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**THE HUMAN DIMENSIONS OF PALEONTOLOGICAL RESOURCES:
CONTRIBUTING TO SCIENCE, STEWARDSHIP, AND CONSERVATION IN
NATIONAL PARK SERVICE AREAS**

A Dissertation in
Recreation, Parks, and Tourism Management
by
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ABSTRACT

Paleontologists strive to fill in the gaps in the fossil record. Those few paleontologists working for federal land managing agencies encounter a multitude of fossil management issues that are not traditionally part of their education and training in paleontology and are often unfamiliar to many professional paleontologists. This research was designed to better understand the relationships between people and fossils. Presented here is a conceptual framework for assessing the human dimensions of paleontological resources based upon the diversity of values that people ascribe to fossils.

This research focuses primarily upon fossil-related issues identified within the U.S. National Park Service (NPS) including the two-hundred and eighty-seven parks currently known to preserve fossils. The mission of the NPS is defined in part by statutory and regulatory mandates which are integrated with scientific principles and resource management practices. NPS paleontologists embody the principles of the 1916 Organic Act (codified as Title 54 of the U.S. code) by safeguarding the complex mission of ensuring resource stewardship while promoting public enjoyment are applied to park paleontological resources.

Surveys exploring the relationships between park visitors and fossils were undertaken at two national parks with distinctly different scope, significance, distribution, and management issues associated with the respective park's paleontological resources. Badlands National Park, South Dakota, was selected for this study based upon the park's rich, abundant, and relatively accessible paleontological resources and the complex fossil management issues documented at the park. Denali National Park and Preserve, Alaska,

was selected because of the relatively recent discovery of fossils in remote locations in the park which have received considerable media attention increasing public awareness and interest in the park's fossils. The demographic data and descriptive statistics presented here are intended to inform park managers about visitor perspectives involving park paleontological resources and their management.

An additional component of this research focuses on National Fossil Day (NFD) and data obtained through a survey of NFD partners. The NPS funded this survey in 2016 to inform and guide the agency's coordination of the NFD outreach partnerships established to promote the scientific and educational values of fossils. The results of this 2016 NFD partner survey are presented with discussion of the role this nationwide celebration serves in promoting fossil stewardship with the public.

Collectively, the development of the conceptual framework for the human dimensions of paleontological resources, the results of the two exploratory visitor surveys, and the data obtained by surveying NFD partners to fill in some gaps in knowledge associated with paleontological resources management and the stewardship of fossils on federal and other public lands.

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Chapter 1

Introduction

Many professional paleontologists report that their interest in fossils is tied to some childhood opportunities or experiences that sparked their developing intellectual curiosity and imagination. How often have you heard a child respond to the question “What do you want to be when you grow up?” by enthusiastically stating “...become a paleontologist!” The fascination people, especially children, have with fossils, especially dinosaurs, is almost universal and can be observed among diverse cultures from around the world.

Park rangers at Badlands National Park, Fossil Butte National Monument, Petrified Forest National Park, and other national parks rich in fossils have shared some exciting moment with a park visitor who discovers their very first fossil emerging from strata during their hike together in the park. The rangers know that moments like this provide a perfect time to discuss why it is important to leave the fossil where it was found in order that other visitors and families may have a similar moment of discovery.

Fossil exhibits, especially those displaying dinosaurs, are extremely popular with the public and are often one of the primary attractions at natural history museums and science centers. Museums present the best access for the public to see actual fossils, sometimes assembled into complete or near-complete skeletons of the prehistoric inhabitants of Planet Earth. The ability to stand next to or take a photograph of the reconstructed remains of giant dinosaurs, mammoths, or sabretooth cats allows museum

visitors to make a more meaningful connections with and gain a greater understanding of life from our past. Each year millions of visitors will encounter fossils in museums across the United States and around the world.

The National Park Service and other public lands provide visitors different fossil-experiences where petrified remains of ancient animals and plants can be observed in a natural condition within a geologic context. Observing fossils “in the wild” within rock strata is a very different experience from viewing fossils on display in a museum. The types of questions that visitor’s often have when seeing fossils within geologic strata are different from the types of questions visitors often ask at museums. Visitors observing in situ fossils seek answers to questions such as: 1) “What is the relationship between fossils and the rocks they are preserved?”; 2) “How do paleontologists safely remove the fossils from the rock and make them look so good when displayed in museums?”; 3) “What do the rocks and fossils tell us about the ancient environments?”.

The U.S. National Park Service (NPS) administers 287 different park units in which fossils have been documented (Fig. 1-1; Appendix A). Eighteen NPS areas include specific reference to paleontology or fossils in the park’s enabling legislation or proclamation, most of which are both nationally and globally significant fossil localities. The fossil record of the NPS spans nearly 2 billion years. Some of the oldest fossils in North America are exposed high in the Rocky Mountains within Glacier National Park, Montana, and represent ancient algal mats known as stromatolites exquisitely preserved in Precambrian rocks. Many NPS areas share a more recent and diverse record of ice age fossils which include Pleistocene vertebrate remains preserved within caves at Grand Canyon National Park, Arizona, and Guadalupe Mountains National Park, Texas.

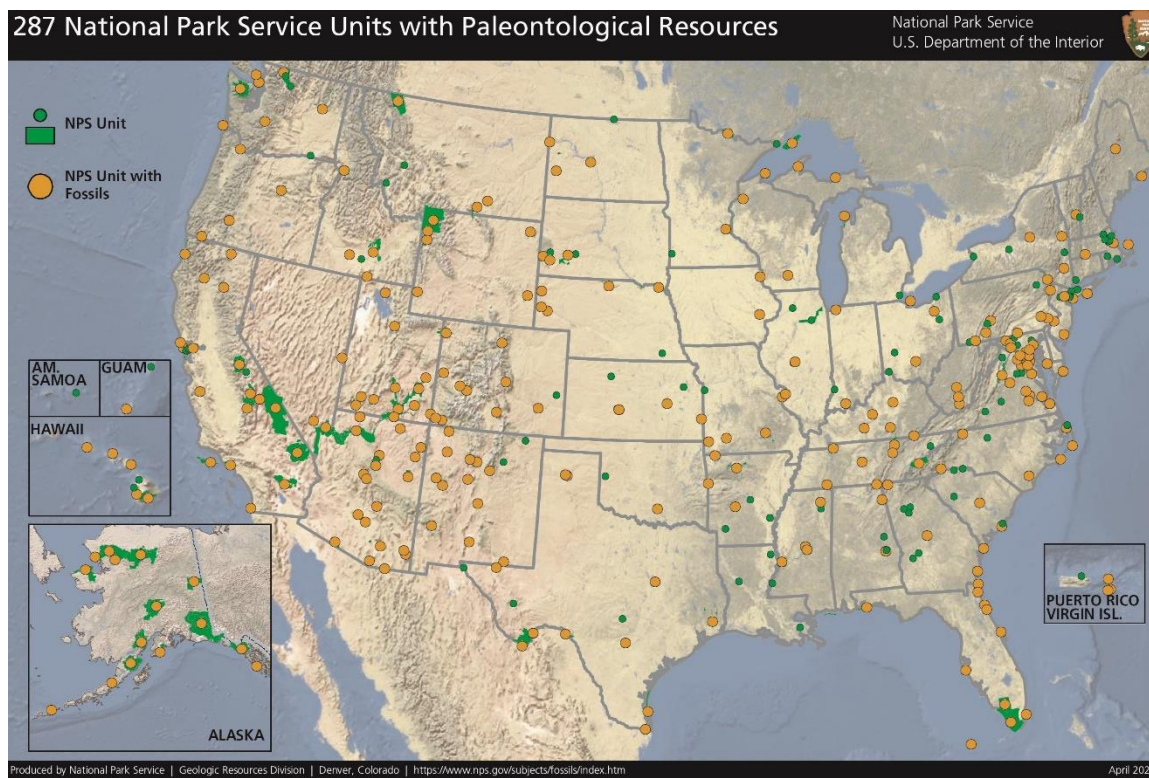


Figure 1-1: United States map showing the 287 National Park Service areas in which paleontological resources have been documented. (NPS Photo).

The paleontologist's view that our knowledge of the fossil record is only as good as the fossil discoveries made during the previous field season continues to be supported by recent fossil discoveries within the national parks. The discovery of fossil footprints in ice age playa lake deposits at White Sands National Park over the past decade have uncovered evidence confirming the contemporary co-occurrence of humans and Late Pleistocene megafauna (Bustos et al., 2018, 2024; Bennett et al., 2021). This research has helped raise new questions related to the antiquity of humans in the New World documented human footprints at the park which date to at least 23,000 years before the present (Bennett et al., 2020; Pigati et al., 2023). Recent paleontological resource inventories at Mammoth Cave National Park have revealed an incredibly rich and diverse

Mississippian marine fauna including more than 70 species of fish, six of which have been described and named as new species (Hodnett et al., 2023, 2024a, 2024b, 2025). Recent discoveries of dinosaur remains in Alaska national parks, a rare burrowing mammal-like reptile at Glen Canyon National Recreation Area, and the documentation of thousands of mummified bats in remote caves in Grand Canyon National Park are all a testament to the importance of proactive stewardship and protection of NPS paleontological resources (Fiorillo et al., 2014; Druckenmiller et al., 2017; Chambers et al., 2024; Milner et al., 2024).

The NPS Paleontology Program provides agency-wide support to the 287 parks with fossils with a wide range of park-specific needs involving the management, inventory, monitoring, stabilization, research, curation, interpretation, protection, planning, and other technical support for the non-renewable paleontological resources (Santucci, 2017; Santucci et al., 2018). The NPS employs only twelve professional paleontologists, and many parks lack the expertise to address the various needs with the management of fossils.

The NPS offers extraordinary opportunities for paleontological research and public education, but unfortunately experience incidents of unauthorized fossil collecting. Any collection or removal of fossils in NPS areas is illegal unless a park approved research and collecting permit is issued. Interpretation and education programs in fossil parks emphasize the importance of preservation and protection of non-renewable paleontological resources. Fossil stewardship messaging is important to the NPS and is incorporated into programming, media, and the Junior Paleontologist Program.

Rangers and paleontologists working in the NPS have identified the need for better information and training on the best practices for communicating stewardship and leave no trace principles applied to park fossils. The research presented here is a first attempt to understand and define the human dimensions of paleontological resources and the relationships between people and fossils. Chapter 2 presents a conceptual framework for assessing the human dimensions of paleontological resources and their management. This venture benefited greatly from the collective work of other pioneers investing their careers in applying the principles of human dimensions of natural resources in places like Yellowstone National Park where the interactions between people and wildlife has challenged park staff (Decker et al., 2001; Manfredo et al., 2002, 2004; Manfredo, 2008; Anderson et al., 2010; Coleman et al., 2013; Richardson et al., 2016; Richardson and Enriquez 2024).

Once the conceptual framework was designed for the human dimensions for paleontological resources, there was a need to develop a targeted research project to gather data to begin to understand some of the relationships between people and fossils. To support management interests and questions which have arisen within the NPS, two exploratory visitor fossil surveys were designed and implemented. This research involved information collection from park visitors relative to their values, interests, and other perspectives involving park fossils and their management. Chapter 3 presents the results of the two visitor fossil surveys one undertaken at Badlands National Park, SD, and the other conducted at Denali National Park and Preserve. These two parks were selected for visitor fossil surveys based upon park-specific interests and needs presented in this dissertation.

Interpretation and education are important tools used by NPS rangers to promote awareness, understanding, and advocacy for the agency's resource stewardship responsibilities. The Paleontological Resource Preservation Act specifically mandates for federal agencies "...to establish a program to increase public awareness about the significance of paleontological resources." Chapter 4 of this dissertation summarizes the successful partnership National Fossil Day (NFD) which promotes the scientific and educational values of fossils and presents the results of a survey of NFD partners conducted in 2016 to better understand the scope and utility of NFD outreach.

Finally, Chapter 5 presents a strategic vision for National Park Service paleontology. The goal is to use and synthesize the information in this dissertation to serve as a foundation for future planning and activities for the NPS and the NPS Paleontology Program.

Chapter 2

Toward a Conceptual Framework for Assessing the Human Dimensions of Paleontological Resources and Their Management

People and Paleontology

A fundamental topic in paleontology that has garnered little attention is an evaluation of the values that humans ascribe to fossils. Some examples of human values associated with fossils include scientific, educational, recreational, spiritual, commercial, and even aesthetic values. An assessment of the types and diversity of values that humans place on fossils should shed light on individual and societal attitudes, perceptions and even behaviors linked to fossils. Increased understanding of the human dimensions of paleontological resources may shed light on the motivations influencing human thinking and behaviors. In turn, social science research involving the human dimensions of fossils may help to better reveal the basis for some of the following questions, which highlight normative occurrences and historical events related to paleontology:

- Why are children so universally passionate about fossils? (And how can that enthusiasm about fossils be used to further children's interest in science?)
- Why are movies such as *Jurassic Park* and *Jurassic World*, which feature dinosaurs, some of the highest grossing box-office draws of all time?

- Why are some members of the public willing to pay millions of dollars to own an original skeleton of a prehistoric creature?
- Why do some individuals knowingly take the risk of stealing fossils from a national park or other type of protected area, when this action is illegal and subject to penalty?
- What human factors contributed to the disappearance of the paleontological resources at Fossil Cycad National Monument, South Dakota, resulting in this monument becoming abolished as a unit of the National Park Service?

This compilation is a first attempt to develop a conceptual framework for assessing the human dimensions of paleontological resources. The purpose of this conceptual framework is to lay the foundation for future research by beginning to identify and define the interrelationships between people and fossils (Fig. 2-1). Through future study, it will be important to identify whether there are basic social or demographic patterns which influence the human dimensions and values associated with paleontological resources. There is a general lack of data available regarding the range of human values, beliefs, perspectives, motivations and behaviors which may result in either positive or negative impacts on non-renewable resources (Kim and Weiler, 2013).

It is important to recognize that fossils possess their own scientific and educational values and are often managed in accordance with laws and in the public trust. The impairment of paleontological resources due to human-related activities would result in the loss of the scientific and educational values these resources possess (Shimada et al.,

2014). The data gained through targeted social science research may help inform scientists, educators, business owners, public land managers and others to better understand and implement effective strategies for the enjoyment, use, management and stewardship of non-renewable fossils.

