collection of digital and hard copy documents, publications, photographs and other archives associated with the paleontological resources documented in 268 parks. The organization and preservation of the NPS paleontology archives has been the focus of intensive data management activities by a small and dedicated team of NPS staff. The data preservation strategy complemented the NPS servicewide inventories for paleontological resources. The first phase of the data management, referred to as the NPS Paleontology Synthesis Project, compiled servicewide paleontological resource data pertaining to geologic time, taxonomy, museum repositories, holotype fossil specimens, and numerous other topics. In 2015, the second phase of data management was implemented with the creation and organization of a multi-faceted digital data system known as the NPS Paleontology Archives and NPS Paleontology Library. Two components of the NPS Paleontology Archives were designed for the preservation of both park specific and servicewide paleontological resource archives and data. A third component, the NPS Paleontology Library, is a repository for electronic copies of geology and paleontology publications, reports, and other media. The NPS Paleontology Archives and Library has been an important investment supporting data discovery, current and future resource management, protection, scientific research, curation, education and other activities involving NPS paleontological resources.

INTRODUCTION

The National Park Service (NPS) Paleontology Program provides servicewide support for a wide variety of paleontological resource issues and technical assistance. The management of non-renewable paleontological resources and their associated data from NPS lands is required by federal law, regulations, policy, and guidance documents. The Paleontological Resources Preservation Act of 2009 mandates the management of fossils using scientific principles and expertise. Servicewide inventories for paleontological resources from NPS administered lands have yielded extensive information and data confirming the occurrence of fossils in at least 268 park units, including 17 parks with enabling legislation which references paleontological resources (Appendix A). Despite the fact that 64% of all NPS areas preserve fossils, fewer than 10 parks employ staff paleontologists to support management issues involving that park's fossils. Two servicewide paleontologists within the NPS Geologic Resources Division support paleontological resource issues, needs, and data management for the remaining nearly 260 parks with fossils.

Using 1985 as a baseline year, the amount of information pertaining to the scope, significance, distribution, and management issues associated with NPS paleontological resources has grown steadily (Fig. 1). The year 1985 was selected based on when the senior author began compiling servicewide paleontological resources information, with the general understanding at the time that there was a total of 12 NPS areas with paleontological resources. Paleontological resource inventories and data mining have contributed significantly to the growth in number of NPS areas identified with fossils. Between 2002 and 2012, the NPS funded baseline paleontological resource inventories for parks included in the 32 Inventory and Monitoring networks, in the process generating large datasets for NPS paleontology (Santucci et al., 2009; Santucci et al., 2012). Figure 2 is a pie chart which shows the relative abundance of NPS areas with documented fossils grouped by NPS region (Figure 3).

The justification, needs for, and benefits derived from undertaking paleontological resource inventories in the NPS are substantial and not merely bureaucratic "bean counting." In addition to the fact that paleontological resource inventory and monitoring are mandated by the Paleontological Resources Preservation Act (2009), resource inventories are recognized as important resource management strategies and practices initially adopted for all NPS natural resources under the Natural Resource Challenge during the 1990s. Resource inventories increase the awareness and understanding pertaining to the scope, significance, distribution, and management issues relative to park fossils and other resources. This increased understanding helps to inform park managers involved with planning and decision-making at the park, region, network, or Washington office levels. This is particularly important for NPS paleontological resources which sometimes experience negligent management due to the predominant focus and emphasis on modern biological and ecological resources by park managers with little to no education, training, or experience with the management of non-renewable fossils. This may be further exacerbated by factors such as insufficient staffing and funding, high rates of staff turnover, and the multitude of time-sensitive demands and responsibilities facing park resource managers.

Park-specific fossil inventories undertaken since 1998 have resulted in significant fossil discoveries with new information for dozens of NPS areas including, but not limited to: Aniakchak National Monument and Preserve (ANIA), Arches National Park (ARCH), Capitol Reef National Park (CARE), Denali National Park and Preserve (DENA), Death Valley National Park (DEVA), Glacier Bay National Park and Preserve (GLBA), Glen Canyon National Recreation Area (GLCA), Grand Canyon National Park (GRCA), Mesa Verde National Park (MEVE), Point Reyes National Seashore (PORE), Salinas Pueblo Missions National Monument (SAPU), White Sands National Monument (WHSA) and Wupatki National Monument (WUPA).

Thematic servicewide paleontological resource inventories

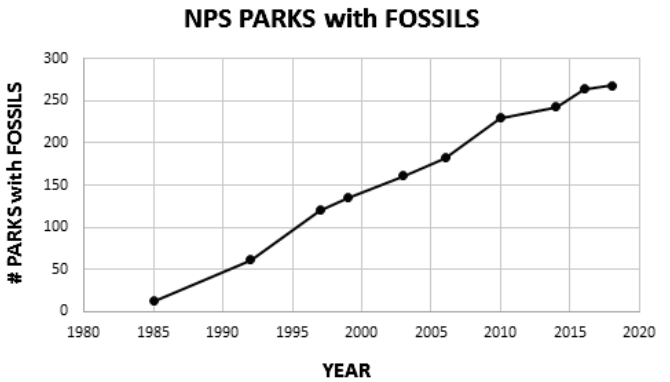

FIGURE 1. Graph showing the growth in the number of NPS areas confirmed with paleontological resources between 1985 and 2018.

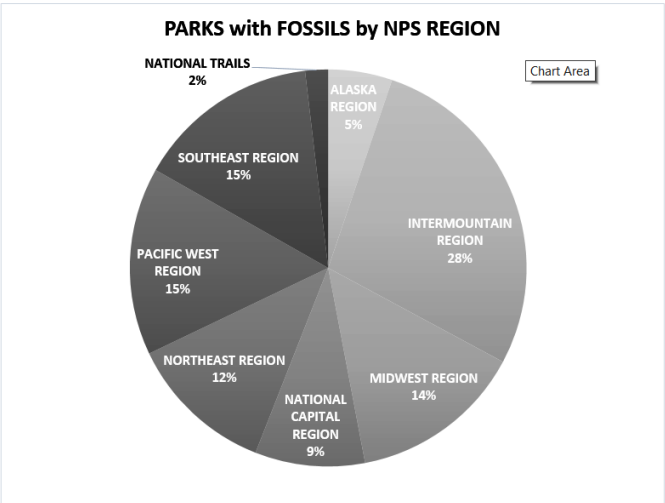

FIGURE 2. Pie chart showing the relative percentages of NPS areas with confirmed paleontological resources grouped by NPS region.

have also been undertaken which assess the occurrence of specific types of paleontological resources throughout the NPS. Examples of thematic paleontological resource inventories include the inventory for fossils from NPS caves (Santucci et al., 2001) and an inventory of fossil fish from NPS areas (Hunt et al., 2006). Future paleontological resource inventories in the NPS will continue to expand the information associated with park fossils and their management, further increasing the need for a well-organized structure for data management for the NPS Paleontology Program.

NPS PALEONTOLOGICAL RESOURCE DATA MANAGEMENT

A myriad of archives and records associated with the history and science of NPS paleontology extends back more than a century. The conservation and preservation missions for the NPS apply not only to the fossils found in parks, but also apply to the critically important scientific information and data associated with these resources. It is through the associated data that paleontologists are able to breathe life into dusty old bones, shells, wood and footprints in order to understand the diversity of ancient life and how the organisms interacted over geologic time. Field notes, sketches, photographs, maps, reports, publications and fossil specimens are the components of the NPS paleontological legacy and are deserving of care and preservation.

FIGURE 3. Map showing the seven regions of the U.S. National Park Service.

Life in the "Information Age" has presented tremendous new technological advances which have changed the way we do business, how individuals communicate, and has fueled significant cultural evolution. As with other fields of study, paleontology is rapidly transitioning from paper to digital records. Many questions, challenges and opportunities have emerged in data preservation that have been contemplated and implemented for NPS paleontology and associated archives. The many sources of NPS fossil information must be considered in order that "one of a kind" reports or photos are not lost or forgotten. Collectively, hundreds of thousands of paleontology records exist for the NPS, sometime lying dormant in parks file, museum collections and other locations yet to be discovered.