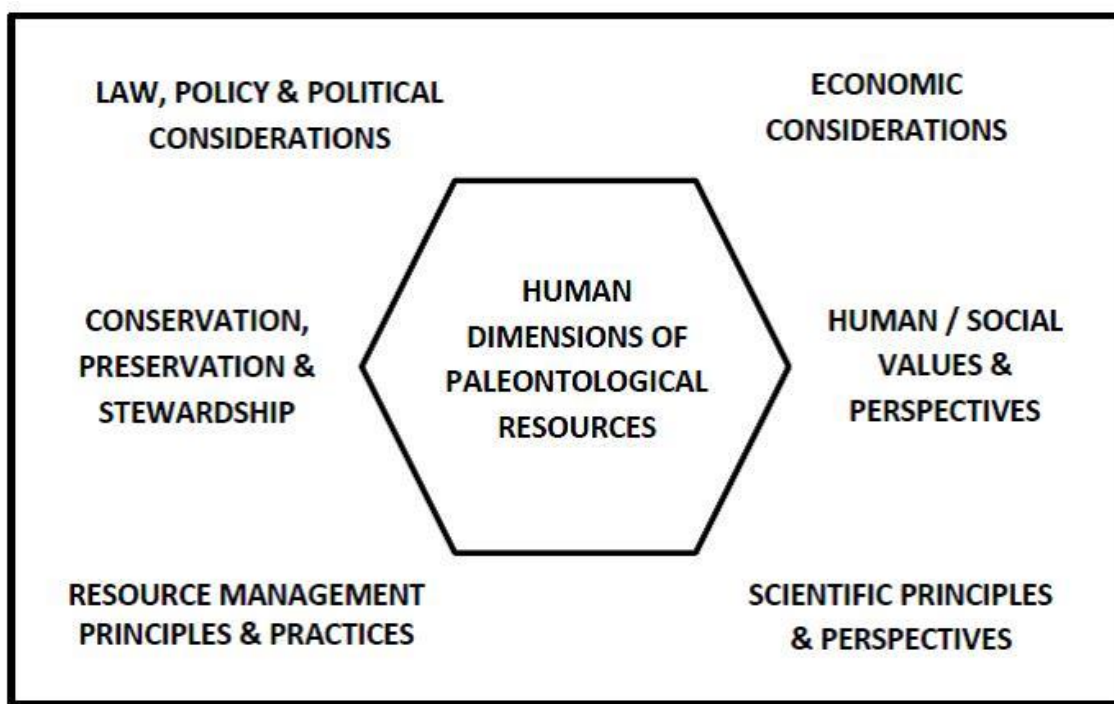


Figure 2-1: Conceptual model identifying the 6 primary factors defining the human dimensions of paleontological resources.

What are Paleontological Resources?

In order to assess and understand the human dimensions of paleontological resources, it is important to define the scope of meaning applied to the resource. Based on the intent of this discussion we are using the terms paleontological resources and fossils

synonymously and interchangeably. Although there are some subtle variations between the scientific and legal definitions for fossils, there is uniform consensus that paleontological resources are the non-renewable remains of past life preserved in a geological context (Santucci, 2002).

The non-renewable nature of paleontological resources is an important consideration for science, education, resource management and other human dimensions associated with fossils. Despite the fact that fossils may be abundant or rare, fossils are finite in the geologic record. Therefore, for all extinct genera and species, the fossil record for these ancient organisms is limited to the physical remains which have been previously preserved in geologic strata deposited during the lifespan of a particular group of organisms. No additional remains from extinct fauna or flora will become fossilized once the group is extirpated. For example, the famous dinosaur *Tyrannosaurus rex* lived and became extinct during the Late Cretaceous. The skeletal remains of *T. rex* are preserved in several Upper Cretaceous geologic formations. Therefore, no fossil remains of *T. rex* have been preserved since the Late Cretaceous and all *T. rex* fossils are limited to those which are still buried beneath the surface, are weathering at the surface, or have been removed from the geologic context and maintained in museum or private collections.

The non-renewable nature of fossils influences a variety of human dimensions pertaining to fossils. These include basic scientific principles and resource management practices involving fossils. The non-renewability of fossils may also influence the commercial interest and value of certain types of fossils in a “supply and demand” environment. Conversely, extant biological taxa are renewable resources because they

have the potential to perpetuate themselves through reproduction. Recent successes through captive breeding of endangered species, including the black-footed ferret (*Mustela nigripes*) and the California condor (*Gymnogyps californianus*), show the potential to rescue species on the brink of extinction.

Paleontological resources include the fossil remains of the morphological components of once-living organisms including bones, teeth, hair, scales, shells, leaves, seeds, wood, pollen, amber and a wide variety of other physical components of organisms. Additionally, a category of paleontological resources referred to as trace fossils (ichnofossils) preserve evidence of biological activity rather than the actual physical remains of the organism. Examples of trace fossils include fossil footprints, feces, root casts, burrows, nests, and other evidence of biological activity preserved in a geologic context.

It is important to recognize the similarities and differences between paleontological resources and archeological resources. The most important similarity is that both paleontological resources and archeological resources are non-renewable and represent old objects preserved at or near the Earth's surface. Both paleontology and archeology are fields of study which employ similar methodologies and techniques for the excavation and removal of resources from within strata and soils. The principal difference between paleontological and archeological resources relates to the types of resources that are being studied and excavated. The study of archeology focuses on remains associated with human history and culture such as archeological artifacts, prehistoric and historic structures, petroglyphs and pictographs, and other human-related objects. The study of paleontology focuses on the evidence of past biological organisms

and their activities preserved within geologic strata. It is worth noting that fossils can occur secondarily within a cultural resource context (Figs. 2-2 and 2-3), where fossils may be discovered within archeological sites or within the building stones of historic structures (Kenworthy and Santucci, 2006). The many facets of the fossil record have likely captured the attention of humans throughout the course of humanity.



Figure 2-2: Projectile point made from petrified wood discovered at Petrified Forest National Park Arizona (NPS Photo).



Figure 2-3: Triassic dinosaur tracks (*Atreipus milfordensis*) preserved in the building stones of an historic bridge at Gettysburg National Military Park, Pennsylvania. (V. Santucci Photo).

Previous Work and Review of the Literature

The literature associated with the science of paleontology consists of tens of thousands of books, journal articles and other publications. These publications contribute to a greater understanding of the scientific aspects of fossils, including systematics, taxonomy, biostratigraphy, paleoecology, evolution, paleobiogeography, taphonomy, functional morphology, ichnology, and a wide range of other subdisciplines in paleontology. The extensive scientific research associated with the field of paleontology

is interesting to note, but beyond the scope of this publication. However, it is important to recognize that there are comparatively few research publications devoted to social science and fossils.

Archeological evidence indicates prehistoric people encountered, observed and sometimes collected fossils for thousands of years (Mayor, 2005, 2007, 2011; Kenworthy and Santucci, 2006). The history of early fossil discoveries and the birth of the science of paleontology include wonderfully rich narratives of the human experience and evolving intellect within natural philosophy and science (Rea, 2001). Despite this history, specific empirical research and scientific literature assessing the human dimensions of paleontological resources are nearly non-existent.

An extensive and growing body of literature, including both natural science and social science research, focuses on the relationships of human activities and behaviors associated with natural resources (Decker et al., 1996; Manfredo et al., 2004; Enck et al., 2006; Leong et al., 2013). Many publications specifically examine the impacts to natural resources based on human behavior and activities (Wise, 1982; Gramann and Vander Stoep, 1987; Johnson and Vande Kamp, 1996; Muth and Bowe, 1998; Decker et al., 2001; Gavin et al., 2010). Additionally, there is also an abundance of research focusing on the use of education and interpretation in promoting natural resource stewardship (Olson et al., 1984; Daniels and Marion, 2005; Marion and Reed, 2007).

A review of the literature associated with depreciative behavior and natural resources yields more targeted studies which have some relevancy and transferability to the assessment of human behaviors involving paleontological resources (Bradford, 2005; Lawhon, 2013; Lawhon et al., 2014; Sheffield, 1988). Beginning during the 1990s,

researchers at Virginia Polytechnic Institute undertook evaluations of visitor attitudes and perceptions to better understand behavior associated with fossil theft at Petrified Forest National Park, Arizona, and Fossil Butte National Monument, Wyoming (Williams et al., 1993; Widner & Roggenbuck, 2000, 2003; Hockett & Roggenbuck, 2002, 2003; Hockett, 2008). The results of these studies provided valuable data to the National Park Service informing resource protection planning and demonstrate the need for further research on the human dimensions of paleontological resources.

Human Dimensions of Paleontological Resources

The principal focus of this summary is to develop a conceptual framework for assessing the human dimensions of paleontological resources. The human dimensions of natural resources represent an expanding area of social science research which informs land and resource managers about the relationships and interactions of humans with natural resources (Ewert, 1996a, 1996b). For example, studies focused on the human dimensions of wildlife attempt to understand human motivations and behaviors, which may lead to conflict or unsafe interactions with wild animals (e.g. grizzly bears or bison). This article proposes a framework for applying the principles of human dimensions research to non-renewable paleontological resources.

The application of the human dimensions concept to non-renewable paleontological resources has great potential for benefiting those individuals, organizations, institutions and agencies involved with fossils. Previous human dimensions research provides valuable insights which are directly applicable in

developing a framework for assessing human values associated with fossils (Manning & Moore, 2002; Harmon and Putney, 2003; Harmon, 2004;). The application of social science research in paleontology may yield information and understandings which would benefit the management, protection, science, education, partnerships and stewardship of fossils.

Human and Social Values Associated with Fossils

To begin to assess the human dimensions of paleontological resources, and to gain a greater understanding of the human attitudes, perspectives, motivations and behavior associated with fossils, we should first identify the range of human and social values applied to fossils. The identification of the range and differences in human values associated with fossils may reveal the basis for conflicting perspectives. A proposed list of human values associated with fossils, which are values often considered in other human dimensions of natural resource evaluations, include: aesthetic values, personal values, heritage values, historical values, scientific values, educational values, recreational values, commercial or economic values, and perhaps some spiritual values (Decker et al., 1996, 2001; Harmon & Putney, 2003; Harmon, 2004; Manfredo et al., 2004, 2008; Manfredo, 2008).

AESTHETIC VALUES: The tremendous diversity of life represented in the fossil record exhibits some exceptionally beautiful, morphologically diverse and uniquely preserved fossils. The symmetry of a fossil starfish, the intricate details displayed in a fossilized bird feather, or the colorful patterns of agatized petrified wood have aesthetic

qualities that may evoke human emotions in relation to the sense or perception of beauty. The opal-like or iridescent organic preservation of the aragonite shells from two species of the ammonite genus *Placenticerus* is extremely popular and is mined for use as a gemstone called ammolite. Fossil ammonites exhibiting this beautiful form of mineralization can yield tens of thousands of dollars for an individual specimen on the commercial fossil market.

PERSONAL VALUES: Individuals may have their own personal values they place on a fossil based on an infinite array of personal reasons. These scenarios exist when there is some meaningful personal connection between the individual and the fossil, although that personal value may not be recognized by other individuals. For example, an individual may have a sentimental value for a particular fossil if it was the first fossil that individual ever found. Another example would be when the individual has an attachment to a fossil that was passed down from a beloved family member or friend. Another scenario where there may be some personal value tied to a fossil specimen could be based upon the fact that the fossil was dug up on the family property. These personal values applied to fossils would be individual and varied.

HERITAGE VALUES: Heritage values are directly linked to the values of humans and cultural groups. These values may be based upon some resource significance or how different populations perceive the significance of a resource, potentially contributing to resource conservation. The heritage values specifically applied to the conservation and preservation of fossils and fossil localities have been demonstrated widely with the establishment of many paleontological parks, monuments, landmarks, and other designations for the benefit of the public and to support science and education.

Another example of heritage value is demonstrated with the designation of a fossil known from within a particular state as the “State Fossil”.

HISTORICAL VALUES: The science of paleontology has a rich and colorful history which dates back many centuries. Both Thomas Jefferson and Benjamin Franklin had a great fascination with mammoths and today fossilized remains of mammoths are on display at Jefferson’s home at Monticello, in Virginia. Often superlative characteristics, such as largest, most complete, earliest, etc., bring notoriety or fame to a particular fossil. One well known example is the 1858 discovery of a first nearly complete dinosaur skeleton (*Hadrosaurus foulkii*) in Haddonfield, New Jersey. This famous fossil specimen is one of the most revered in the science of vertebrate paleontology and is unquestionably valuable from a historic perspective.

SCIENTIFIC VALUES: Perhaps one of the most obvious values associated with fossils is tied to the scientific information that humans have gained through the excavation, preparation and study of fossils. Through the study of fossils worldwide the evolutionary relationships between extinct and modern biota have become better understood. Fossils and the geologic context in which they are preserved provide evidence for past ecosystems and biotic communities, the environments of deposition and relative relationships of fossils over time. The temporal data derived from fossils has been used as the primary source of information to delineate the Phanerozoic portion of the global geologic time scale. The main subdivisions (Paleozoic Era [time of ancient animal life], Mesozoic Era [time of middle animal life] and Cenozoic Era [time of recent animal life]) have been adopted as the standard divisions for geologic time by geologists from around the world. Although the division and subdivisions of the geologic time scale

are a human convention, they are based on globally consistent paleontological data. Finally, some of the strongest data supporting climate change over geologic time is derived from the evidence in the fossil record.

EDUCATIONAL VALUES: Another obvious value that humans have demonstrated relative to fossils relate to education. Human interest in fossils, especially children's interest, is observable around the world by the popularity of fossil exhibits in museums, nature centers, fossil sites, and other venues. Children are naturally interested in fossils and dinosaurs. This fact alone is one of the strongest observations justifying the need for further research on the human dimensions of paleontology. Fossils and dinosaurs are routinely used by elementary school teachers to begin getting children interested in science (Gunckel, 1994). The establishment of National Fossil Day in 2010, as part of Earth Science Week, has been a catalyst to a nationwide partnership promoting the scientific and educational values of fossils. Nearly 350 partners nationwide, including museums, professional science organizations, professional teacher organizations, universities, public and private fossil sites, universities, libraries, amateur fossil groups and other groups interested in fossils, have joined to celebrate America's Fossil Heritage and the outreach to millions of children across the U.S. During the past six years, the National Park Service Junior Paleontologist Program has resulted in nearly 100,000 children taking the Junior Paleontologist pledge and inspiring an entire generation of future fossil stewards (Fig. 2-4).



Figure 2-4: Hundreds of children take the Junior Paleontologist pledge during the 2010 National Fossil Day celebration on the National Mall in Washington, D.C. (NPS Photo).

RECREATIONAL VALUES: The development of recreational paleontology and fossil tourism demonstrate another example of how some individuals value fossils. Large numbers of amateur fossil collectors and rockhounds participate in the search for fossils across the U.S. Some families plan weekend trips to local fossil localities where they are able to legally discover and collect fossils. Some serious avocational fossil collectors compile large and valuable collections and often share the rare discoveries with scientists and museums for study.