A paleontological resource data management strategy was conceptualized in 2012 in order to integrate the extensive hard copy NPS Paleontology Archives with the growing digital records for NPS paleontology. The NPS Paleontology Synthesis Project (PSP) was initiated as a transitional step in data preservation for NPS paleontology records and archives. A series of spreadsheets piloted around 2000 were updated and systematically expanded to integrate NPS paleontology data pertaining to geologic time, taxonomy, holotype specimens, museum repositories, historic and cultural context, and other categories of information. Several years of data mining in support of the PSP project led to the need to establish a permanent digital archive for organization and preservation of a broad spectrum of NPS paleontological resource information. The NPS Paleontology Archives was created in 2015 with two distinct components: one for "park-specific" paleontological resource information; and one for "servicewide" NPS paleontological resource information.

A third component of the NPS Paleontology Archives involves the organization of electronic scans of publications, articles, reports, and other media from a variety of sources into what is referred to as the NPS Paleontology Library. The scope of this library is fairly broad and inclusive of many geology and paleontology focused publications, with a focus on compiling all known publications associated with NPS paleontology. Many hard copy publications, reports and other archives have been scanned to incorporate into this library. This includes rare gray literature and internal NPS reports which may not be publicly accessible. The library is organized alphabetically by the last name of the first author with separate folders for each letter of the alphabet. Currently there are approximately 7,000 electronic files (PDF's, etc.) within the NPS Paleontology Library.

A "Finding Aid" has been developed for the NPS Paleontology Archives (both park-specific archives and servicewide archives) to facilitate their use in locating particular types of records and archives. This "Finding Aid" continues

to expand and incorporate information to allow users of the archives to understand the organizational structure of this digital archive and where to locate specific categories of records. The NPS Paleontology Archives and Library are stored on a dedicated server which continuously backs up the information to ensure preservation of the archives and library. The records are restricted access due to the sensitive paleontological resource locality information available within some of the records. NPS staff or researchers are able to contact the NPS Paleontology Program in order to obtain copies of any records of interest.

GEOLOGIC TIME

The fossil record preserved within the 268 NPS parks collectively span the geologic time scale from the Proterozoic through the Holocene. The NPS Paleontology Archives include a database which contains information on all of the geologic time intervals represented as surface exposures for each park, as well as, enabling the ability to search for all parks which preserve fossils for a particular geologic time interval. This servicewide park data is particularly useful for public education and interpretation and scientific research. Figure 4 shows the distribution of park records for fossils from a particular geologic time interval.

The Precambrian is the geologic time interval which has the fewest number of parks (8 parks) represented by fossils. Conversely, the Pleistocene is the geologic time interval which has the largest number of parks (121 parks) with documented fossils. Table 1 provides a breakdown of the number and identities of each park which preserves fossils from each geologic time interval. The NPS Paleontological Archives maintains the geologic time information in a database that subdivides each time interval into early, middle and late.

Table 2 shows the NPS areas containing the most geologic time intervals exposed that have documented paleontological resources. DENA has the greatest number of fossiliferous geologic time intervals with 15, with DEVA and YUCH close behind with 14 geologic time intervals.

TAXONOMY

Collectively the NPS PSP has documented an extensive diversity of fossil taxa from the 268 parks which are determined to preserve paleontological resources. The taxonomic information for NPS fossils is maintained within the NPS Paleontology Archives under five broad taxonomic categories: Plant Fossils (Paleobotany), Invertebrate Fossils (Invertebrate Paleontology), Vertebrate Fossils (Vertebrate Paleontology), Trace Fossils (Vertebrate and Invertebrate Ichnology) and Other Fossils.

Within each taxonomic category are subcategories which are based upon widely accepted taxonomic classification for fossil and extant biota which are in accordance with the codes established by the International Commission on Zoological Nomenclature (ICZN, 1999) and the International Association for Plant Taxonomy (IAPT) (Turland et al., 2018). Within the various subdisciplines of paleontology, specialists working on specific taxonomic groups may have differing interpretations on taxonomic identities and affinities which present some challenges in determining placement of some fossil taxa within our NPS Paleontology Archives taxonomic organization. An additional challenge involves remaining current with revisions of taxonomic nomenclature in instances where name-bearing taxa undergo formal renaming of genera and/or species. As these changes in taxonomic nomenclature are encountered the information is amended in the NPS Paleontology Archives. Although name-bearing fossil taxa are closely tied to this discussion of fossil taxonomy, we have included a dedicated section in this paper and within our organization of the NPS Paleontology Archives to specifically address NPS holotype fossils. This discussion of taxonomy considers all fossil taxa from NPS areas, regardless of their status as holotypes.

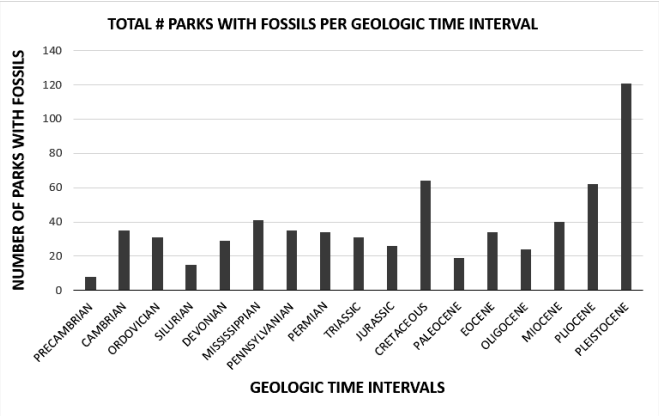

FIGURE 4. Graph showing the distribution and total number of NPS areas that have documented fossils for each geologic time interval.

In some instances, the taxonomic identity of a fossil specimen may not be feasible due to the lack of diagnostic morphological characteristics. Weathering, erosion, transport, metamorphism, mineralization, and other factors may contribute to diminished preservation of fossil specimens. There are also instances where taxonomic identification requires more rigorous study or preparation of a specimen than may be feasible. One common example is isolated pieces of petrified wood. Macroscopic examination of a specimen of petrified wood typically does not enable identification at the genus or species level, which may be possible through microscopic examination of cell morphology and structure. Therefore, a "catch-all" subcategory for "unclassified petrified wood", documented in 77 NPS units, has been included in the NPS Paleontology Archives.

Plant Fossils (Paleobotany): The Plant Fossil (Paleobotany) category includes taxa within the Kingdom Plantae, primarily multicellular and photosynthetic eukaryotes. Among the fossils are green algae, terrestrial plant macrofossils such as leaves, wood, stems, and macroscopic seeds, as well as plant palynomorphs which include pollen and spores. Many forms of traditional "algae" often associated with plants are excluded from Fossil Plants and instead are discussed in the "Other Fossils" category. According to the NPS Paleontology Archives, fossil plants are documented in 152 units of the NPS and are divided into 19 subcategories (Table 3).

A more comprehensive inventory of plant fossils from NPS areas needs to be undertaken in the future in collaboration with professional paleobotanists and palynologists. Paleobotanical research has been undertaken by a number of past and current paleobotanists, including: Sid Ash, Erling Dorf, Frank H. Knowlton, Leo Lesquereux, Steve Manchester, Herb Meyer, William Tidwell, Lester Ward, Elizabeth Wheeler, David White, Scott Wing, and Jack Wolfe. Santucci et al. (2014a) present an example of a NPS region-wide inventory for fossil plants from national parks within the National Capital Region in the District of Columbia, Maryland, Virginia and West Virginia.

Invertebrate Fossils (Invertebrate Paleontology): The Invertebrate Fossil (Invertebrate Paleontology) category includes invertebrate taxa within the Kingdom Animalia. Invertebrates are animals which do not possess a vertebral column and represent the majority of known animal species. The protists and other prokaryotic heterotrophic mobile forms outside of Animalia are discussed and organized in the "Other Fossils" category. Fossil invertebrates are documented from 165 NPS areas and are organized into 34 subcategories in the NPS Paleontology Archives (Table 3).

Research and field collection of invertebrate fossils from

TABLE 1. The number and identification of parks, presented as four-letter acronyms, which have documented fossils from specific geologic time intervals. See Appendix A for the names of parks associated with each park acronym used in the table.