Some individuals and families plan vacations to participate in organized fossil excavations sponsored by museums or private organizations. Local chambers of commerce or state tourism bureaus promote fossil or dinosaur tourism in some of the western states. The Dinosaur Diamond Prehistoric Highway is a 480-mile route in western Colorado and Eastern Utah. This tour includes fossil sites such as Dinosaur National Monument, the Cleveland-Lloyd Dinosaur Quarry (National Natural Landmark), Fruita Paleontological Area, Mill Canyon Dinosaur Trail and the Eastern Prehistoric Museum in Price, Utah.

COMMERCIAL/ECONOMIC VALUES: According to Mayor (2005) fossils have been collected, bartered, bought and sold by humans for thousands of years. The commercial sale of fossils and fossil replicas has become a well-established business in the U.S and internationally. In the United States, the fossil trade ranges from the small town “mom and pop” rock shop to the “Fossil and Mineral Galleries” in more upscale markets such as Jackson Hole, Wyoming, Sante Fe, New Mexico, or Sedona, Arizona. The sale of the nearly complete *Tyrannosaurus rex* specimen nicknamed “Sue” for over 8 million dollars demonstrates how valuable fossils can be in the commercial market. A more in-depth assessment of the economic considerations of paleontological resources is presented later in this article.

SPIRITUAL VALUES: The books and publications of Adrian Mayor (2000, 2005, 2007), especially “Fossil Legends of the First Americans,” have enhanced our understanding and appreciation of the relationships between fossils and pre-Columbian Native Americans and ancient Europeans. Fossils discovered in archeological sites demonstrate the utilization of fossils by early cultures, from projectile points fashioned

from petrified wood to Native American burials which include jewelry incorporating fossils such as ammonites, trilobites or crinoid columnals (Kenworthy et al., 2006). The spiritual values associated with fossils are often part of sacred or traditional cultural practices or ceremonies and are not disclosed beyond the members of a cultural group.

Legal Framework for Paleontological Resources

Federal laws, regulations, and policies associated with paleontological resources are specifically developed to address issues that relate to human activities or to define the use, or limits to the use, by the public. This category represents the legal framework in the United States for the human dimensions of paleontological resources. The Paleontological Resources Preservation Act (PRPA; 16 US Code 470aaa) is the principal federal law which specifically focuses on paleontological resources. The PRPA was signed into law on March 30, 2009, and represents the most recent and comprehensive federal authority for the management and protection of fossils on lands administered by the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), Fish & Wildlife Service (FWS), National Park Service (NPS), and U.S. Forest Service (USFS). A number of law review journal articles address the Paleontological Resources Preservation Act and issues associated with the management and protection of fossils on federal and other public lands (Marshall, 1976; Lazerwitz, 1994; Sakurai, 1994; Dussias, 1996; Lundgren 1998; Malmshemer & Hilfinger, 2003; Weimer, 2004; Chew, 2005; Rogers, 2011; Knowles, 2013).

Federal regulations and policies associated with the management of paleontological resources are also directly related to human activities on public lands. The National Park Service has developed strategies for monitoring the stability and condition of paleontological resources relative to both natural and human-caused impacts (Santucci & Koch, 2003; Santucci et al., 2009). Brunner et al., (2010) presents an example of policy evaluation by the National Park Service related to unauthorized fossil collecting on park beaches by park visitors.

Internationally, many foreign countries have specific laws which address paleontological resources. These fossil protection laws are often contained within cultural heritage legislation.

Scientific Principles and Perspectives

The human dimensions of paleontological resources are clearly represented through the science of paleontology. The science of paleontology is an integrated field of study based upon biological and geological principles. Paleontology began to emerge during the 18th and 19th centuries through the observations and contributions of naturalists, including Carl Linnaeus (1707–1778) and Georges Cuvier (1769–1832), and geologists, such as James Hutton (1726–1797), William “Strata” Smith (1769–1839) and Charles Lyell (1797–1875). Over the past 250 years the science of paleontology has advanced and evolved based upon the integrity of the scientific method. In paleontology, our understanding of the fossil record is only as good as the discoveries made during the most recent field season.

Nearly three centuries of scientific inquiry involving fossils has advanced human understanding of important questions related to the history of life on Earth. These questions include, but are not limited to, the evolutionary relationships between ancient and modern biota; interpretations of ancient environments, climates and paleoecosystems; patterns of evolution and extinction preserved in the fossil record; and the biogeographic and temporal distribution of life on the planet.

Paleontological Resource Management Principles and Practices

The management of paleontological resources on public lands is often a responsibility defined by legal mandates or scientific principles. Paleontological resource management practices are based upon the recognition that fossils are non-renewable resources. One of the first components of managing fossils involves the completion of baseline field inventories or surveys of geologic strata to identify the scope, significance, distribution and condition of paleontological resources and localities. This availability of this information helps to better inform resource managers about potential or actual occurrences of fossils when involved in planning or decision-making.

Paleontological resource monitoring is a relatively new methodology used for assessing the stability and condition of fossils which are maintained in situ (Santucci & Koch, 2003; Santucci et al., 2009). In 2009, Glen Canyon National Recreation Area (GLCA), Arizona and Utah, was selected as the prototype paleontological resource monitoring park for the National Park Service. GLCA was considered an ideal location

for assessing the paleontological resource monitoring strategies due to the impacts to fossils along the shoreline of Lake Powell given the dramatic changes in lake levels.

Paleontologists and resource managers employ a wide array of techniques to protect and stabilize fossil localities. In cases where the excavation and collection of fossils is warranted, either under a research permit or with permission from the landowner, the use of standardized field methods are essential to limit any damage to fossils during excavation. Paleontological resource management includes the active involvement of human decision-making.

Paleontological Resource Conservation, Preservation, and Stewardship

The conservation and preservation of paleontological resources and localities are intimately tied to human values and collaboration. America's paleontological heritage includes remarkable historical accounts of individuals and organized groups advocating for the protection of fossil sites. During the early years of the twentieth century, John Muir's journeys to the petrified forests of Arizona were influential in establishing Petrified Forest National Monument in 1906, a few months after the Antiquities Act was signed into law. Leopold and Meyer (2012) present a detailed account of paleoconservation in their book on the establishment of Florissant Fossil Beds National Monument, Colorado. In 2014, after nearly a decade of public outreach and education, the Protectors of Tule Springs, National Parks Conservation Association and other conservation organizations celebrated the creation of Tule Springs Fossil Beds National Monument, Nevada, with bipartisan support in the U.S. Congress.

In addition to the establishment of national parks and monuments to preserve paleontological resources and localities in the United States, the National Natural Landmarks Program encourages and supports the voluntary conservation of paleontological sites (<http://www.nature.nps.gov/nnl/> accessed April 20125). At least 37 National Natural Landmarks (Table 2-1) have been designated by the Secretary of Interior based primarily on the significant paleontological resources (personal communication, H. Eggleston, 2016).

On an international level, the World Heritage Program, administered by UNESCO since 1972, designates natural and cultural sites of “outstanding universal value” as World Heritage Sites (Lipps, 2009; Pages, 2009). A small number of paleontological sites are designated as World Heritage Sites, including the Messel Fossil Pit Site (Germany) and Joggins Fossil Cliffs (Canada) (<http://whc.unesco.org/en/list/> accessed April 2025).

Table 2-1: List of 37 National Natural Landmarks established primarily based upon the paleontological resources.

National Natural Landmark Name	State / Territory
Unga Island	Alaska
Comb Ridge	Arizona
Rainbow Basin	California
Rancho La Brea	California
Sharktooth Hill	California
Garden Park Fossil Area	Colorado
Indian Springs Trace Fossil Site	Colorado
Morrison – Golden Fossil Areas	Colorado
Dinosaur Trackway	Connecticut
Hagerman Fauna Sites	Idaho
Hanging Rock and Wabash Reef	Indiana
Ohio Coral Reef / Falls of the Ohio	Indiana / Kentucky
Big Bone Lick	Kentucky
Mississippi Petrified Forest	Mississippi
Bridger Fossil Area	Montana
Bug Creek Fossil Area	Montana
Cloverly Formation Site	Montana
Hell Creek Fossil Area	Montana
Ashfall Fossil Beds	Nebraska
Riker Hill Fossil Site	New Jersey
Ghost Ranch	New Mexico
Ichthyosaur Site	Nevada
Fall Brook Gorge	New York
Fossil Coral Reef	New York
Petrified Gardens	New York
Chazy Fossil Reef	New York / Vermont
John Day Fossil Beds	Oregon
Mammoth Site of Hot Springs	South Dakota
Big Bone Cave	Tennessee
Dinosaur Valley	Texas
Greenwood Canyon	Texas
Cleveland-Lloyd Dinosaur Quarry	Utah
Coki Point Cliffs	Virgin Islands
Vagthus Point	Virgin Islands
Ginkgo Petrified Forest	Washington
Como Bluff	Wyoming
Crooked Creek Natural Area	Wyoming

The concepts of paleoconservation and paleoheritage have emerged in the scientific literature during the past decade. The global scientific community recognizes the importance of preserving fossil sites around the world, and is working at local, national, and international levels to support the protection and interpretation of fossil sites (Endere & Prado, 2015; Henriques & dos Reis, 2015). These efforts will collectively demonstrate the value in understanding the human dimensions of paleontological resources.

Economic Considerations Associated with Fossils

Human interest in fossils can frequently be measured by a wide range of economic considerations and influences. The use of fossils and especially dinosaurs have been effective for marketing fossil tourism, entertainment, merchandising and even the commercial sale of original and replica paleontological specimens. Fossils can also represent a source for employment and income for individuals, especially in fossil-rich areas around the world.

As non-renewable resources, fossils exhibit the influences of the principle of supply and demand relative to commercial values. Rare and more complete fossil specimens tend to demand higher commercial values (Browne, 1994; McClain, 1996; Hippensteel & Condliffe, 2013). The escalating commercial fossil market observed during the 1990s generated interest in fossils as financial investments, and Forbes Magazine published articles on the theme of fossils as investments (Ebeling, 2000; Rohleder, 2001). In 1997, an individual skeleton of a nearly complete *Tyrannosaurus rex*

specimen, nicknamed “Sue”, was auctioned by Sotheby’s for \$8.35 million dollars. This extreme example demonstrates how the economics of fossils can be a powerful factor influencing human values, attitudes, behaviors and motivations.

The commercial fossil market expanded from rock shops to catalog and internet sales offering a diverse range of fossils, including complete skeletons of fossil vertebrates. Large annual rock, mineral and fossil shows, such as the Tucson Gem, Mineral and Fossil Show, draw thousands of visitors from around the world. Sotheby’s, Heritage and other well-established auction houses feature high priced fossil specimens during their natural history auctions.

Fossils are an important economic resource in several developing countries, providing jobs in the excavation and preparation of fossils (Krowitz, 2001). Fossils from Morocco, Madagascar and other locations around the world are legally collected and exported for sale to meet the demand for these fossils. According to Sicree (2009) the Moroccan fossil industry, including fossil mining operations for Paleozoic trilobites and Cretaceous marine invertebrates and vertebrates, may represent the country with the highest grossing fossil industry, with annual fossil sales estimated at \$40 million dollars and employing as many as 50,000 individuals.

Serious fossil-minded individuals are able to experience a real fossil dig offered by a number of museums, organizations and commercial fossil operations as volunteers or paying participants. These digs provide opportunities for novice fossil hunters to work side-by-side with professional paleontologists uncovering ancient remains. A few public (<http://mentalfloss.com/article/50997/10-states-fossil-hunting-sites-public>) and private fossil sites offer opportunities for fossil collecting. Commercial fossil quarries in the

Eocene Green River Formation, near Kemmerer, Wyoming, offer opportunities for “pay to dig” to the public. The ancient lake sediments preserve millions of fossil fish and other lifeforms exhibiting an extraordinary degree of preservation, typically preserving complete or near complete skeletons. Green River fossil fish are found in rock shops and museums around the world. Similar “pay to dig” fossil localities enable the search, discovery and collection of a wide range of fossils including trilobites, dinosaurs, shark’s teeth and fossil remains of many other ancient plants and animals. Typically, the “pay to dig” fossil sites allow the participants to keep the common fossils; however, the rarer types of fossils discovered are retained by the individuals or businesses managing the fossil site.

Dinosaurs and other prehistoric organisms have been the focus of motion pictures, television productions and other entertainment media (Table 2-2 and 2-3). The *Jurassic Park* series of movies are among some of the highest grossing films in history. Preschoolers are able to enjoy their own age-appropriate dinosaur-themed television show called *Dinosaur Train*. Both Walt Disney World and Universal Studios theme parks have major dinosaur-focused attractions. In Downtown Disney in Orlando, Florida, a popular restaurant named *T-rex Café* is every “fossil-enthusiast” dream, with a menagerie of prehistoric animatronic lifeforms and fossil-themed menu selections.

“Fossil Tourism” is a pervasive concept in locations around the world enabling the public to experience the world of fossils. Federal, state and local fossil parks, museums, education centers, and a variety of other categories of paleontological sites draw tens of thousands of visitors each year to experience and learn about paleontology. Local chambers of commerce and offices of tourism recognize and utilize the power of

paleontology in drawing tourist dollars to small towns such as Vernal, Utah, near Dinosaur National Monument, or Kemmerer, Wyoming, near Fossil Butte National Monument. Fossils are sometimes incorporated into advertising in order to draw tourists to discover the paleontological heritage of the American west.

For the ultimate fossil getaway, the Best Western Denver Southwest is another dinosaur-themed destination catering to the paleontologically inspired traveler. Located in Lakewood, Colorado, the hotel décor is dominated by a Mesozoic menagerie of skeletal remains to inspire the would-be paleontologist, young or old. The hotel is located near several fossil attractions including the Denver Museum of Nature and Science and the Morrison – Golden Fossil Areas National Natural Landmark featuring Dinosaur Ridge, Fossil Trace and the *Triceratops* Trail <https://dinoridge.org/> (accessed April 2025).

The use of fossils and dinosaurs in marketing, advertising and merchandising has been designed and constructed on the notion that people are attracted to these prehistoric icons. The Sinclair Oil dinosaur is perhaps one of the most familiar examples of dinosaur-focused marketing (Fig. 2-5). First introduced in 1930, the Sinclair “*Brontosaurus*” gained fame at the Chicago World Fair “Century of Progress” during 1933–1934. The dinosaur exhibit was displayed at the 1936 Texas Centennial Exposition and the New York World’s Fairs during 1939–1940 and again in 1964–1965. During the most recent exhibition, the Sinclair dinosaurs made a dramatic appearance in New York City with a *Triceratops* sculpture being delivered by helicopter and several dinosaurs traveled by barge on the Hudson River. Today Sinclair dinosaur merchandise and souvenirs are popular collectibles in antique shops and on Ebay.

Table 2-2: List of dinosaur and fossil themed motion pictures productions (1916 – 2015), dates of release and production companies.

RELEASE DATE	FILM TITLE	PRODUCTION COMPANY
June 23, 2015	<i>Jurassic Prey</i>	Polonia Brothers Entertainment
June 12, 2015	<i>Jurassic World</i>	Universal Pictures & Amblin Entertainment
May 29, 2015	<i>Jurassic City</i>	Canal & Little Dragon Productions
May 19, 2015	<i>Cowboys and Dinosaurs</i>	Oracle Film Group
December 14, 2014	<i>Dinosaur Island</i>	Extinct Productions
October 31, 2013	<i>Raptor Ranch</i>	Nu Imagination
August 10, 2012	<i>The Dinosaur Project</i>	Moonlighting Films
April 20, 2012	<i>Attak of the Jurassic Shark</i>	Dudez Productions
January 26, 2012	<i>The Dino King</i>	C J Entertainment
February 28, 2011	<i>Azteca Rex</i>	Rigel Entertainment & Talkstory Productions
July 28, 2009	<i>The Land That Time Forgot</i>	Asylum
June 5, 2009	<i>Land of the Lost</i>	Universal Pictures
July 29, 2008	<i>100 Million B.C.</i>	Asylum
July 11, 2008	<i>Journey to the Center of the Earth</i>	New Line Cinema
December 14, 2005	<i>King Kong</i>	Universal Pictures
September 2, 2005	<i>A Sound of Thunder</i>	Franchise Pictures & Crusader Entertainment
July 14, 2005	<i>Attack of the Sabertooth</i>	Film Brokers International & Wood Canyon Ventures
April 20, 2004	<i>Dinocroc</i>	Concorde - New Horizons
March 23, 2004	<i>Sabertooth</i>	International Film Group & Sabertooth Productions
July 18, 2001	<i>Jurassic Park III</i>	Universal Pictures & Amblin Entertainment
April 28, 2000	<i>The Flintstones in Viva Las Vegas</i>	Universal Pictures, Amblin Entertainment & Hanna Barbera Productions
May 20, 1998	<i>Godzilla</i>	Centropolis Film Productions & Independent Pictures
May 23, 1997	<i>The Lost World: Jurassic Park II</i>	Universal Pictures & Amblin Entertainment
January 17, 1997	<i>Carnosaur 3: Primal Species</i>	Concorde - New Horizons
December 14, 1995	<i>Theodore Rex</i>	J&M Entertainment & New Line Cinema
February 23, 1995	<i>Carnosaur 2</i>	Concorde - New Horizons
May 27, 1994	<i>The Flintstones</i>	Universal Pictures, Amblin Entertainment & Hanna Barbera Productions
March 23, 1994	<i>Dinosaur Island</i>	Unknown
September 23, 1993	<i>Prehysteria!</i>	Full Moon Entertainment & Paramount Pictures
June 11, 1993	<i>Jurassic Park</i>	Universal Pictures & Amblin Entertainment
May 21, 1993	<i>Carnosaur</i>	New Horizons Picture
February 12, 1992	<i>Adventures in Dinosaur City</i>	Smart Egg Pictures
March 22, 1985	<i>Baby: Secret of the Lost Legend</i>	Silver Screen Productions & Touchstone Pictures
April 17, 1981	<i>Caveman</i>	Turner Foster Company
August 27, 1979	<i>Planet of Dinosaurs</i>	Deathbeast Productions
August 17, 1977	<i>The People that Time Forgot</i>	American International Pictures
March 1, 1977	<i>The Crater Lake Monster</i>	Crown International Pictures
February 11, 1977	<i>The Last Dinosaur</i>	Rankin Bass Productions
August 13, 1975	<i>The Land That Time Forgot</i>	Amicus Productions & Lion International
March 17, 1971	<i>When Dinosaurs Ruled the Earth</i>	Hammer Films
July 19, 1969	<i>Valley of the Gwangi</i>	Morningside Productions
February 21, 1967	<i>One Million Years B.C.</i>	Associated British Pathe & Hammer Films
May 19, 1905	<i>Journey to the Beginning of Time</i>	Ceskoslovensky Statni Film
March 21, 1961	<i>Gorgo</i>	King Brothers Productions
August 10, 1960	<i>Dinosaurs!</i>	Fairview Productions
July 13, 1960	<i>The Lost World</i>	20th Century Fox Film Corporation
January 14, 1960	<i>Journey to the Center of the Earth</i>	20th Century Fox Film Corporation
March 3, 1959	<i>The Giant Behemoth</i>	Artistes Alliance Limited. & Diamond Pictures Corporation
October 1, 1957	<i>The Animal World</i>	Irwin Allen Productions
August 1, 1957	<i>The Land Unknown</i>	Universal International Pictures
August 1, 1956	<i>The Beast of Hollow Mountain</i>	Nassour Studios
April 27, 1956	<i>Godzilla: King of the Monsters</i>	Toho Company & Jewell Enterprises Inc.
June 17, 1955	<i>King Dinosaur</i>	Zimgor Productions
June 13, 1953	<i>The Beast from 20,000 Fathoms</i>	Jack Dietz Productions
August 17, 1951	<i>Lost Continent</i>	Sigmund Neufeld Productions
April 5, 1940	<i>One Million B.C.</i>	Hal Roach Studios
April 7, 1933	<i>King Kong</i>	Radio Pictures
June 22, 1925	<i>The Lost World</i>	First National Pictures

Table 2-3: List of dinosaur and fossil themed animation movies (1914 – 2016), dates of release and production companies.

RELEASE DATE	ANIMATION FILM TITLE	PRODUCTION COMPANY
July 26, 2016	<i>Ice Age: Collision Course</i>	20th Century Fox Film Studios & Blue Sky Studios
November 25, 2015	<i>The Good Dinosaur</i>	Walt Disney Pictures
July 13, 2012	<i>Ice Age: Continental Drift</i>	20th Century Fox Film Studios & Blue Sky Studios
July 7, 2011	<i>March of the Dinosaurs</i>	Wide-Eyed Entertainment
July 1, 2009	<i>Ice Age: Dawn of the Dinosaurs</i>	20th Century Fox Film Studios & Blue Sky Studios
March 30, 2007	<i>Meet the Robinsons</i>	Walt Disney Pictures
March 23, 2006	<i>Ice Age: The Meltdown</i>	20th Century Fox Film Studios & Blue Sky Studios
March 15, 2002	<i>Ice Age</i>	20th Century Fox Film Studios & Blue Sky Studios
May 19, 2000	<i>Dinosaur!</i>	Walt Disney Pictures
November 24, 1993	<i>We're Back! A Dinosaur's Story</i>	Universal Pictures & Amblin Entertainment
November 18, 1988	<i>The Land Before Time</i>	Universal Pictures & Sullivan Bluth Studios
November 5, 1985	<i>Prehistoric Beast</i>	Tippett Studio
November 17, 1918	<i>The Ghost of Slumber Mountain</i>	Herbert M. Dawley Productions
1915	<i>The Dinosaur & the Missing Link: A Prehistoric Tragedy</i>	Conquest Pictures & Herman Wobber
September 15, 1914	<i>Gertie the Dinosaur</i>	Windsor McCay & Vitagraph Company of America



Figure 2-5: Sinclair Oil advertising featuring their iconic dinosaur painted on the wall of a building. (V. Santucci Photo)

There are many examples of prehistoric animal sculptures, sometimes life-size, which are used as popular roadside attractions for travelers. Along interstate 90 in western South Dakota, the famous Wall Drug in Wall, South Dakota, has a life-size sauropod model on display. The attraction is one way that Wall Drug helps to draw in customers to purchase a meal and buy souvenirs in their world-renowned business. There are dozens of examples of businesses and community recreational parks featuring models or sculptures of prehistoric animals to attract users.

Fossil and dinosaur toys, games, figures and other merchandise have been popular sales items for children and adults. There are quite a few Ph.D. paleontologists in museums and universities that have these fossil toys on display in their offices. Several competing companies have produced authentic plastic replicas of prehistoric creatures, especially the dinosaurs. Louis Marx and Company (MARX) began producing dinosaur toy sets in the 1950s and has been followed in recent decades by Safari Ltd.'s "Carnegie Collection", Invicta Inc., Battat Inc., Papo Co., Schleich Co., and several other companies (<http://www.dinosaur-toys-collectors-guide.com/toy-companies.html>).

Many libraries and bookstores have shelves filled with children's books about dinosaurs. Some of the classic and vintage books such as the "How and Why Wonder Books on Dinosaurs & Prehistoric Mammals", "The Golden Book on Dinosaurs", "Danny and the Dinosaur", and the more recent "Magic School Bus: In the Time of the Dinosaur", have inspired millions of junior paleontologists. For adult readers, Edgar Rice Burroughs' "*Land That Time Forgot*" (1924) or Michael Crichton's "*Jurassic Park*" (1990), were best-selling books for the grown-up paleontology enthusiasts.

Whatever the motivation, passion or factor which links humans to fossils, there are clearly economic benefits and consequences associated with the sale of actual or replica fossils, prehistoric-themed merchandise and entertainment. Future social science research evaluating the human dimensions of paleontological resources may enable us to better understand the basis of the economy of paleontology and to better understand how to answer questions such as “How much is that dinosaur in the window?”

Ethical Considerations for Paleontological Resources

In the assessment of the human dimensions of paleontological resources, a consideration of any ethical or moral issues pertaining to fossils would be worth investigating. Ethics, or more specifically moral philosophy, is the branch of knowledge pertaining to moral principles and the concepts of right or wrong pertaining to human behavior and decision-making. This review is not intended to specifically address those right or wrong opinions related to paleontological resources, but rather to provide a few examples of considerations which are ethical in nature.

The first and most fundamental consideration related to the fact that fossils are non-renewable resources which possess scientific and educational values. Although various fossils may be abundant or rare in the fossil record, they all are non-renewable. Therefore, should our behavior and decision-making relative to fossils include consideration that they are non-renewable resources? This topic is worthy of extensive scholarly and resource management discussion.

Directly tied to the non-renewable nature of paleontological resources is the fact that there are many genera and species of fossil taxon which are known from only a single specimen of that extinct group of organisms. It is widely acknowledged by taxonomists and paleontologists that most of the prehistoric lifeforms that once inhabited the Earth are not yet known from fossils or described in the scientific literature. Perhaps many of these forms will never be known to science due to a variety of factors. However, there is an ethical question involving those rare or one-of-a-kind fossil specimens pertaining to access and preservation of the specimen. Since a single specimen of an ancient group may provide the only available data for scientific research or public education, should there be any ethical considerations relative to scientific or public access to these rare specimens? Should rare or one-of-a-kind specimens be viewed in the same context as an endangered species of modern biota? Should there be safeguards or provisions in place to ensure that one-of-a-kind fossils are not lost to science? Is there a human desire to ensure that we strive to preserve the most complete understanding for the fossil record of life available to science and education? Do we have a responsibility to all of those fossil-loving school children to ensure the highest level of integrity and completeness of the fossil record? Additional ethical questions involving rare fossil specimens should be evaluated through future research.

Shimada and others (2014) consider the commercialization of fossils as the greatest challenge to 21st century paleontology and that it threatens the science. The hotly debated topic of commercial versus scientific fossil collecting dates back at least four decades (Padian, 2000; Shimada, et al., 2014). Attempts to address some of the ethical issues related to commercial and scientific fossil collecting have been incorporated into

Codes of Ethics adopted by both the Society of Vertebrate Paleontology and the Association of Applied Paleontological Sciences (previously known as the American Association of Paleontological Suppliers. National Public Radio developed a webpage addressing the ethics associated with buying and selling fossils online.

Another important ethical consideration related to paleontology involves the legality and permission for the physical collection of fossils from geologic strata. Authorized fossil collection should only be undertaken with the informed permission / consent from the landowner (if private lands) or from the appropriate government agency authorized to administer the lands and resources. Illegal fossil collecting has been widespread in the United States and includes documented cases of fossil theft incidents from public lands and even a few cases of fossil theft from museums. Illegal fossil collecting is an ethical breach worth assessing both in the United States and internationally (Kim and Weiler, 2013).

A related ethical consideration in paleontology involves the intentional falsification of the locality information from which the fossil was collected. In some instances, the actual locality information for a fossil may not be disclosed in order to conceal the fact the specimen was collected in an area where the removal of the fossil was not permitted or prohibited. Clearly the falsification of fossil locality information is unethical and unscientific and compromises the integrity of the scientific information associated with the paleontological specimen.

There are a number of other potential ethical issues associated with paleontological resources, including: the creation and sale of fossil forgeries; poor collecting techniques which lead to damage or loss of scientifically important fossil

specimens; and the illegal international trade in fossil specimens involving countries which prohibit the collection or export of fossils as defined in that country's laws. Some of these ethical considerations may be influenced by the rapid escalation of fossils on the commercial fossil market, where the financial rewards may outweigh the risks or influences related to laws and ethics.

Paleontological Resource Crimes and Depreciative Behaviors

Paleontological resource theft and vandalism is documented in countries around the world (Mamalis, 2012; Roolf, 2012). The U.S. National Park Service maintains data extending back to 1991 documenting incidents of paleontological resource crimes, including fossil theft and vandalism. Hundreds of individual case incidents related to fossil crimes in national parks illustrates the need for social science research to better understand those variables which may contribute to inappropriate behaviors by park visitors to the fossil parks. The unfortunate story of Fossil Cycad National Monument exemplifies the extent of resource degradation that can occur to non-renewable paleontological resources (Santucci & Hughes, 1998; Santucci & Ghist, 2014). In this case, a unit of the National Park Service was abolished due to the complete removal of rare plant fossils at the surface through unauthorized collecting.

The pioneering social science research assessing human behaviors linked to paleontological resources was undertaken by the faculty at Virginia Tech during the 1990s. The National Park Service documented several decades of unauthorized collecting of petrified wood by visitors to Petrified Forest National Park, Arizona. Funding was

obtained by the National Park Service to support a three-year study to assess visitor attitudes, perceptions and behaviors associated with the petrified wood during visits to Petrified Forest National Park (Widner & Roggenbuck, 2000, 2003). This research provided the National Park Service with social science data that park managers could use for public education, interpretive media, and effective messaging to deter the unauthorized "souvenir" collecting of petrified wood by park visitors.

The seminal work of the VA Tech team was adapted to assist the National Park Service at Fossil Butte National Monument, Wyoming, by assessing visitor attitudes, perceptions, and behaviors associated with the fossils present at Fossil Butte National Monument (Roggenbuck & Hockett, 2002, 2003; Hockett, 2008). The area surrounding Fossil Butte National Monument represents the largest commercial operations for the collection of fossil vertebrates in the United States. The commercial fossil industry in southwestern Wyoming is an important revenue-generating enterprise and enhances tourism in an economically depressed area. Hockett (2008) evaluated how the commercial interests and economic values associated with fossils in southwestern Wyoming may have influenced visitor attitudes and behaviors during their visit to Fossil Butte National Monument.