GEOLOGIC TIME INTERVAL	# PARKS	PARK ACRONYMS
PLEISTOCENE	121	ACAD, AMIS, ARCH, ASIS, AZRU, BADL, BELA, BEOL, BIBE, BICA, BICY, BISC, BITH, BOHA, BUFF, BUIS, CABR, CACH, CACO, CAGR, CAHA, CAKR, CALO, CANA, CANY, CARE, CASA, CAVE, CEBR, CHCU, CHIS, CIRO, COLM, COLO, CONG, CRLA, CRMO, CUGA, CUIS, DENA, DEVA, DRTO, EBLA, ELMA, EVER, FIIS, FLFO, FOBU, FOMA, FOMC, FOSU, FOUS, GAAR, GATE, GICL, GLAC, GLBA, GLCA, GOGA, GRBA, GRCA, GRSA, GRTE, GUMO, HAFO, HATU, HEHO, HOCU, IATR (ICAG), INDE, JECA, JOTR, KATM, KEFJ, KOVA, LABE, LAKE, LAMR, LAVO, MACA, MISS, MNRR, MOCA, MOJA, NABR, NAMA, NEPE, NOAT, NOCA, OLYM, ORCA, ORPI, OZAR, PAIS, PIMA, PINE, POHE, PORE, REDW, RUCA, SAGU, SAJH, SAMO, SAPU, SEKI, SHEN, THRO, TICA, TUSK, VAFO, VALL, VICK, WACO, WAMO, WHSA, WICA, WUPA, YELL, YOSE, YUCH, ZION
PLIOCENE	62	ALFL, ASIS, BADL, BAND, BELA, BIBE, BICA, BICY, BITH, BRCA, CACO, CAHA, CALO, CANA, CASA, COLO, CONG, CUIS, DENA, DESO, DEVA, EVER, FOFR, FOMA, FOMR, FRSP, GICL, GLBA, GOGA, GRCA, GRSA, GUIS, HAFO, JOTR, LAKE, LAMR, MNRR, MOCA, MOJA, NATR, NIOB, OLYM, PARA, PEFO, PETE, PETR, PORE, REDW, RICH, SAAN, SAFE, SAMO, TIMU, TONT, TUMA, TUZI, VAFO, WAPA, WRST, WUPA, YELL, YOSE
MIOCENE	40	AGFO, ALFL, BELA, BIBE, CAHA, CALO, CHIS, COLO, CUIS, DENA, DEVA, FOMR, FOPU, GEWA, GLBA, GOGA, GRTE, HATU, JODA, JOTR, LACL, LAKE, LAMR, LEWI, MOCA, MOJA, MORA, NEPE, NIOB, OLYM, PARA, PINE, PINN, PORE, REDW, SAMO, SCBL, SUIT, TUZI, WRST
OLIGOCENE	24	ANIA, BADL, BIBE, CAHA, CHIS, CHRO, DEVA, FOPU, GLAC, GLBA, JODA, KATM, LACL, LAKE, LEWI, MORA, OLYM, PINE, SAMO, SCBL, THRO, VICK, WICA, WRST
EOCENE	34	ANIA, ARCH, BADL, BIBE, BRCA, CACO, CAHA, CEBR, CHIS, COLM, COLO, DEVA, FLFO, FOBU, FOMR, FOPU, GEWA, GLAC, JODA, KATM, LACL, LEWI, MABI, MORA, NOCA OLYM, PINE, PORE, SAMO, THRO, WRST, YELL, YUCH, ZION
PALEOCENE	19	BIBE, BRCA, CEBR, CHIS, DENA, FOPU, FOUS, FOWA, GEWA, GOGA, KATM, LACL, PINE, PISC, SAMO, SUIT, THRO, WRST, YUCH
CRETACEOUS	64	AMIS, ANIA, ARCH, BADL, BAWA, BEOL, BIBE, BICA, BLCA, BRCA, BRCR, BUIS, CABR, CAHA CAKR, CARE, CHCU, CHIR, CHIS, COLM, CONG, CURE, DENA, DINO, ELMA, FIIS, FOFO, FOMC, FOSU, FOWA, GAAR, GATE, GEWA, GLAC, GLCA, GOGA, GREE, GRTE, JODA, JODR, KATM, KOVA, LIBI, MEVE, MNRR, NATR, NOAT, PINE, PRWI, REDW, RICH, RIGR, ROCR, SAFE, SAMO, SARI, VIIS, WHHO, WICA, WRST, YELL, YUCH, YUHO, ZION
JURASSIC	26	CACH, CAKR, CANY, CARE, CAVE, CHIR, DENA, DEVA, DINO, ELMA, GAAR, GLBA, GLCA, GRCA, GRTE, GUMO, JECA, KEFJ, LAKE, MOJA, NABR, NOAT, PARA, PECO, SAFE, SAPU, TAPR, WACA, WICA, WRST, WUPA, YELL, YUCH, ZION
TRIASSIC	31	ARCH, CACH, CANY, CARE, CHOH, COLM, DENA, DEVA, DINO, GAAR, GLCA, GOGA, GRCA, GRTE, LACL, LAKE, LAMR, MANA, MOJA, NOAT, NOCA, PEFO, PISP, RABR, SEKI, SPAR, WRST, WUPA, YELL, YUCH, ZION
PERMIAN	34	CACH, CAKR, CANY, CARE, CAVE, CHIR, DENA, DEVA, DINO, ELMA, GAAR, GLBA, GLCA, GRCA, GRTE, GUMO, JECA, KEFJ, LAKE, MOJA, NABR, NOAT, PARA, PECO, SAFE, SAPU, TAPR, WACA, WICA, WRST, WUPA, YELL, YUCH, ZION
PENNSYLVANIAN	35	ALPO, ARCH, BICA, BISO, BUFF, CANY, CARE, CHIR, CUGA, DENA, DEVA, DINO, FOBO, FONE, FOSC, GAAR, GLCA, GOSP, GRCA, GRSA, GRTE, JECA, LAKE, LIRI, MOJA, NERI, NOAT, OBED, PARA, PECO, POHE, SAFE, WICA, WRST, YELL
MISSISSIPPIAN	41	ABLI, BICA, BISO, BUFF, CAKR, CHIC, CUGA, CUVA, DENA, DEVA, DINO, FODO, FOLA, GAAR, GRCA, GRTE, GWCA, JECA, JEFF, KOVA, LAKE, LINC, MACA, MOJA, NAMA, NERI, NOAT, NOCA, PARA, PERI, RUCA, TICA, ULSG, WAMO, WHHO, WHIS, WICA, WICR, WRST, YELL, YUCH
DEVONIAN	29	BELA, BICA, CACO, CAKR, CHIC, CHOH, CUVA, DENA, DEVA, DEWA, FOLA, GAAR, GLBA, GRBA, GRCA, GRTE, KAWW, KOVA, LAKE, MOJA, NOAT, NOCA, PARA, PIMA, UPDE, WICA, WRST, YELL, YUCH
SILURIAN	15	APPA, BELA, BUFF, CHIC, CHOH, DENA, DEVA, DEWA, GAAR, GLBA, GRBA, KAWW, KOVA, NOAT, YUCH
ORDOVICIAN	31	BELA, BIBE, BICA, BUFF, CHIC, CHOH, DENA, DEVA, DEWA, EFMO, GAAR, GRBA, GRSM, GRTE, HOSP, KAWW, KOVA, LINC, MISS, NATR, NOAT, OZAR, PIRO, ROVA, SACN, SARA, STRI, WAMO, WICA, YELL, YUCH
CAMBRIAN	35	ANAC, ANTI, APPA, BICA, BLRI, CACO, CHOH, DEVA, DINO, EFMO, GAAR, GEWA, GRBA, GRCA, GREE, GRTE, IATR (ICAG), KAWW, KOVA, LAKE, LINC, MOJA, NOAT, OXHI, OZAR, PARA, PIRO, SACN, SAGU, SHEN, SUIT, VAFO, WICA, YELL, YUCH
PRECAMBRIAN	8	APPA, BOHA, DEVA, GLAC, GRCA, MOJA, TONT, YUCH

areas currently administered by the NPS has been undertaken by scientists including Warren Addicott, Robert Blodgett, Frank M. Carpenter, Bill Cobban, T.D.A. Cockerell, Timothy Abbott Conrad, Arthur Cooper, Thomas Dutro, George Girty, James Hall, Ralph Imlay, Edwin McKee, Charles Merriam, Allison Palmer, John Reeside, Reuben Ross, Charles Schuchert, Samuel Scudder, Benjamin F. Shumard, Norm Silberling, Edward O. Ulrich, Charles Walcott, Henry Wickham, and Ellis Yochelson. Norr et al. (2016) represents the first taxonomic inventory for the NPS focused on a group of fossil invertebrates, reporting on the occurrence of trilobites (Class Trilobita) preserved in 33 NPS areas. More than 120 species of trilobites are based on fossils collected and described from NPS-administered lands.