Future Considerations

This initial attempt to understand the scope of human values, attitudes, motivations and behaviors associated with paleontological resources demonstrates a rich and interesting relationship between people and fossils. Future research which measures

human attitudes and behaviors pertaining to fossils will enable the correlation of these variables to the values people identify with and assign to our paleontological heritage resources.

A fundamental first step for future social science research would be to acquire demographic information in conjunction with any surveys assessing human values, perspectives and motivations related to fossils, their enjoyment, use, and management. Once baseline human dimension data for fossils are available, there will be the ability to evaluate and monitor how human values, motivations and other factors change over time or among different social groups. Further, these data can potentially serve as indicators to assess how social variables influence thinking and behavior. Additionally, these data will be valuable for determining strategies to address conflict relative to legal, ethical and other considerations involving the enjoyment, use, and management of paleontological resources.

Further information can be gained by targeted research on the traits of a people who have already taken an active role in support of paleontology outreach and fossil resource conservation. The National Fossil Day partnership includes over 335 partners across the U.S. According to the American Geosciences Institute, National Fossil Day and Earth Science Week reach tens of millions of people annually. The National Fossil Day partnership includes a wide range of stakeholders from professional to amateur paleontologists celebrating America's Paleontological Heritage. Future research should include social science surveys of the National Fossil Day participants and partners in order to further illuminate our understanding of the human dimensions that lead to advocacy, stewardship and volunteer participation.

The rich story regarding the history and evolution of life on Earth is worth preserving and sharing. This story has inspired and continues to inspire generations of children living in every corner of the Earth. Some of these children never lose their childhood fascination about dinosaur and other prehistoric creatures and carry this enthusiasm forward throughout life. In life's journey from a junior paleontologist to a senior paleontologist, there are some yet undiscovered human dimensions associated with fossils that wait to be uncovered through future research.

Chapter 3

Assessing Visitor “Fossil Stewardship Attitudes” Towards National Park Service Paleontological Resources

Exploratory Visitor Fossil Surveys

The application of social science research involving human values, interests, understandings, motivations, and behaviors associated with fossils and paleontological resources is a relatively new focus of study. In 2016, a conceptual framework for assessing the human dimensions of paleontological resources was first introduced by the National Park Service (NPS) and faculty from Penn State University (Santucci, et al., 2016). The collective body of research focused on human relationships with fossils is limited to a handful of published scientific articles and doctoral dissertations.

Here we present two case studies involving exploratory social science surveys undertaken to assess visitor perspectives, referred to collectively as “Fossil Stewardship Attitudes”, related to NPS paleontological resources. The first visitor fossil survey was undertaken at Badlands National Park (BADL), South Dakota, between May and July 2017. The second visitor fossil survey was undertaken at Denali National Park and Preserve (DENA), Alaska, between July and August 2018. Each park was selected for the human-fossil focused surveys based on factors involving the occurrence, distribution, and public access to fossil localities in each park. Both BADL and DENA identify

paleontological resources in the parks' respective Foundation Document as fundamental resources and values (National Park Service, 2014; National Park Service, 2017).

Badlands National Park, South Dakota, preserves one of the richest deposits of Eocene and Oligocene fossil vertebrates from anywhere on Earth. Fossil-rich strata at BADL are exposed throughout most of the approximately 244,000-acre park and are often resources of interest to the approximately one million annual park visitors. Scientific collection of fossils from areas now within the park boundaries dates to the 1840s, yielding a diverse assemblage of ancient vertebrate fauna. Fossil collecting and research continues to occur at the park under the authority of an NPS-approved research and collecting permit to support science and resource stewardship; however, the park has unfortunately experienced unauthorized and illegal collection of fossils since the monument was established in 1939. The collection, removal, or disturbance of fossils within a national park, without a permit, is prohibited by federal law, regulations, and NPS policies (Paleontological Resources Preservation Act of 2009, 16 USC §470aaa).

Denali National Park and Preserve, Alaska, also preserves significant paleontological resources which are not as well inventoried or studied from across the more than six million acres of park lands. Over the past two decades the discovery of fossil dinosaur footprints in remote locations and wilderness areas of DENA has received scientific and media attention. DENA still largely remains a trailless park, and most visitors access popular areas of the park via shuttle bus. At least currently, this limits visitor access to fossil areas, yet this could change as visitor desires, expectations (particularly related to paleontological resources), and park infrastructure change in the

future. Although only a small number of DENA's nearly 600,000 annual visitors access the remote fossil localities in the park, increased public interest and media attention associated with the fossil dinosaur tracks may lead to more visitors planning backcountry hikes to view these non-renewable fossils.

The two exploratory visitor fossil surveys at BADL and DENA have yielded data and information to better understand some of the human dimensions of paleontological resources observed within each of these national parks. Individually and together, these surveys present preliminary data tied to visitor values, attitudes, and motivations related to park fossils that may influence visitor behaviors involving park fossils during park visits. This information will help increase awareness and inform park managers about visitor perspectives and "Fossil Stewardship Attitudes" pertaining to park paleontological resources. These exploratory visitor fossil surveys also suggest that further research involving the human dimensions of paleontological resources is warranted and should be considered.

Human Dimensions of Paleontological Resources: Previous Work

The pioneering work introducing the concept of the human dimensions of paleontological resources was presented by Santucci, et al., (2016). This conceptual framework outlined the range of human values associated with fossils, which include scientific, historical, educational, recreational, economic / commercial, personal, spiritual, aesthetic, and other values. Fossils were considered relative to laws, scientific

principles, resource management practices, conservation, preservation, stewardship, commercial interests, and ethics (Santucci, et al., 2016).

Fossils have also gained recognition in recent years as “Paleontological Heritage” in discussions of global geologic heritage and geoconservation (Endere & Prado, 2015; Page, 2018; Larwood & Prosser, 2019; Larwood, et al., 2022). Important fossil localities from around the world are being protected as national parks and monuments in the United States or designated as World Heritage Sites under UNESCO. The term paleontological heritage fundamentally denotes and conveys the relationships and connections between humans and fossils.

Although not specifically referenced as human dimensions research, only a few social science projects have focused on NPS paleontological resources. During the 1990s, two NPS areas were the focus of social science studies led by researchers at Virginia Polytechnic Institute, to evaluate visitor attitudes and perceptions relative to paleontological resources. The initial study involved a multi-year visitor study undertaken at Petrified Forest National Park (PEFO), Arizona, to better understand visitor behavior associated with the souvenir collecting of petrified wood from localities within the park by visitors (Williams et al., 1993; Widner & Roggenbuck, 2000, 2003). A similar research project was undertaken at Fossil Butte National Monument, Wyoming, during the late 1990s to evaluate visitor attitudes related to fossils considering the active commercial fossil collecting operations surrounding the monument (Hockett & Roggenbuck, 2002, 2003; Hockett, 2008). The results of these studies provided important

information to inform NPS managers about how visitors and local residents viewed fossils in and around the NPS-administered lands.

More recently, Kim and Weiler (2013) examined visitors' attitudes towards fossil collecting by tourists in the Charmouth coastal area in the southwest of England. The Charmouth coastal area is a popular area for avocational fossil collecting, and the research revealed two distinct populations of fossil collectors based on environmental attitudes. The two tourist groups varied in terms of demographic, attitudinal, and behavioral characteristics relative to environmental sensitivity and responsibilities. The analysis revealed that two groups were significantly different in terms of gender, age, and recreational use patterns.

This previous research demonstrates the need for similar fossil-focused social science work on other public lands preserving paleontological resources. The use of visitor fossil surveys has yielded data available for evaluation using basic descriptive statistics to assess "Fossil Stewardship Attitudes" serving as the basis for the two case studies presented here for BADL and DENA.

Case Study: Badlands National Park

Paleontological resources are identified as part of the "Park Purpose", "Park Significance", "Fundamental Resources and Values" and a primary "Interpretive Theme" in the Badlands National Park Foundation Document (2017). The NPS specifically references one of the purposes of BADL is to, *"Preserve, interpret, and provide for scientific study of the paleontological and geological resources of the White River*

Badlands.” Two park significance statements pertaining to the paleontological resources of BADL are presented in the park’s Foundation Document including: 1) “*The park’s geological and paleontological resources provide insight into climatic history, biological diversity, evolution, and geological processes particular to the boundary between the Eocene and Oligocene epochs, as well as a unique opportunity to trace the evolution of the prairie ecosystems of the Great Plains.*”; and, 2) “*The long history of research in the White River Badlands has contributed greatly to the science of vertebrate paleontology in North America.*” Finally, the Fundamental Resources and Values at BADL are recognized in the following statement, “*The White River Badlands preserves one of the most extensive records of the Eocene/Oligocene transition in North America, providing insight into climatic history, biological diversity, and evolution. Badlands National Park manages the largest paleontological museum collection in the National Park Service and is the source of more than 200 type and potential type specimens.*”

One of the earliest published reports of fossils from the American west occurred during the 1840s involving western fur traders collecting fossil specimens from the “*mauvaises terre*” or badlands of the Dakota Territory to transport back east for trade or sale (Prout, 1846). Despite more than 175 years of fossil discovery and study from the fossiliferous strata in and around BADL, new fossil taxa continue to be described and named (Welsh, 2021; Santos et al., 2023; Shreero et al., 2024). The globally significant paleontological resources from BADL attract scientists and park visitors from around the world. The first annual National Fossil Day logo issued in 2010 features a brontothere, one of the iconic fossils from BADL (Fig. 3-12a). The annual visitation at BADL ranges

between 870,000 to over 1.2 million visitors per year; many of whom come to view and learn about the park's fossils. Visitors to BADL have the opportunity to participate in a variety of fossil-focused educational and recreational experiences including observe naturally occurring fossils within the geologic strata; hike the Fossil Exhibit Trail; view fossil-themed exhibits in the park's visitor center; observe fossil preparators clean fossils; and join a ranger for a fossil talk or walk.

In 2017 an exploratory survey of visitors at BADL was undertaken to gather data on several human dimension variables associated with fossils. BADL was selected as the fossil park to undertake a pilot visitor fossil survey based on both the rich interpretive programs for paleontology hosted by the park and the fact that the park has a history of unauthorized fossil collecting by park visitors. The collection of fossils without an NPS-approved research and collecting permit is prohibited by federal laws, regulations, and NPS policy (Paleontological Resources Preservation Act 2009). The rapidly eroding and fossiliferous strata at BADL expose high-quality fossils, sometimes complete and articulated skeletons of ancient mammals and other vertebrates (Fig. 3-1). These qualities, combined with the widespread geographic occurrence and abundance of the fossils, often result in incidents of unauthorized fossil collecting (theft) within the park.



Figure 3-1: Well preserved fossil skull with teeth of an Oligocene mammal exposed at the surface at Badlands National Park. (NPS Photo)

Badlands National Park Visitor Fossil Survey

The BADL visitor fossil survey was designed to gather data to help address a series of questions to inform park management about visitor's interests, knowledge, values, understandings, attitudes, motivations, and recreational choices with respect to paleontological resources. The survey questions also seek to identify and better understand "fossil stewardship attitudes" through the evaluation of visitors' responses pertaining to "fossils and their management" in the park. Below are six areas of interest on which we focused this exploratory study to gain a baseline understanding of human

dimensions of paleontological resources through the voluntary survey of park visitors at BADL.

- R1: (Demographics) Who are the visitors to Badlands National Park in terms of gender, age, race, education, previous visits to park, group category, group size, and other demographic variables?
- R2: (Awareness and Knowledge) How knowledgeable are park visitors about fossils, and how do they self-report on their knowledge about fossils?
- R3: (Values) What are the park visitors' values associated with fossils?
- R4: (Understanding) How well do visitors understand park rules pertaining to fossils?
- R5: (Fossil Stewardship Attitudes) What attitudes do visitors have regarding the collection of fossils from Badlands National Park?
- R6: (Recreational Choice) What fossil-related activities do visitors participate in during their visit to Badlands National Park?

Visitor fossil surveys were distributed to visitors at four locations in BADL. The survey locations included: outside of the Ben Reifel Visitor Center, Cedar Pass Campground Amphitheater, Fossil Exhibit Trail, and Windows / Door Trail Entrance (Fig. 3-2). These locations were selected to be inclusive of the variety of recreational and interpretive experiences available throughout the park and represent areas with sufficient visitor use to support the survey.

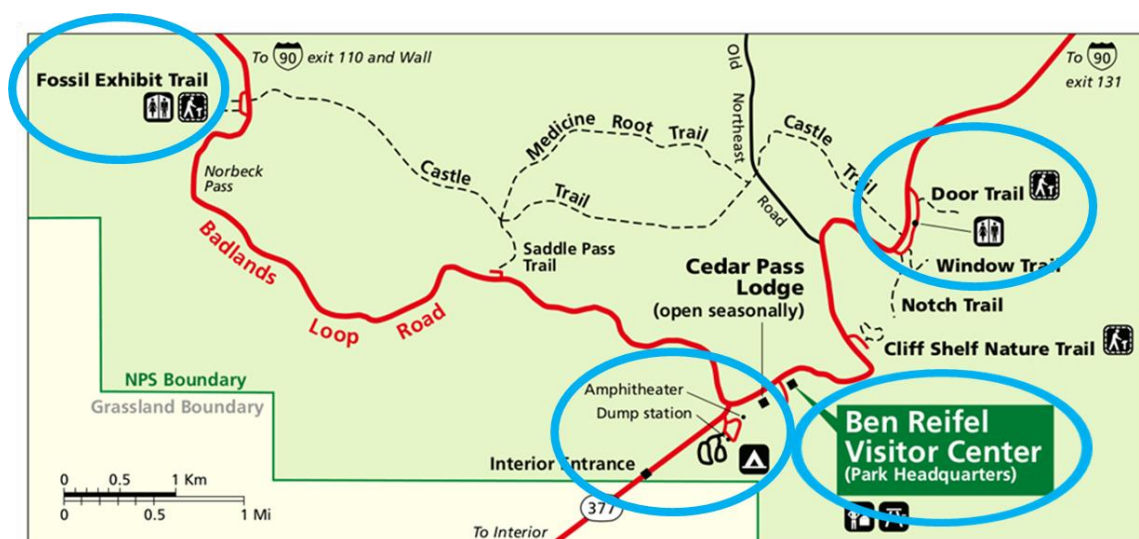


Figure 3-2: Badlands National Park Visitor Fossil Survey locations including: Ben Reifel Visitor Center, Door / Window Trail, Cedar Pass Campground Amphitheater, and Fossil Exhibit Trail. (NPS Map)

The study involved the distribution of in-person written questionnaires to visitors at BADL between May 20 and August 10, 2017 (Appendix 1). The survey was intended for adult (18 years or above) participants visiting the park. The survey questions were designed to evaluate the relationships between the visitor demographics, interests, knowledge, values, understanding, fossil stewardship attitudes, and recreational choices pertaining to fossils.

This study sought to determine whether there are any relationships between visitor values or level of knowledge about fossils and the visitor's decision (recreational choices) to participate or not to participate in specific park programs and activities related to the park's fossil resources. Additionally, the survey sought to determine if there are any relationships between visitor values, knowledge, and interests in fossils and whether visitors engage in behaviors which are appropriate or inappropriate in U.S. national

parks. Surveys were distributed to visitors at 4 locations within BADL (Fig. 3-2). Visitors were welcome to complete the surveys at the site of distribution or to complete the surveys later during their visit to BADL and drop off at one of the four distribution locations in the park.

All individuals participating in the survey did so voluntarily and the identity of all participants is maintained as anonymous. The participants of the survey were not asked to disclose any personal identity information, and therefore the survey will not pose any identity risks to the participants. We did not employ any methods to assess the non-response bias for the BADL visitor survey.

Badlands National Park Visitor Fossil Survey Results and Evaluation

R1: (Demographics) Who are the visitors to Badlands National Park in terms of gender, age, race, education, previous visits to the park, group category, group size, and other demographic variables?

Demographic information was obtained from visitor responses to Questions 9 through 17 in the BADL Visitor Fossil Survey (Appendix 1). A previous visitor demographic survey was conducted at BADL between August 2 – 8, 2000 and a report was published in July 2001 (Simmons & Gramman, 2001). The 2000 survey was distributed to 798 visitors, which resulted in a total of 639 surveys completed or 80.1% response rate. Based on the 2000 BADL survey, 93% of the visitors reported they were U.S. citizens and 7% were international visitors, 65% reported they were first time

visitors to BADL, 83% of visitors reported spending less than one day at BADL, 61% of visitors reported they were in family groups, and 50% of the visitors reported they had completed bachelor's degree or higher. The 2000 survey demographic data were used for comparison to the data obtained from the more recent 2017 visitor fossil survey at BADL. Table 3-1 presents a comparison between the demographic data from the 2000 and 2017 visitor surveys at BADL and exhibits some remarkable similarity.

Table 3-1: Comparison between the demographic data obtained during two different visitor surveys at Badlands National Park undertaken in 2000 and 2017.

	2000 SURVEY	2017 SURVEY
COMPLETED SURVEYS	639	700
VISITORS CONTACTED	798	858
RESPONSE RATE	80.1%	81.6%
AGE (MEAN)	45.5	45.27
AGE BETWEEN 36 – 55	40%	41%
GROUP – ALONE	7%	4.3%
GROUP – FAMILY	61%	67%
GROUP – FRIENDS	20%	14.6%
GROUP SIZE (MEAN)	3.75	3.79
GROUP SIZE = 2	39%	34.1%
EDUCATION = BS and ABOVE	50%	69.2%
% US VISITORS	93%	95.4%
% FOREIGN VISITORS	7%	4.6%
# OF STATES	44	46
# OF FOREIGN COUNTRIES	14	19
FIRST VISIT	65%	68%
PREVIOUS VISITS	35%	32%

R2: (Awareness and Knowledge) How knowledgeable are park visitors about fossils and how do they self-report on their knowledge about fossils?

The BADL visitor responses to this question (Question #1 in BADL Visitor Fossil Survey) involved assessing the visitors' awareness and knowledge of the significant resources preserved at BADL. The survey presented eight different significance statements associated with park resources. Five of the significance statements accurately represent the resources at BADL and three are inaccurate statements and do not represent true significance statements associated with the resources at BADL. The survey included a 7-point Likert Scale for this question with a score of 7 indicating the visitor strongly agreed with the significance statement about BADL resources and a score of 1 indicating the visitor strongly disagreed with the significance statement about BADL resources.

The five significance statements which accurately represent the resources at BADL include: "World Renowned Geology", "Prairie Ecosystem", "Native American History", "Important Fossil Localities", and "Home to Buffalo Herd." The three inaccurate significant statements which are not associated with BADL include: "Dinosaur Locality", "Shaped by Ice Age Glaciers", and "First National Park." The results of the survey for this question indicate that most of the visitors are aware and knowledgeable about the significant park resources for BADL and are able to recognize the inaccurate significant statements associated with BADL (Table 3-2).

However, there is one important observation from the results of the visitor survey which show the mean visitor score for one of the inaccurate significant statements ("Dinosaur Locality") was slightly higher than the mean visitor score for one of the actual

significant statements (“Home to Buffalo Herd”). In other words, the survey results indicate there is a greater belief (although false) that there are dinosaur localities at BADL compared to the awareness that there is a modern “bison herd” in BADL (which is true). These results reflect a common misunderstanding of the park resources by some park visitors. This misunderstanding by park visitors is something that the experienced BADL park rangers are aware of and is directly related to one of the important interpretive themes for BADL addressed in the park planning documents (NPS 2017; E. Welsh, pers. comm. 2024). The basis for this misunderstanding is simple and tied to the fact that many visitors automatically think “dinosaur” when they hear the word “fossil”. Although BADL is one of the richest fossil localities on Earth, there are no dinosaur fossils in the park. The world-renowned fossils of BADL are primarily a rich assemblage of fossil mammals which existed and preserved as fossils after the extinction of the dinosaurs. The BADL visitor fossil survey provides the first scientific data to confirm what the BADL rangers have long recognized about visitor misunderstanding of BADL fossils. Given the survey results indicating that more visitors incorrectly responded, “there are dinosaurs at BADL” compared to the number of visitors who responded they were aware that “modern buffalo inhabit the park”, suggests the park rangers have an opportunity to provide more resource education at BADL (Table 3-2).

Table 3-2: Table showing the responses obtained from the Badlands National Park Visitor Fossil Survey question #1 involving visitor awareness of the significant resources preserved at the park. Eight different categories of park resources were presented including five actual park resources categories (shown in green) and three false resource categories not occurring at the park (shown in orange). A 7-point Lickert scale was used for participants to select for each of the resource categories (e.g., score = 1 indicates “Strongly Disagree” and score = 7 indicates “Strongly Agree.”

BADL SIGNIFICANT RESOURCES	SAMPLE SIZE	MEAN	STD DEV	% SCORE
WORLD RENOWNED GEOLOGY	696	6.61	0.828	94.4
PRAIRIE ECOSYSTEM	691	6.50	0.942	92.9
NATIVE AMERICAN HISTORY	691	6.26	1.187	89.4
IMPORTANT FOSSIL LOCALITIES	689	6.05	1.158	86.6
DINOSAUR LOCALITY	694	5.47	1.813	78.1
HOME TO BUFFALO HERD	678	5.32	1.715	76.1
SHAPED BY ICE AGE GLACIERS	682	3.55	2.093	50.7
FIRST NATIONAL PARK	682	3.00	1.970	42.9

R3: (Values) What are the park visitors’ values associated with fossils?

The BADL visitor responses to this question (Question #4 in BADL Visitor Fossil Survey) involved rating categories of human values associated with fossils. The survey included a 7-point Likert Scale for this question with a score of 7 indicating the highest level of importance assigned to a particular value, and a score of 1 indicating the lowest level of importance assigned to this value. The results of the survey indicated that all the value categories collectively received at least a medium level score, showing that the participants recognized the diverse values associated with fossils. However, both

“Scientific” and “Educational” values received the highest mean scores which were greater than 6.5 out of a total 7, or greater than a 95 percent (Table 3-3).

Table 3-3: Table showing the responses obtained from the Badlands National Park Visitor Fossil Survey question #4, “For each of the following potential values of fossils, please rate how important you think that value is.” A 7-point Lickert scale was used for participants to rate each of seven values associated with fossils (e.g., 1 = “Low”; 4 = “Moderate”; and 7 = “High”).

VALUES OF FOSSILS	SAMPLE SIZE	MEAN	STD DEV	% SCORE
SCIENTIFIC VALUE	677	6.69	0.65	95.6
EDUCATIONAL VALUE	674	6.66	0.70	95.1
AESTHETIC VALUE	677	5.45	1.57	78.0
RECREATIONAL VALUE	674	5.27	1.67	75.4
ENTERTAINMENT VALUE	676	4.99	1.79	71.4
SPIRITUAL VALUE	673	4.95	1.96	70.8
MONETARY / COMMERCIAL VALUE	672	4.69	1.89	67.4

R4: (Understanding) How well do visitors understand park rules pertaining to fossils?

The BADL visitor responses to this question (Questions #5, 7 and 8 in BADL Visitor Fossil Survey) involving visitor understanding of park rules pertaining to fossils is integrated and discussed below with R5 (Fossil Stewardship Attitudes).

R5: (Fossil Stewardship Attitudes) What attitudes do visitors have regarding the collection of fossils from Badlands National Park?

The BADL visitor responses to R4 (Understanding) question involving visitor understanding of park rules pertaining to fossils is integrated and discussed here with R5 pertaining to the concept of Fossil Stewardship Attitudes (Questions #5, 7 and 8 in BADL Visitor Fossil Survey). Fossil Stewardship Attitudes are beliefs and perspectives

that individuals possess towards the management practices associated with fossils as expressed with some degree of favor or disfavor. In the case of questions R5 the focus involves the visitor perspectives related to fossil collecting at BADL.

The visitor surveys used the psychometric Likert scales for responses. For the BADL survey a 7-point Likert scale was used to score responses where a score of 1 = strongly disagree and a score of 7 = strongly agree. A score of 4 = neutral response. The mean score is based on the mean of all the survey responses; for the BADL survey N = 639 completed surveys. Presented below are 30 Fossil Stewardship Attitudes showing the mean scores and percentages of participants who agreed or disagreed in each attitude. The black row in the middle of the Table 3-4 below is essentially the inflection point where the questions transition from above and below the neutral zone score of 4.

R6: (Recreational Choice) What fossil-related activities do visitors participate in during their visit to Badlands National Park?

Visitors to BADL are presented with a wide variety of educational and recreational opportunities which are specifically tied to the park's rich paleontological resources. These include both ranger-led and self-guided opportunities to observe, discover, learn about, and understand the fossils preserved in the park. Fossils can be observed throughout a large percentage of the park, and hikes along developed trails or in the backcountry offer the opportunity to discover or view in situ fossils. The park's visitor center hosts fossil-themed exhibits and a fossil preparation lab to view paleontologists working to clean and study fossils (Fig. 3-3). Park rangers working in the

visitor center distribute Junior Paleontologist activity booklets as part of a resource-specific educational outreach for children. The park bookstore offers many fossil-themed books and souvenirs for visitors to purchase.

Table 3-4: Table showing the mean scores and percentages of visitors participating in the Badlands National Park Visitor Fossil Survey who either agree or disagree with the “Visitor Fossil Attitude” statements included in Questions 5, 7 and 8 in the survey.

FOSSIL STEWARDSHIP ATTITUDES	MEAN	% AGREE	% DISAGREE
UNAUTHORIZED FOSSIL COLLECTION COULD LEAD TO FINE OR OTHER PENALTY	6.45	92.1	7.9
FOSSILS IN PARKS ARE PROTECTED BY LAW	6.41	91.5	8.5
VISITORS SHOULD REPORT FOSSIL DISCOVERIES TO PARK RANGER	6.40	91.5	8.5
VISITOR COLLECTION OF FOSSILS NOT ALLOWED IN PARK	6.29	89.9	10.1
FOSSIL EXCAVATION MUST BE UNDERTAKEN BY PROFESSIONAL TO PRESERVE INFO	6.23	89.0	11.0
VISITORS NOT ALLOWED TO COLLECT FOSSILS FROM PARKS	6.09	87.0	13.0
MAINTAIN SOME FOSSILS IN FIELD FOR OTHER VISITOR'S TO EXPERIENCE	6.01	85.9	14.1
FOSSILS CAN ONLY BE COLLECTED UNDER PERMIT ISSUED BY PARK	5.93	84.7	15.3
FOSSILS ARE NON-RENEWABLE RESOURCES	5.83	83.3	16.7
ANY COLLECTION OF FOSSILS ONLY ALLOWED UNDER A RESEARCH PERMIT	5.81	83.0	17.0
NOT ALL FOSSILS CAN BE COLLECTED & SOME WILL BE LOST TO NATURAL PROCESSES	5.46	78.0	22.0
DECISION FOR FOSSIL COLLECTION SHOULD CONSIDER IMPACTS TO OTHER RESOURCES	5.44	77.7	22.3
RARE FOSSILS MUST BE COLLECTED TO PRESERVE SCIENTIFIC INFO	4.87	70.0	30.0
FOSSILS ARE RARE	4.61	65.9	34.1
VISITORS UNAWARE COLLECTION OF FOSSILS NOT PERMITTED IN PARKS	3.99	57.0	43.0
IF FOSSIL NOT COLLECTED IT WILL BE WEATHERED & DESTROYED	3.64	52.0	48.0
FOSSILS ARE COMMON	3.35	47.9	52.1
UNAUTHORIZED FOSSIL COLLECTION IN PARK MAY RESULT IN "BAD LUCK"	3.09	44.1	55.9
EDUCATION GROUPS ALLOWED TO COLLECT FOR EDUCATION PURPOSES	2.89	41.3	58.7
VISITOR DESIRE TO COLLECT FOSSILS GREATER THAN POTENTIAL RISK OR PENALTY	2.69	38.4	61.6
FOSSILS HAVE MONETARY VALUE & VISITOR MAY NEED MONEY	2.55	36.4	63.6
OKAY TO COLLECT FOSSILS IF USED FOR EDUCATION	2.49	35.6	64.4
IF FOSSIL NOT COLLECTED, SOMEONE ELSE WILL LIKELY COLLECT	2.35	33.6	66.4
ALL FOSSILS MUST BE COLLECTED SINCE NPS ALLOWING FOSSILS TO DISAPPEAR	2.16	30.9	69.1
FOSSILS ARE RENEWABLE RESOURCES	2.05	29.3	70.7
VISITORS ALLOWED TO COLLECT RARE FOSSILS THREATENED BY EROSION	1.86	26.6	73.4
VISITORS ALLOWED TO COLLECT COMMON FOSSILS IN PARKS	1.78	25.4	74.6
COLLECTION OF ONE OR FEW FOSSILS WILL NOT BE NOTICED	1.72	24.6	75.4
FAMILY TRADITION TO COLLECT FOSSILS IN PARK	1.72	24.6	75.4
VISITOR IS FOSSIL EXPERT & KNOWS MORE THAN NPS	1.53	21.8	78.2

Along the park roads and trails are interpretive wayside exhibits which present information about the geology and paleontology of BADL. The Fossil Exhibit Trail is a popular and award-winning trail for visitors to stretch their legs and learn about the park's globally significant fossils. Visitor's to BADL are presented with outstanding

recreational choices involving fossils, and the visitor fossil survey grouped these activities into eight categories: 1) view fossils in the visitor's center; 2) attend a ranger program on fossils; 3) see fossils while hiking in the park; 4) view fossils being prepared in the visitor center; 5) collect fossils in the park (which is an unauthorized activity); 6) hike the Fossil Exhibit Trail (Fig. 3-4); 7) participate in the "Junior Paleontologist" activity; and, 8) purchase fossil-themed books or souvenirs in the park's bookstore.