Vertebrate Fossils: The Vertebrate Fossil (Vertebrate Paleontology) category includes vertebrate taxa within the Kingdom Animalia. Vertebrates are animals which possess a vertebral column, including jawless fish (agnathans), cartilaginous fish (chondrichthyans), bony fish (osteichthyans), amphibians, reptiles, birds and mammals. Conodonts are of questionable affinity to vertebrates and are therefore included within invertebrate fossils within the NPS Paleontology Archives for taxonomy. Fossil vertebrates are documented from

TABLE 2. NPS areas containing the most exposed geologic time intervals that preserve paleontological resources.

PARK	# GEOLOGIC TIME INTERVALS
DENA	15
DEVA	14
YUCH	14
WRST	12
GAAR	11
GRTE	11
LAKE	11
NOAT	11
YELL	11

121 NPS areas and are organized into 27 subcategories in the NPS Paleontology Archives (Table 3).

Notable vertebrate paleontologists who have undertaken research and field collecting in NPS areas include Larry Agenbroad, Rachel Benton, Charles Camp, Dan Chure, John Clark, Edward Drinker Cope, Earl Douglass, Nick Famoso, Tony Fiorillo, Ted Fremd, Dave Gillette, Charles Gilmore, Jim Kirkland, Wann Langston, Tom Lehman, Joseph Leidy, Spencer Lucas, O.C. Marsh, Greg McDonald, Jim Mead, John C. Merriam, Bill Parker, Olof Peterson, Charles Repenning, Eric Scott, Morris Skinner, Kathleen Springer, and Chester Stock.

Several NPS-wide thematic paleontological resource inventories involving vertebrate fossils have been completed over the past two decades. The research and data mining associated with these inventories has greatly expanded our understanding of the diversity and distribution of fossil vertebrates within the NPS. Hunt et al. (2006) inventoried the occurrences of fossil fish from NPS areas yielding information on 42 parks with fish fossils. Since this inventory was completed in 2006, at least a dozen additional parks have been identified with the remains of fossil fish. Servicewide vertebrate paleontological resource inventories were undertaken for Mesozoic mammals and non-mammalian therapsids (Tweet and Santucci, 2015) and for non-avian dinosaurs (Tweet and Santucci, 2018).

Trace Fossils (Ichnology): The Trace Fossils (Ichnology) category includes biogenic features and structures preserved in sediments through activities (bioturbation) of past organisms. Trace fossils record the activities and behaviors of ancient invertebrates, vertebrates and plants resulting in a wide variety of traces that can be preserved in a geologic context. Fossil footprints, tracks, trails, burrows, nests, middens, eggs/egg shells, coprolites/dung, root casts, rhizoliths and biogenic sedimentary structures such as stromatolites are examples of trace fossils. Collectively trace fossils are also referred to as ichnofossils, with distinct ichnotaxa which include ichnogenera and ichnospecies. Trace fossils are documented from 127 NPS areas and are organized into 17 subcategories in the NPS Paleontology Archives (Table 3).

Scientists Erwin Barbour, Matthew Bennett, David Bustos, Don Curry, Charles Gilmore, Steve Hasiotis, Adrian Hunt, Martin Lockley, Andrew Milner, Torrey Nyborg, and Jack Wood are among those who have studied NPS ichnofossils. Inventories for fossil vertebrate tracks preserved in NPS areas have identified at least 32 parks (Santucci et al. 1998; Santucci et al. 2006). During 2012, inventories for coprolites (Hunt et al., 2012) and packrat middens (Tweet et al., 2012) from NPS administered lands were completed.

"Other Fossils": The Other Fossils category includes a diverse spectrum of fossil biota, many of which are microfossils. Ediacaran biota, foraminifera, radiolarians, acritarchs, coccoliths, diatoms, dinoflagellates, and fungi are among the 15 subcategories of Other Fossils documented in 104 NPS areas. This total number of parks likely represents an undercounting because of the microscopic nature of these types of fossils, which make them difficult to observe, collect, identify, and study without proper techniques and equipment. No specific inventories have been undertaken for any subcategory within the Other Fossils category.

NPS FOSSIL HOLOTYPES

The establishment of name-bearing type specimens of fossil taxa is a fundamental practice in the science of paleontology. The classification of fossil flora and fauna is derived from the principles and practices of Linnaean taxonomy first proposed by Carl Linnaeus in his publication *Systema Naturae* (Linnaeus, 1735). Modern biological and paleontological taxonomic classification and taxonomic nomenclature are defined by the codes established by the International Commission on Zoological Nomenclature (ICZN, 1999) and the International Association for Plant Taxonomy (IAPT) (Turland et al., 2018).

The defining, description and naming of fossil genera and species enables the ability to recognize the diversity of life preserved in the fossil record, the relationship between fossil taxa, evolutionary changes in taxa over time, paleobiogeographic distributions of taxa, and other important scientific information pertaining to fossils. The name-bearing type fossil specimens serve as the "blueprint" for the design and structure of the fossil record of life on Earth. Therefore, the value of the fossil specimens selected to define a paleontological genus or species warrants careful protection and curation of holotype fossil specimens.

Identification of holotype fossil specimens collected from lands administered by the NPS has been one of the objectives of the NPS PSP. Tweet et al. (2016) presented the first servicewide compilation of name-bearing holotype fossil specimens collected from NPS administered lands. Based on over two decades of research, at least 2,293 holotype fossils have been confirmed as originating from 71 NPS areas and one abolished national monument. This total reflects holotype fossil specimens collected either before or after the establishment of a given park since the locality from which the specimen was derived is now managed by the NPS. The preservation of paleontological resource locality data, regardless of whether a fossil was collected prior to NPS administration, is a critical component of the NPS strategy for the management of non-renewable paleontological resources in parks.

In addition to the 2,293 holotype fossil specimens confirmed from NPS areas, another 2,556 holotype fossil specimens potentially were collected on NPS lands, but remain unconfirmed (Table 4). As discussed in Tweet et al. (2016), non-confirmation is usually the result of ambiguous or missing locality information, an issue which is particularly problematic from the beginning of paleontological studies in the United States through the 1920s. Florissant Fossil Beds National Monument is the NPS area with the largest number of holotype fossil specimens with 430 types confirmed and another 1,315 potential holotypes which are not yet confirmed from the monument. The other NPS areas with high numbers of confirmed holotype fossil specimens include

TABLE 3. Categories of fossil plants, invertebrates, vertebrates and trace fossils used within the organization of the NPS Paleontology Archives. Some categories that are used in the archives have been lumped together for ease of reading. Some taxonomic groups are broken down in more detail than others, due in part to relative abundances of diagnostic fossils across parks. Categories and subcategories are subject to change in response to fossil discoveries and taxonomic reassessment.

PLANT FOSSIL SUBCATEGORIES (19)	INVERTEBRATE FOSSIL SUBCATEGORIES (34)	VERTEBRATE FOSSIL SUBCATEGORIES (27)	TRACE FOSSIL SUBCATEGORIES (17)	OTHER FOSSIL SUBCATEGORIES (15)
Chlorophytes	Sponges	Agnathans	Bioturbation	Proterozoic microfossils
Charophytes	Corals	Placoderms	Stromatolites	Ediacaran biota
Mosses	Bryozoans	Chondrichthyans	Root Traces & Casts	Phanerozoic Acritarchs
Liverworts	Brachiopods	Acanthodians	Invertebrate Burrows	Coccoliths
Hornworts	Hyoliths	Actinopterygians	Invertebrate Tracks	Foraminifera
Lycopods & Allies	Chitons	Sarcopterygians	Invertebrate Nests	Radiolarians
Horsetails & Allies	Bivalves	Other Fish	Invertebrate Coprolites	Diatoms
Ferns	Ammonites	Amphibians	Other Invertebrate Traces	Silicoflagellates
Seed ferns	Coleoids	Turtles	Vertebrate Burrows	Dinoflagellates
Cycads	Nautiloids	Ichthyosaurs	Vertebrate Tracks	Receptaculitids
Cycadeoids	Gastropods	Plesiosaurs	Vertebrate Eggs	Seaweeds
Ginkgoes	Scaphopods	Lepidosaurs	Vertebrate Coprolites	Coralline Red Algae
Conifers	Other Mollusks	Mosasaurs	Vertebrate Regurgialites	Unspecified "Algae"
Gnetophytes	Annelids	Phytosaurs	Other Vertebrate Traces	Fungi
Angiosperms	Arthropoda	Aetosaurs	Packrat Middens	Other Fossils
Unclassified Petrified Wood	Trilobites	Crocodylomorphs	Other Middens	
Unclassified Foliage	Cheliceratans	Dinosaurs	Other Trace Fossils	
Spores & Pollen	Myriapods	Pterosaurs		
Other Fossil Plants	Branchiopods	Other Reptiles		
	Barnacles	Birds		
	Ostracodes	Synapsids		
	Malacostracans	Therapsids		
	Other Crustaceans	Early Mammals		
	Insects	Metatherian Mammals		
	Other Arthropods	Eutherian Mammals		
	Asteroids	Other Mammals		
	Ophiuroids	Other Vertebrate Fossils		
	Blastoids			
	Crinoids			
	Echinoids			
	Other Echinoderms			
	Graptolites			
	Conodonts			
	Other Invertebrates Fossils			

Guadalupe Mountains National Park (219 holotypes), John Day Fossil Beds National Monument (198 holotypes), Yellowstone National Park (175 holotypes), and Grand Canyon National Park (162 holotypes).

MUSEUM REPOSITORIES

The field collection of paleontological specimens is critical to the science of paleontology. The preservation and curation of fossil specimens collected from units of the NPS and other federal lands is based on federal laws, policies, guidance documents and professional museum standards. The care of paleontological specimens in museum collections and the accountability of the repositories, including those maintained within NPS areas, are recognized as essential responsibilities to ensure the preservation of the scientific and educational values of fossils.

As of July 2018, the total number of cataloged specimens in the servicewide NPS paleontology collections is 640,845. These fossil collections are curated and maintained in individual park museums, regional NPS curatorial centers, and in at least 185 museum repositories outside of the NPS. At least 19 museum repositories with NPS fossil collections are located in foreign countries. Badlands National Park (BADL) holds the distinction of having fossil collections in the highest number of outside repositories, totaling 27 museums, compared to all other NPS areas (Table 5).

The regional NPS curatorial centers provide facilities for a large number of parks, within a defined geographic area, to maintain collections of park objects and specimens. The Western Archeological and Conservation Center (WACC) is located in Tucson, Arizona, and maintains fossil collections from 34 NPS areas mostly from the Intermountain Region (IMR) parks. The Midwest Archeological Center (MWAC) is located in Omaha, Nebraska, and maintains fossil collections from at least 21 NPS areas primarily in the Midwest Region (MWR) parks. The Southeast Archeological Center (SEAC) is located

TABLE 4. Total number of confirmed and possible holotype fossil specimens from NPS administered lands (Tweet, et al. 2016).

FOSSIL CATEGORY	CONFIRMED	POSSIBLE	TOTAL
PLANT FOSSILS	540	230	770
INVERTEBRATE FOSSILS	1250	1926	3176
VERTEBRATE FOSSILS	298	373	671
TRACE FOSSILS	80	8	88
OTHER FOSSILS	125	19	144
TOTAL - ALL CATEGORIES	2293	2556	4849

in Tallahassee, Florida, and maintains fossil collections from at least 16 NPS areas located within the Southeast Region (SER) parks. Finally, the Museum Resource Center (MRCE) is located in Landover, Maryland, and maintains fossil collections from at least 10 NPS areas located within the National Capital Region (NCR) parks.

The Smithsonian National Museum of Natural History (USNM) is the museum institution which curates and maintains paleontological collections from more NPS areas than any other museum (Table 6). USNM has fossil specimens from at least 72 confirmed NPS areas, with another possible 7 parks which are not yet confirmed. There are also fossil collections at the USNM from the abolished Fossil Cycad National Monument, South Dakota, which are not counted as part of the 72 confirmed NPS areas. The USNM and the University of California, Museum of Paleontology each maintains a large collection of fossils obtained by U.S. Geological Survey geologists and paleontologists. The NPS has undertaken some limited inventory of these U.S. Geological Survey fossil collections and have identified many fossil localities in parks which are currently not known by NPS staff (Santucci et al., 2014b).

HISTORICAL AND CULTURAL RESOURCE CONTEXT

The history of NPS paleontology extends well before the creation of the NPS in 1916, and even the establishment of Yellowstone National Park in 1872. Santucci (2017) presented a detailed overview of the history of paleontology associated with the NPS which includes the discovery of fossil localities in areas before they were national parks. There is an important historical story regarding an abolished NPS unit (Fossil Cycad National Monument, South Dakota) and how the loss of all of the fossils at the surface led to the site being deauthorized as a unit of the NPS in 1957 (Santucci and Ghist, 2014).

The occurrence of fossils within a cultural resource context presents some interesting human dimensions of paleontological resources (Kenworthy and Santucci, 2006; Santucci et al., 2016). A variety of fossils have been documented from archeological sites and in conjuction with archeological excavations. Projectile points made from petrified wood, crinoids and other fossils used in the manufacturing of jewelry by ancient people, and effigies carved into fossils are examples of fossils in an archeological resource context.

Fossils are also occasionally found within the building stones of historic structures (Kenworthy and Santucci, 2006). Many of the monuments and memorials in the nation's capital, including the Lincoln Memorial and Washington Monument, contain fossils, especially those in which the fossiliferous Indiana Limestone is used in the building stone. The stone bridge over Plum Run along South Confederate Avenue at Gettysburg National Military Park contains several Triassic vertebrate footprints (Santucci and Hunt, 1995). The foundations of the Theodore Roosevelt Lodge at Yellowstone National Park and the Painted Desert Inn at Petrified Forest National Park are constructed of local petrified wood.

Fossils in a cultural resource context have been included in our NPS paleontological resource inventories and within the NPS Paleontology Archives since these fossils require some management action and preservation.

ADDITIONAL ARCHIVES AND DATA MANAGEMENT

The NPS Paleontological Resource Archives include several other categories of information and data which either have begun to be compiled or are planned for the future. These categories may be important sources of information for individual parks and/or collectively in agency wide evaluations. Below are a few paleontological resource categories which will be the focus of development and data mining in the future:

Stratigraphy—The compilation of paleontological resource data pertaining to fossiliferous stratigraphic units exposed in NPS areas has already been demonstrated in two multi-park research projects including "The Morrison Formation Extinct Ecosystem Project" (Turner et al., 1996; Engelmann and Callison, 1998) and "The Chinle Formation Extinct Ecosystem Project" (Martz et al., 2017). Both the Morrison (Jurassic) and Chinle (Triassic) formations research were multidisciplinary studies which involved the evaluation of the geology and paleontology of the respective fossiliferous formations across

TABLE 5. National Park Service areas with the highest number of outside repositories which maintain paleontological collections from that park. **IMR** = Intermountain Region; **MWR** = Midwest Region; **CHDN** = Chihuahuan Desert Network; **NCPN** = Northern Colorado Plateau Network; **NGPN** = Northern Great Plains Network; **ROMN** = Rocky Mountain Network; **SCPN** = Southern Colorado Plateau Network.