Figure 3-3: Paleontology-themed exhibits on display at the Ben Reifel Visitor Center at Badlands National Park. (NPS Photo)

Visitors who have not yet visited the visitor center, hiked in the park, or participated in a park ranger led activity, will not have participated in some or all the visitor fossil activities available within the park. Therefore, the visitor responses to the

survey will reflect whether they have just entered the park or have been able to experience the visitor center and other activities (Figs. 3-5 and 3-6).



Figure 3-4: The Fossil Exhibit Trail at Badlands National Park offers a fossil-themed interpretive hike for park visitors. (NPS Photo)

Question #2 in the survey indicates that approximately 59% ($n = 700$) of the survey participants responded “YES” that they have viewed fossils at the visitor center (Fig. 3). This would suggest that approximately 40% or greater of the visitors did not yet experience the BADL visitor center or at least view the exhibits in the visitor center at the time they participated in the visitor fossil survey, or they did not visit the visitor center at all. The viewing of fossils at the park’s visitor center is the activity with the highest response rate in the survey, suggesting the importance of highlighting fossil education and outreach at the visitor center. Hiking the “Fossil Exhibit Trail” (42% reporting this

activity) and viewing fossil preparation (nearly 38%) in the visitor center were also reported as other fossil themed activities visitors were participating in. The visitor survey included eight fossil-themed activities for visitors to participate during their visit to BADL. The responses range from visitor participation in zero (0) fossil-themed activities up to a total of eight (8) fossil-themed activities (Figs. 3-5 and 3-6).

The visitor fossil survey includes six individuals who responded that they collected a fossil or fossils as an activity they participated during their visit to BADL. The collection of fossils from a National Park Service area such as BADL is prohibited, unless the collecting is undertaken with an approved research and collecting permit. Therefore, if these responses are accurate, they reflect instances of unauthorized fossil collection and in violation with NPS laws. One explanation is that these responses were made by individuals who were not accurately reporting, or these individuals honestly reported on this illegal activity of fossil collecting during their visit to BADL. It is important to note that the park has no plans to investigate these survey results with respect to maintaining the anonymity and confidentiality of the participants which is paramount in this type of social science research.

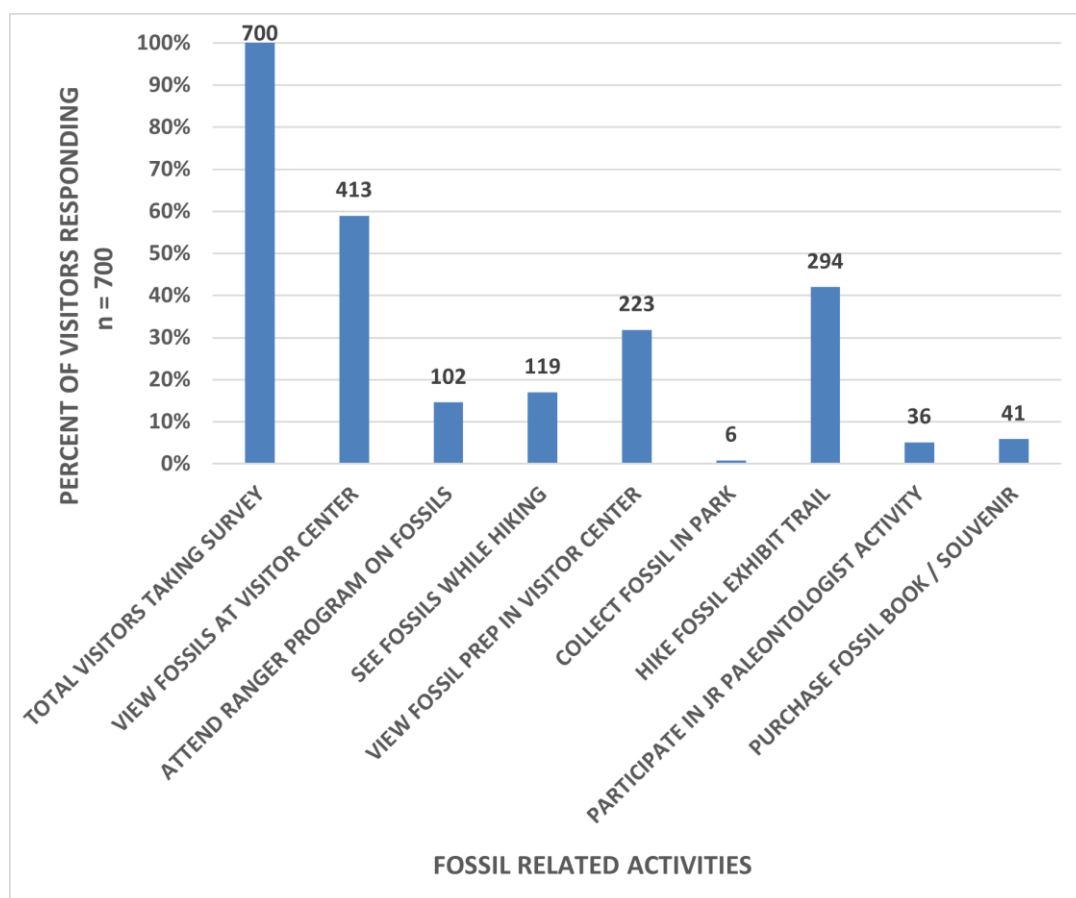


Figure 3-5: The visitor survey responses to the 2017 Badlands National Park Visitor Fossil Survey question #2 pertaining to whether the visitor participated in one or more of the eight fossil-themed activities during their visit to the park. The totals shown for each activity reflect the number of “YES” responses recorded in the visitor fossil survey. (n = 700)

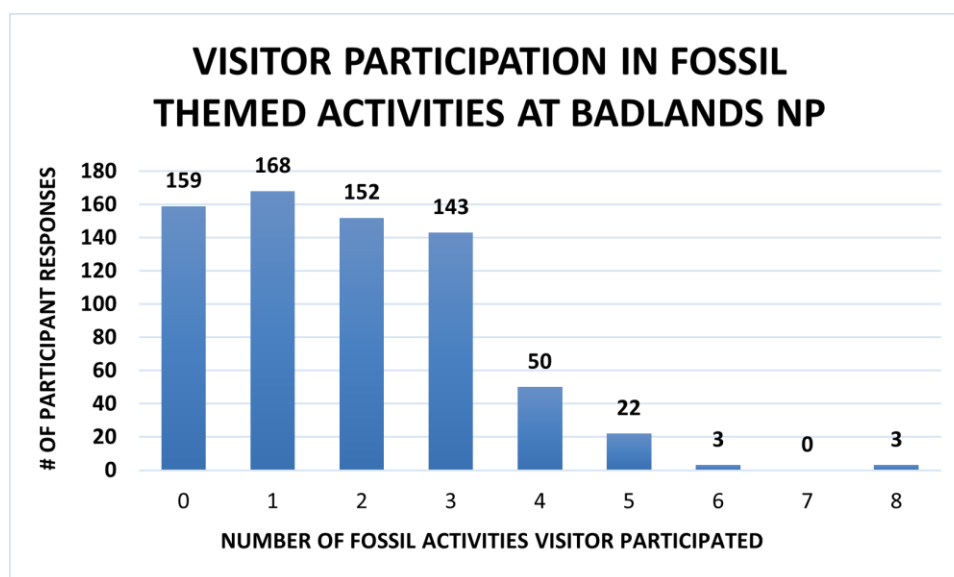


Figure 3-6: The visitor survey responses derived from question #2 pertaining to the number of different fossil themed activities they participated during their visit to Badlands National Park. The responses range from visitor participation in zero (0) fossil-themed activities up to a total of eight (8) fossil-themed activities.

Case Study: Denali National Park and Preserve

Denali National Park and Preserve (DENA) encompasses over six million acres of Alaskan wilderness landscape preserving tundra, glaciers, mountains, alpine forests, and wildlife. The park's iconic namesake Denali (formerly Mount McKinley) is the tallest peak in North America, reaching an elevation of 6,190 m (20,310 ft). The area was established as a national park on February 26, 1917, and was originally named Mount McKinley National Park in honor of President William McKinley. The park was expanded and renamed DENA in 1980. The discovery of globally significant paleontological resources at DENA has captured the attention of scientists, the public, and media for more than a decade. Documentation of extensive dinosaur trackways,

preserved in backcountry wilderness, has revealed one of the largest fossil track localities in North America.

Both paleontological resources and wilderness are identified as significant and fundamental park resources and values in the Denali National Park and Preserve Foundation document (National Park Service, 2014). Paleontological resources are identified in one of DENA's significant statements, which specifically states, "*Denali is one of the premier protected areas in North America for understanding the ecological relationships among species and the environment at the end of the Age of Dinosaurs about 70 million years ago. Thousands of trace fossils of dinosaurs and other species have been found in the Cantwell Formation since 2005, when the first dinosaur track was found.*"

In 2005, fossil vertebrate footprints, primarily associated with dinosaurs, were discovered in the Cretaceous Cantwell Formation at DENA (Fig. 3-7). Over the next 15 years, thousands of trace fossils of fish, pterosaurs, dinosaurs (theropods, hadrosaurs, ceratopsians and possibly ankylosaurs), birds, and terrestrial and aquatic invertebrates have been documented at DENA (Fiorillo et al., 2006, 2007, 2011; Santucci et al., 2011). Fossil track localities range from large bedding planes with thousands of tracks, to single footprints with skin impressions, tail drags, coprolites, and other isolated traces (Brease et al., 2009). A single manus track from DENA was identified as pterosaur representing the first record of a pterosaur from Alaska as well as the northernmost occurrence of pterosaurs (Fiorillo et al., 2009; Fiorillo et al., 2011). A diverse avian ichnofauna is also

documented from multiple localities in the Cantwell Formation at DENA (Fiorillo et al., 2011).



Figure 3-7: Isolated Cretaceous fossil dinosaur footprint exposed at Tattler Creek in the backcountry of Denali National Park and Preserve. (NPS Photo)

The Tattler Creek fossil track locality in DENA is globally significant and preserves thousands of fossil footprints, mostly hadrosaurid, that appears to represent the movement of a multi-generational hadrosaur herd (Fiorillo et al., 2014). Handprints (manus) and footprints (pes) are attributed to a juvenile hadrosaur, providing evidence of facultative quadrupedalism in juvenile hadrosaurs as well as adults (Fiorillo & Tykoski, 2016). Significant unpublished sites are the subject of ongoing study, yielding trackways of ceratopsians and hadrosaurs, as well as various avian and non-avian theropods (Druckenmiller et al., 2017; P. Druckenmiller, personal commun., 2018; Tweet & Santucci, 2018).

The scientific interest and public awareness of the fossil dinosaur tracks at DENA continues to increase as new discoveries are reported in scientific publications, news media, and interpretive exhibits at the park (Fig. 3-8). DENA dinosaurs and dinosaur footprints are featured in the 2021 National Fossil Day logo (Fig. 3-12b). The Tattler Creek fossil tracksite is in a remote portion of the park managed as wilderness; this represents the best known and most commonly visited fossil locality in the park (Hodges and Capps, 2013). Consequently, DENA fossils are helping to illuminate both the geology and paleontology linking Alaska with Asia and the circum-Pacific landmasses during the Paleozoic and Mesozoic. The park is becoming recognized as a “paleontological frontier” by the scientific community, the media, and the public. Beginning in 2013, the National Park Service began to monitor the fossil track locality at Tattler Creek to assess natural processes and potential anthropogenic impacts. The 2018

visitor survey and the interviews of park visitors at Tattler Creek represents the first effort to evaluate visitor's interests and attitudes involving DENA's paleontological resources.



Figure 3-8: Cretaceous Denali mural depicting prehistoric life documented from localities within the park. Painting produced by artist Karen Carr. (NPS Photo)

Denali National Park and Preserve Visitor Fossil Survey

The DENA Visitor Fossil Survey was designed as an onsite and park-based social science research project to collect important new data in the fields of paleontological resource management and protection. Specifically, the purpose of this research is to obtain visitor-use social science data that informs the DENA staff on important paleontological resource management considerations and visitor perspectives regarding park fossils. A Paleontological Resources Management Plan, a document that guides the management and protection of the valuable and non-renewable paleontological resources

of the park, was finalized and implemented at DENA in 2024 (Capps et al., 2024). The visitor survey was conducted at DENA during the summer of 2018 to assess the human dimensions of paleontological resources at the park (Santucci, et al., 2016) (Appendix 2). Visitor surveys were obtained from $n = 477$ (71% response rate) visitors outside of the DENA Visitor Center during July and August 2018. The survey included five research questions presented below:

R1: What are park visitors' attitudes, interests, and motivations related to paleontological resources, both generally and specifically to DENA?

R2: Are visitors aware of DENA's paleontological resources? If so, how and where are visitors obtaining information regarding DENA's paleontological resources?

R3: What are visitors' opinions about hypothetical management actions related to paleontological resources in DENA?

R4: How do visitor demographics and trip characteristics relate to paleontological resource measures, like attitudes, interests/motivations, information, and other components measured?

R5: What are the salient qualities of visitor experience related to engagement with paleontological resources, and how do DENA's unique wilderness character qualities influence these experiences?

Surveys were collected at the Denali National Park and Preserve Visitor Center for 17 days between July 6th and August 15th, 2018 (Fig. 3-9). Sampling days were stratified by day, time, and location. Trained research assistants administered the

sampling of visitors. During the sampling period, trained surveyors used a random number generator to choose a number between 0 and 30 that represented the time at which they would intercept their first visitor group that was either entering or exiting the sampling location. Visitors were then asked if they would be willing to participate in a survey. Visitors who were unwilling or unable to participate in the survey were asked two questions that assessed non-response bias. Visitor groups who agreed to participate in the survey were then asked who had a birthday closest to the current date. This method allowed for randomization within groups. Because of the high volume of visitors at the Denali Visitor Center, researchers would intercept every 3rd group they encountered.