PARK	REGION	NETWORK	CONFIRMED REPOSITORIES
Badlands National Park (BADL)	MWR	NGPN	27
Agate Fossil Beds National Monument (AGFO)	MWR	NGPN	23
Grand Canyon National Park (GRCA)	IMR	SCPN	22
Florissant Fossil Beds National Monument (FLFO)	IMR	ROMN	21
Petrified Forest National Park (PEFO)	IMR	SCPN	19
Fossil Butte National Monument (FOBU)	IMR	NCPN	18
Guadalupe Mountains National Park (GUMO)	IMR	CHDN	17
Dinosaur National Monument (DINO)	IMR	NCPN	15

TABLE 6. List of museum repositories that maintain paleontological collections from the highest number of National Park Service areas.

INSTITUTIONS	CONFIRMED NPS UNITS	POSSIBLE NPS UNITS
National Museum of Natural History (USNM)	72	7
University of California Museum of Paleontology (UCMP)	44	10
U.S. Geological Survey (USGS)	35	1
Western Archeological and Conservation Center (WACC)	34	-
Peabody Museum (YPM)	23	3
Midwest Archeological Center (MWAC)	21	2
Natural History Museum of Los Angeles County (LACM)	19	-
American Museum of Natural History (AMNH)	17	2
Southeast Archeological Center (SEAC)	16	-
University of Michigan Museum of Paleontology (UMMP)	15	2
University of Colorado–Boulder Museum of Natural History	14	3
Academy of Natural Sciences (ANSP)	13	2
Field Museum of Natural History (FMNH)	12	3
Museum of Northern Arizona (MNA)	12	-
Cincinnati Museum Center (CMC)	11	1

numerous NPS areas in which those formations were exposed. Evaluating the paleontology for an individual geologic formation over a wide geographic area may enhance the opportunities for scientific interpretations and public education as it pertains to that geologic time interval.

Paleontological Research—Another category of paleontological resource information for the NPS is associated with scientific research conducted in parks. Sources of existing paleontological research information are able to be searched through the NPS Research Permit and Reporting System (RPRS). The RPRS website (https://irma.nps.gov/rprs/Home) provides access to the NPS research permit database which extends back to 1991. RPRS enables searches for NPS research permits based on keywords, park name, investigator name, and year.

A second source of research information within the NPS RPRS database includes access to Investigator Annual Reports (IAR) (https://irma.nps.gov/rprs/Iar/Search). IARs are summary abstracts of work undertaken in the NPS through a research and collecting permit. These annual summaries of research and accomplishments are required from all investigators issued a NPS research permit, although there is not 100% compliance to completing IARs by researchers. Both the RPRS permit database and the Investigator Annual Reports database provide information on paleontological research which may not be available through other sources, since some research projects are not always accompanied by formal scientific publications.

E&R Reports—An important unpublished source of NPS paleontological resource information are the "Examination and Report on Referred Fossils" or E&R reports created by USGS geologists and paleontologists since the late 1800s. Originally, E&R reports were informal documents produced by geologists and mappers working in the field and identifying fossil localities. Some were intended as a means for communication with specialists to help determine relative age of undescribed geologic units in the field or for correlation of fossiliferous strata.

The E&R system was eventually formalized as a two-part process including a form sent by the transmitting geologist in the field and a reply by a USGS geologist or paleontologist who was familiar with the fossils of a particular time period, stratigraphic unit or taxonomic group. In some instances the fossil identifications were incorporated into publications, but in many cases this information was never published. E&R reports include the documentation of many paleontological localities within current NPS areas. This information is often unknown to NPS staff. In many instances the E&R reports were generated prior to the establishment of the NPS unit. Regardless of when the report was generated, the information is relevant to the management of paleontological resources that are managed today within NPS areas. Beginning in 2014 the NPS was extended access to the primary E&R archives at the USGS Center in Reston, Virginia. The systematic review of E&R reports which potentially contain paleontological locality data associated with current NPS areas has resulted in the recognition of hundreds of fossil localities which were not previously known to the NPS (Santucci et al., 2014b). E&R reports which provide paleontological resource locality within or just adjacent to NPS areas are maintained in the NPS Paleontology Archives and are organized by both the NPS unit and the investigator associated with the report.

Theft and Vandalism—The NPS-wide compilation of data involving incidents of paleontological resource theft and vandalism dates back to 1988 with the implementation of the NPS servicewide Natural Resource Crimes Assessment and Action Program. The NPS Ranger Activities Division (RAD) in Washington, D.C. was preparing a budget request from the

NPS seeking funds from Congress to support the assessment and evaluation of resource crimes in parks. A team of resource specialists with backgrounds in specific types of natural resources (wildlife, vegetation, fossils) were assembled to gather baseline information related to natural resource crimes in the NPS. The loss of paleontological resources due to human activities, including unauthorized fossil collecting in parks, was viewed to be a critical resource protection issue for the NPS. The senior author of this publication was selected to coordinate the assessment of NPS paleontological resource crimes including the theft and vandalism of non-renewable fossils.

The initial resource crimes assessment was completed in 1992 and reported that between 1989 and 1991, a minimum of 1,638 fossil specimens were illegally collected in NPS areas. During this period, 154 citations were issued collectively totaling $5,920 in fines. Additionally, five arrests were reported during this period associated with paleontological resource crimes in parks. One of the conclusions resulting from the 1989–1991 paleontological resource crimes study was that there was a general under-reporting of fossil-related incidents and paleontological resource protection training was recommended by RAD.

A similar servicewide paleontological resource crimes assessment was conducted between 1997 and 1999. A total of 721 fossil crime incidents were reported, resulting in 421 citations being issued and six arrests. The total fines for paleontological resource crimes during this period totaled $119,925. Although it is not possible to accurately report the reason for the increase in citations between the first study (1989–1991) and the second study (1997–1999), it is assumed that the increased training and awareness for over 700 NPS rangers may have contributed to the increase in fossil crime citations being issued.

Beginning in 2000, the NPS has formally included annual reporting for paleontological resource crimes, and these data are maintained in the NPS Paleontological Resource Archives. Observation of the paleontological resource crime data for approximately 18 years (2000-2018) suggests that there is still an under-reporting of fossil-related incidents.

Planning documents—The NPS has historically generated a variety of planning documents to support park and resource management activities. These include General Management Plans (GMPs), Resource Management Plans (RMPs), Resource Stewardship Strategies (RSSs) and more recent planning documents referred to as Foundation Documents. Planning documents are important tools, sometimes required by law, to support planning in parks which allow public input. GMPs have been the standard for comprehensive park planning defining the direction of park management for a span of 10 to 20 years. However the considerable time and expense for developing GMPs has limited the ability to produce these documents for all the parks that need this planning. Within the past decade the NPS has adopted a new and more efficient planning strategy with the development of park Foundation Documents. Foundation Documents are viewed as mini-GMPs for parks, which require much less time and funding to produce.

Similarly, the NPS has discontinued producing the traditional park Resource Management Plans (RMPs) and have developed a new planning strategy for resource managers called the Resource Stewardship Strategy (RSS). RSSs are planning documents which provide guidance to park managers integrating resource management, research, and resource education as the core components. A central focus of the RSS is to define the desired condition of park resources and to implement strategies in order to assess, monitor and maintain desired resource conditions.

Paleontological resources are included, where appropriate, in park Foundation Documents and Resource Stewardship Strategies. Park Foundation Documents identify and make recommendations for where baseline data and planning are needed for particular resources, including fossils. As of the date of this publication, 340 NPS areas have recently completed Foundation Documents. A search of the NPS Foundation Document database, containing data for the 340 parks with completed Foundation Documents, revealed at least 86 park requests for paleontological resource data needs and at least 19 park requests for paleontological resource planning needs. As the remaining 77 park Foundation Documents are completed, the number of paleontological resource data and planning needs will likely increase.

Photoarchives and Photogrammetry—The NPS Paleontology Archives also maintains photographs and photogrammetric images associated with NPS paleontological resources. Tens of thousands of NPS geology and paleontology-themed photos are maintained in the archives, mostly distributed within individual park folders designated for photos. Recent work by the NPS Paleontology Program has led to the acquisition of photogrammetric images of fossil specimens from several dozen NPS areas (Wood and Santucci, 2014). These images were obtained of specimens in situ at parks and of specimens curated within museum collections. Photogrammetry creates an electronic model of specimens which supports scientific research, resource management, monitoring, and interpretation and education by parks and cooperating partners.

CONCLUSION

Each year the paleontological resource information associated with the NPS continues to expand through new scientific research, resource management, inventory and monitoring, curatorial activities, educational outreach and other factors. As with other NPS resources, the NPS Paleontology Program strives to preserve park fossils and their associated information for the benefit of future generations, especially Junior Paleontologists of all ages.

The holistic approach to paleontological resource data management for the NPS is much more than “bean-counting” by federal bureaucrats. Our role as federal land and resource managers is to consider all values and management needs association with these non-renewable resources. Although research is extremely important, it does not represent the full spectrum of responsibilities we are required to address as stewards of the NPS fossil record. Maintaining this body of historic, scientific and other information will prove to be useful to those who will inherit the care of NPS fossils in the future. We also must recognize that we need to communicate our goals, objectives and information to individuals who may not be paleontologists, geologists or even scientists. We must also continue to consider and be prepared to adapt to the evolving technologies that will likely become available in the future. The labor-intensive efforts we put forth now to preserve the broadest range and most comprehensive information and data tied to NPS paleontological resources will empower our future paleontology stewards.

ACKNOWLEDGMENTS

Over the course of compiling NPS paleontological resource information, photos and other information since 1985, there have been a large number of individuals who have contributed to this long term effort. Scores of museum curators and collection managers, both in parks and outside repositories, have consistently been tremendous sources of information related to NPS paleontological resources and collections. Kathy Hollis (USNM), K.C. McKinney (USGS), Erica Clites (UCMP), Colleen Hyde and Kim Besom (GRCA), Erin Eichenberg (LAKE and TUSK), and Mike Antonioni (NACE) are just a few museum curators among many who have helped to expand our NPS paleontology archives.

We are greatly indebted to the generous support from USGS Nancy Stamm and David Soller to discover the wealth of NPS paleontology information contained in the USGS E&R reports which represent an important component of the NPS Paleontology Archives. We want to extend our appreciation to retired NPS Historian Harry Butowsky for championing NPS geology and paleontology through his NPS History website. Additional thanks to Erin Eichenberg (TUSK) and J.P. Hodnett for providing valuable feedback through review of this manuscript.

In recent years the development of the NPS Paleontology Archives and Library has been supported by the leadership within the NPS Geologic Resources Division (GRD) including Hal Pranger, Dave Steensen and Lisa Norby. Additionally, we want to acknowledge Jim Wood, Jack Wood and the late John Ghist from GRD for contributing their time, energy and ideas to develop new innovations for NPS paleontology through outreach, education and the use of new technologies.

I have been very fortunate to work with, and for, three outstanding superintendents who recognized the value of NPS efforts beyond individual park boundaries. I will always be indebted to Dave McGinnis (BADL & FOBU), Gary Cummins (PEFO) and David Vela (GWMP) for allowing me to work on servicewide NPS paleontological resource issues.

Finally, one of my fond memories from my NPS career took place in a surplus FEMA trailer that we obtained for our Resource Management Program at FOBU in the late 1990s and early 2000s. I was working half time between FOBU and the NPS GRD, as the first servicewide NPS paleontologist. I spent some formative early days mapping out the goals, objectives and dreams for the NPS Paleontology Program with Jason Kenworthy and Alison Mims. One of our important discussions involved how we should compile, organize and preserve all the NPS paleontology data we were amassing for the parks. Jason, Alison and I shared lots of great ideas, some of which have been implemented and some of which served as the foundation and road map for the work we are doing today in the NPS Paleontology Program.

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APPENDIX A

List of 268 NPS units, organized by NPS region, in which fossils occur *in situ* within a geologic context, in museum collections, and / or within a cultural resource context.

Asterisks (*) identify the 17 NPS units reference paleontological resources in their enabling legislation.

Alaska Region (14)

ANIA	Aniakchak National Monument and Preserve
BELA	Bering Land Bridge National Preserve*
CAKR	Cape Krusenstern National Monument
DENA	Denali National Park and Preserve
GAAR	Gates of the Arctic National Park and Preserve
GLBA	Glacier Bay National Monument and Preserve
KATM	Katmai National Park and Preserve
KEFJ	Kenai Fjords National Park
KOVA	Kobuk Valley National Park
LACL	Lake Clark National Park and Preserve
NOAT	Noatak National Preserve
SITK	Sitka National Historical Park
WRST	Wrangell-St. Elias National Park and Preserve
YUCH	Yukon-Charley Rivers National Preserve*

Intermountain Region (74)

ALFL	Alibates Flint Quarry National Monument
AMIS	Amistad National Recreation Area
ARCH	Arches National Park
AZRU	Aztec Ruins National Monument
BAND	Bandelier National Monument
BEOL	Bent's Old Fort National Historic Site
BIBE	Big Bend National Park
BICA	Bighorn Canyon National Recreation Area
BITH	Big Thicket National Preserve
BLCA	Black Canyon of the Gunnison National Park
BRCA	Bryce Canyon National Park
CACH	Canyon de Chelly National Monument
CAGR	Casa Grande Ruins National Monument
CANY	Canyonlands National Park
CARE	Capitol Reef National Park
CAVE	Carlsbad Caverns National Park
CEBR	Cedar Breaks National Monument
CHCU	Chaco Culture National Historical Park
CHIC	Chickasaw National Recreation Area
CHIR	Chiricahua National Monument
COLM	Colorado National Monument
CORO	Coronado National Memorial
CURE	Curecanti National Recreation Area
DETO	Devil's Tower National Monument
DINO	Dinosaur National Monument*
ELMA	El Malpais National Monument
ELMO	El Morrow National Monument
FLFO	Florissant Fossil Beds National Monument*
FOBO	Fort Bowie National Historic Site
FOBU	Fossil Butte National Monument*
FOLA	Fort Laramie National Historic Site
GICL	Gila Cliff Dwellings National Monument
GLAC	Glacier National Park
GLCA	Glen Canyon National Recreation Area
GOSP	Golden Spike National Historic Site
GRCA	Grand Canyon National Park
GRSA	Great Sand Dunes National Park and Preserve
GRTE	Grand Teton National Park
GUMO	Guadalupe Mountains National Park
HOVE	Hovenweep National Monument
HUTR	Hubbell Trading Post National Historic Site
JODR	John D. Rockefeller, Jr., Memorial Parkway
LAMR	Lake Meredith National Recreation Area
LIBI	Little Bighorn Battlefield National Monument
MEVE	Mesa Verde National Park
MOCA	Montezuma Castle National Monument
NABR	Natural Bridges National Monument
NAVA	Navajo National Monument
ORPI	Organ Pipe Cactus National Monument
PAIS	Padre Island National Seashore
PAAL	Palo Alto Battlefield National Historic Site
PECO	Pecos National Historical Park
PEFO	Petrified Forest National Park*
PETR	Petroglyphs National Monument
PIMA	Hohokam Pima National Monument
PISP	Pipe Spring National Monument
RABR	Rainbow Bridge National Monument
RIGR	Rio Grande Wild and Scenic River
ROMO	Rocky Mountain National Park
SAAN	San Antonio Missions National Historical Park
SAGU	Saguaro National Park
SAPU	Salinas Pueblo Missions National Monument
TICA	Timpanogos Cave National Monument
TONT	Tonto National Monument
TUMA	Tumacacori National Historical Park
TUZI	Tuzigoot National Monument
VALL	Valles Caldera National Preserve
WACA	Walnut Canyon National Monument
WACO	Waco Mammoth National Monument*
WHSA	White Sands National Monument
WUPA	Wupatki National Monument
YELL	Yellowstone National Park
YUHO	Yucca House National Monument
ZION	Zion National Park*

Midwest Region (38)

AGFO	Agate Fossil Beds National Monument*
APIS	Apostle Islands National Lakeshore
BADL	Badlands National Park
BUFF	Buffalo National River
CHRO	Chimney Rock National Historic Site
CUVA	Cuyahoga Valley National Park
EFMO	Effigy Mounds National Monument
FOLS	Fort Larned National Historic Site
FOSC	Fort Scott National Historic Site
FOUS	Fort Union Trading Post National Historic Site
GWCA	George Washington Carver National Monument
HEHO	Herbert Hoover National Historic Site
HOCU	Hopewell Culture National Historical Park
HOSP	Hot Springs National Park
IATR	Ice Age National Scientific Reserve/Scenic Trail
INDU	Indiana Dunes National Lakeshore
ISRO	Isle Royale National Park
JECA	Jewel Cave National Monument
JEFF	Jefferson National Expansion Memorial
KNRI	Knife River Indian Villages National Historic Site
LIBO	Lincoln Boyhood National Memorial
LIHO	Lincoln Home National Historic Site
MISS	Mississippi River National River & Recreation Area
MNRR	Missouri National Recreational River
NIOB	Niobrara National Scenic River

OZAR	Ozark National Scenic Riverways
PERI	Pea Ridge National Military Park Riverway
PEVI	Perry's Victory & International Peace Memorial
PIRO	Pictured Rocks National Lakeshore
SACN	Saint Croix National Scenic Riverway
SCBL	Scotts Bluff National Monument
SLBE	Sleeping Bear Dunes National Lakeshore
TAPR	Tallgrass Prairie National Preserve
THRO	Theodore Roosevelt National Park
ULSG	Ulysses S Grant National Historic Site
VOYA	Voyageurs National Park
WICA	Wind Cave National Park
WICR	Wilson's Creek National Battlefield

National Capital Region (24)

ANAC	Anacostia Park
ANTI	Antietam National Battlefield
BAWA	Baltimore Washington Parkway
CHOH	Chesapeake & Ohio Canal National Historical Park
FODU	Fort Dupont Park
FOFO	Fort Foote Park
FOWA	Fort Washington Park
FRDO	Frederick Douglas National Historic Site
GWMP	George Washington Memorial Parkway
GREE	Greenbelt Park
HAFE	Harpers Ferry National Historical Park
LINC	Lincoln Memorial
MANA	Manassas National Battlefield Park
MLKM	Martin Luther King, Jr. Memorial
MONO	Monocacy National Battlefield
NAMA	National Mall & Memorial Parks
OXCO	Oxon Cove Park/Oxon Hill Farm
PISC	Piscataway Park
PRWI	Prince William Forest Park
ROCR	Rock Creek Park
SUIT	Suitland Parkway
THJE	Thomas Jefferson Memorial
WAMO	Washington Monument
WHHO	White House – President's Park

Northeast Region (32)

ACAD	Acadia National Park
ALPO	Allegheny Portage Railroad National Historic Site
ASIS	Assateague Island National Seashore
BLUE	Bluestone National Scenic River
BOHA	Boston Harbor Islands National Recreation Area
CACO	Cape Cod National Seashore
COLO	Colonial National Historical Park
DEWA	Delaware Water Gap National Recreation Area
FIIS	Fire Island National Seashore
FOMC	Fort McHenry National Monument & Historic Shrine
FOMR	Fort Monroe National Monument
FONE	Fort Necessity National Battlefield
FRSP	Fredericksburg & Spotsylvania National Military Park
GARI	Gauley River National Recreation Area
GATE	Gateway National Recreation Area
GETT	Gettysburg National Military Park
GEWA	George Washington Birthplace National Monument
HATU	Harriet Tubman Underground Railroad National Monument
INDE	Independence National Historical Park
KAWW	Katahdin Woods and Waters National Monument*
MABI	Marsh-Billings-Rockefeller National Historical Park
NERI	New River Gorge National River
PETE	Petersburg National Battlefield
PINE	Pinelands National Reserve
RICH	Richmond National Battlefield Park
ROVA	Roosevelt-Vanderbilt National Historic Sites
SARA	Saratoga National Historical Park
SHEN	Shenandoah National Park
SPAR	Springfield Armory National Historic Park
EDIS	Thomas Edison National Historical Park
UPDE	Upper Delaware Scenic and Recreational River
VAFO	Valley Forge National Historical Park

Pacific West Region (41)

CABR	Cabrillo National Monument
CHIS	Channel Islands National Park*
CIRO	City of Rocks National Reserve
CRLA	Crater Lake National Park
CRMO	Craters of the Moon National Monument and Preserve
DEVA	Death Valley National Park*
EBLA	Ebey's Landing National Historical Reserve
FOVA	Fort Vancouver National Historic Site
GOGA	Golden Gate National Recreation Area
GRBA	Great Basin National Park
HAFO	Hagerman Fossil Beds National Monument*
HALE	Haleakala National Park
HAVO	Hawaii Volcanoes National Park
JODA	John Day Fossil Beds National Monument*
JOMU	John Muir National Historic Site
JOTR	Joshua Tree National Park*
LABE	Lava Beds National Monument
LAKE	Lake Mead National Recreation Area
LARO	Lake Roosevelt National Recreation Area
LAVO	Lassen Volcanic National Park
LEWI	Lewis & Clark National Historical Park
MANZ	Manzanar National Historic Site
MOJA	Mojave National Preserve
MORA	Mount Rainier National Park
NEPE	Nez Perce National Historical Park
NOCA	North Cascades National Park
OLYM	Olympic National Park
ORCA	Oregon Caves National Monument
PARA	Grand Canyon-Parashant National Monument*
PINN	Pinnacles National Monument
PORE	Point Reyes National Seashore
PUHO	Pu' Uhonua o Hōnaunau National Historic Park
REDW	Redwood National and State Parks
SAJH	San Juan Island National Historical Park
SAMO	Santa Monica Mountains National Recreation Area
SEKI	Sequoia and Kings Canyon National Parks
TUSK	Tule Springs Fossil Beds National Monument*
VALR	World War II Valor in the Pacific National Monument
WAPA	War in the Pacific National Historical Park
WHIS	Whiskeytown National Recreation Area
YOSE	Yosemite National Park

Southeast Region (40)

ABLI	Abraham Lincoln Birthplace National Historic Site
BICY	Big Cypress National Preserve
BISO	Big South Fork National River and Recreation Area

BISC	Biscayne National Park
BLRI	Blue Ridge Parkway
BRCR	Brices Cross Roads National Battlefield Site
BUIS	Buck Island Reef National Monument
CANA	Canaveral National Seashore
CAHA	Cape Hatteras National Seashore
CALO	Cape Lookout National Seashore
CARL	Carl Sandberg Home National Historic Site
CASA	Castillo de San Marcos National Monument
CHCH	Chickamauga & Chattanooga National Military Park
CONG	Congaree National Park
CUGA	Cumberland Gap National Historical Park
CUIS	Cumberland Island National Seashore
DESO	De Soto National Memorial
DRTO	Dry Tortugas National Park
EVER	Everglades National Park
FODO	Fort Donelson National Battlefield
FOFR	Fort Frederica National Monument
FOMA	Fort Matanzas National Monument
FOPU	Fort Pulaski National Monument
FORA	Fort Raleigh National Historic Site
FOSU	Fort Sumter National Monument
GRSM	Great Smoky Mountains National Park
GUIS	Gulf Islands National Seashore
LIRI	Little River Canyon National Preserve
MACA	Mammoth Cave National Park
NATR	Natchez Trace Parkway
OBED	Obed Wild and Scenic River
OCMU	Ocmulgee National Monument
RUCA	Russell Cave National Monument
SARI	Salt River National Historical Park & Ecological Preserve
SHIL	Shiloh National Military Park
STRI	Stones River National Battlefield
TIMU	Timucuan Ecological and Historic Preserve
TUIN	Tuskegee Institute National Historic Site
VICK	Vicksburg National Military Park
VIIS	Virgin Islands National Park

National Trails (5) (within multiple regions)

APPA	Appalachian National Scenic Trail
LECL	Lewis & Clark National Historic Trail
OREG	Oregon National Historic Trail
POHE	Potomac Heritage National Scenic Trail
SAFE	Santa Fe National Historic Trail