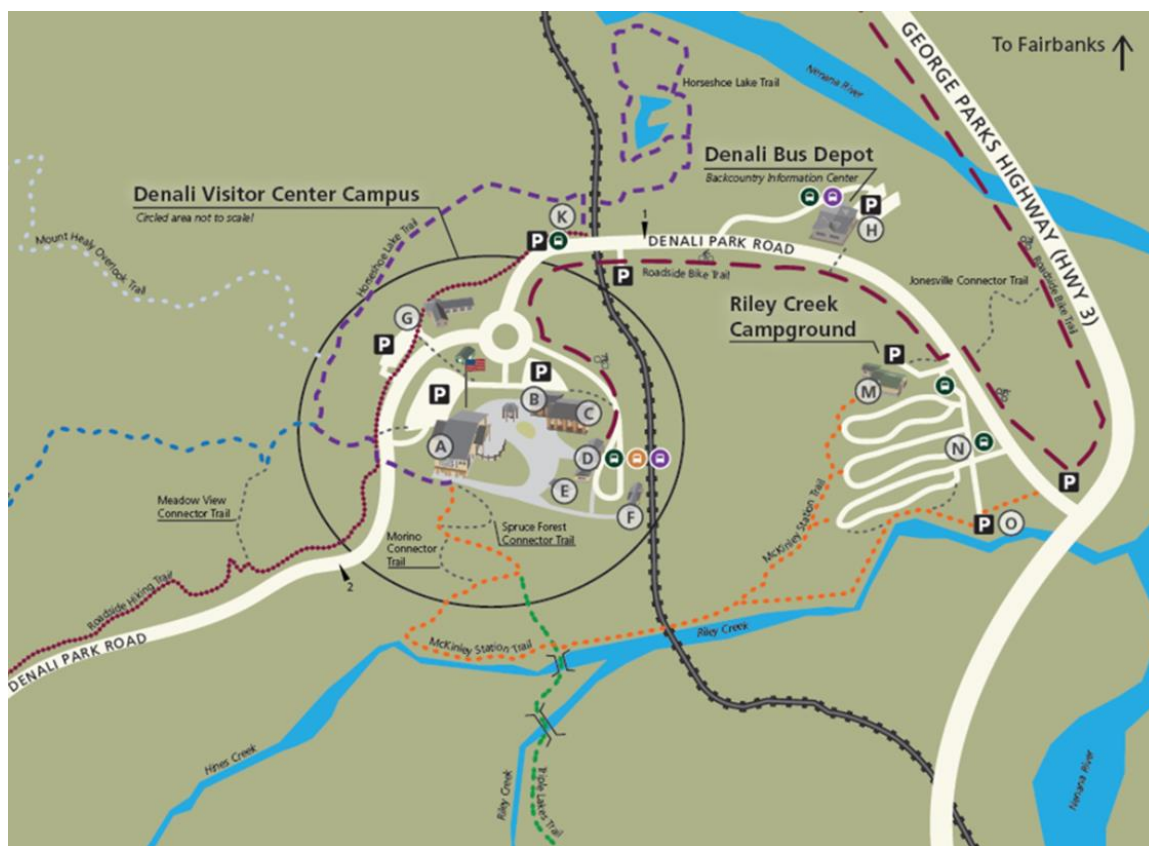


Figure 3-9: Denali National Park and Preserve entrance area map showing the Visitor Fossil Survey location at the Denali Visitor Center Campus. (NPS Map)

Denali National Park and Preserve Visitor Fossil Survey Results and Evaluation

During July and August 2018, staff from Penn State University implemented two components of a social science research project involving information collection from park visitors. The first component involved a visitor survey instrument with data collection at the DENA Wilderness Access Center and the second involved interviews with visitors to Tattler Creek. The visitor interviews provided more qualitative data which is not presented in this summary.

The response rate for the visitor survey was 71% and a total of 477 (n=477) surveys were completed. The gender of the survey participants included 51.4% (n=241) females and 48.6% (n=228) males (Table 3-5). The “Family Group” was reported as the predominant group type during the survey with 60.8% (n=285) of participants in this category (Table 6). The participants of the survey ranged in age between 18 and 85 years old (mean = 52.2; median = 56) (Figure 3-10). U.S. resident or citizens represented 87.7% (n = 413) of the survey participants (Table 3-7).

Table 3-5: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “What is your gender?” (Please select one).

VISITOR RESPONSE	FREQUENCY	PERCENT
FEMALE	241	51.4%
MALE	228	48.6%
TOTAL	469	100%

Table 3-6: Denali National Park and Preserve Visitor Fossil Survey responses to the question regarding group type: “Please select the choice below that best represents your traveling party. (Please select only one choice).”

VISITOR RESPONSE	FREQUENCY	PERCENT
INDIVIDUAL	18	3.8%
FAMILY ONLY	285	60.8%
FRIENDS ONLY	66	14.1%
FAMILY & FRIENDS	51	10.9%
TOUR OR OTHER GROUP	49	10.4%
TOTAL	469	100%

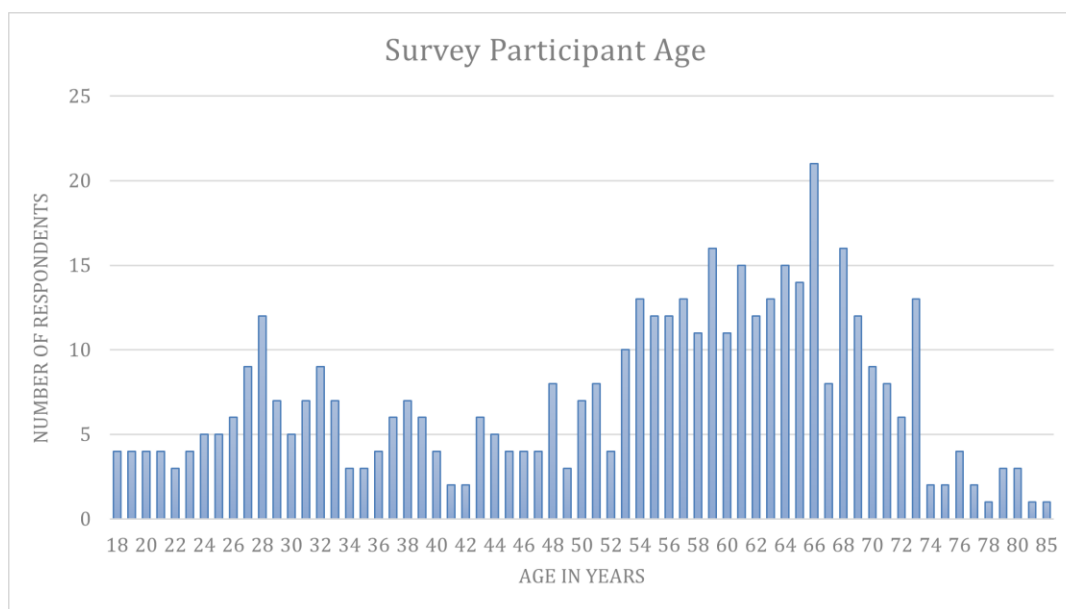


Figure 3-10: Bar chart showing the distribution of Denali National Park and Preserve Visitor Fossil Survey participants by ages.

Table 3-7: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “Are you a permanent resident or citizen of the United States?”

VISITOR RESPONSE	FREQUENCY	PERCENT
NO	58	12.3%
YES	413	87.7%
TOTAL	471	100%

Denali National Park and Preserve Visitor Center Survey

Visitor surveys were obtained from 477 visitors outside of the Denali Visitor Center during July and August 2018. The 477 total surveys obtained are based on 671 visitor intercepts yielding a 71% response rate for the survey.

Research Question #R1: What are park visitors’ attitudes, interests, and motivations related to paleontological resources, both generally and specifically to Denali National Park and Preserve?

The underlying constructs (e.g. interests or motivations) are adapted from existing literature (Fishbein and Ajzen, 2010; Santucci, Newman, Taff, 2016).

VISITOR INTEREST: Question 3 of the visitor survey focused on visitor interest in specific paleontological resource activities. A five-point Likert Scale was used which range from a response of one (1) which represents “*Not At All Interested*” to a response of five (5) “*Completely Interested*”. “*Seeing fossils preserved in rock in a natural setting*”

obtained the highest mean value pertaining to visitor interest, whereas “*Collecting fossils as a hobby*” received the lowest mean value pertaining to visitor interest (Table 3-8).

Table 3-8: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “In general, how interested are you in the following activities”: 1) Not at all interested; 2) Somewhat interested; 3) Very interested; 4) extremely interested; and, 5) Completely interested. A 5-point Lickert Scale was used for this question.

VISITOR RESPONSE	SAMPLE SIZE	MEAN	STD DEV	PERCENT
SEEING FOSSILS PRESERVED IN ROCK IN A NATURAL SETTING	439	3.36	1.16	67.2%
LEARNING ABOUT FOSSILS	439	2.95	1.11	59.0%
VISITING A MUSEUM OR VISITOR CENTER TO SEE FOSSILS	439	2.94	1.14	58.8%
ATTENDING MOVIES FEATURING DINOSAURS OR OTHER FOSSILS	439	2.72	1.24	54.4%
SEARCH FOR OR FINDING FOSSILS	439	2.63	1.35	52.6%
COLLECTING FOSSILS AS A HOBBY	439	1.85	1.20	37.0%

VISITOR MOTIVATION: “Is viewing fossils in Denali a main / large reason for your trip to the park today? (Check one)” - Yes or No. The participant responses to this question resulted in 93.6% indicated “No” (Table 3-9). Only 3.7% of participants responded “Yes” that “viewing fossils in Denali was a main / large reason for your trip to the park today.”

Table 3-9: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “Is viewing fossils in Denali a main / large reason for your trip to the park today? (Check one Yes or No)”.

VISITOR RESPONSE	FREQUENCY	PERCENT
NO	181	96.3%
YES	7	3.7%
TOTAL	188	100%

Research Question #R2: Are visitors aware of DENA’s paleontological resources? If so, how and where are visitors obtaining information regarding DENA’s paleontological resources?

R2: was also explored through the questionnaire data. In one part, we queried how aware visitors are about DENA’s paleontological resources. In a second set of questions, we evaluated the types of information sources visitors are using to get information about DENA’s paleontological resources. Analyses of the survey results are largely descriptive.

VISITOR KNOWLEDGE: Based upon the responses to the visitor survey, 59.3% of the survey participants indicated they were “*Not at all aware*” about Denali’s fossil resources (Table 3-10). The percentage of visitors progressively dropped with increasing awareness about Denali’s fossil resources, with only 0.8% of survey participants responding that they were “extremely aware” of Denali’s fossil resources (Table 3-10 and Figure 3-11).

Table 3-10: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “We would like to know what sources of information you used to get information about fossil resources in Denali. We would also like to know when you obtained each type of information.” (Check one Box for each item)

VISITOR RESPONSE	FREQUENCY	PERCENT
NOT AT ALL AWARE	283	59.3%
SOMEWHAT AWARE	123	25.8%
MODERATELY AWARE	48	10.1%
VERY AWARE	19	4.0%
EXTREMELY AWARE	4	0.8%
TOTAL	477	100.0%

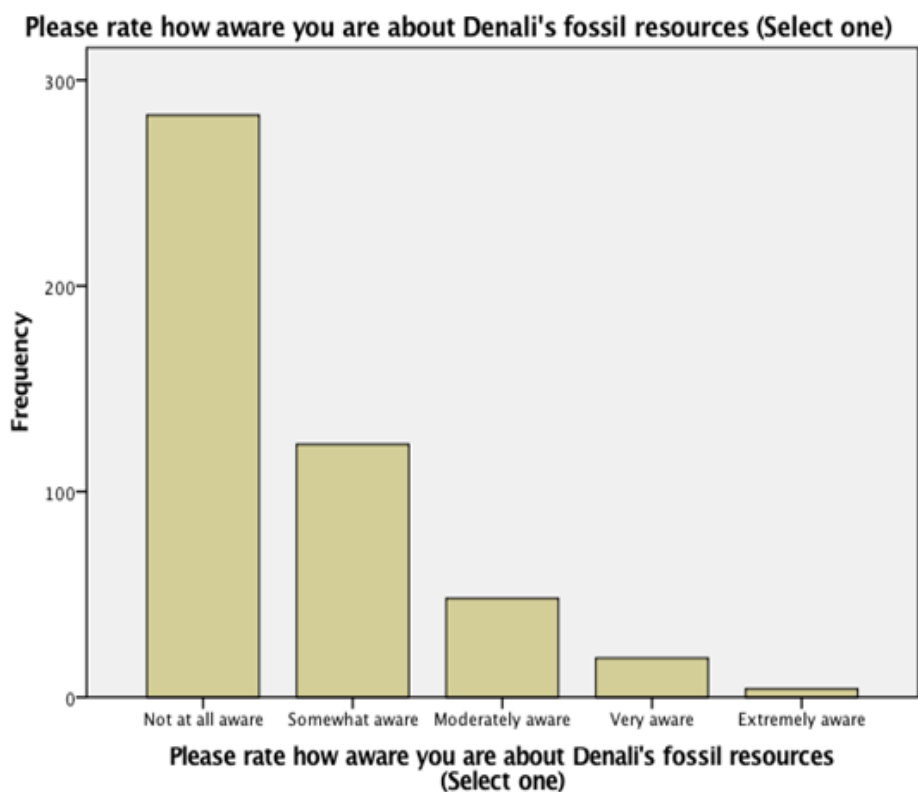


Figure 3-11: Bar chart showing the distribution and frequency of responses in the Denali National Park and Preserve Visitor Fossil Survey to question where visitor rate their awareness about Denali's fossil resources.

SOURCES FOR DENALI FOSSIL INFORMATION: The visitor survey included a question seeking participant responses to the sources of information regarding Denali fossils which they obtained either prior to the park visit or after arriving at DENA (Table 3-11). The responses indicate the largest sources of information about fossils obtained prior to the park visit were from two sources including “News Articles (Print or Online)” (20.1%) and “DENA Website” (20.1%). The participant responses to the survey indicate the largest source of information about DENA’s fossils after arriving at park during park visits was from the "Bus Drivers" (36.4%). Given the apparent importance of the “Bus Drivers” in providing information about park resources and specifically park fossils, the park management may want to provide some guidance and training to the “Bus Drivers” to ensure accurate, consistent, and appropriate information is being shared by the “Bus Drivers” with the public. This should include information promoting resource stewardship and protection of the park’s non-renewable paleontological resources.

Table 3-11: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “We would like to know what sources you used to get information about fossil resources in Denali. We would also like to know when you obtained each type of information.” (Check one Box for each item).

SOURCE OF INFORMATION ABOUT FOSSILS	BEFORE ARRIVING	AFTER ARRIVING
NPS RANGER	3.66%	12.86%
BUS DRIVER	2.44%	36.43%
OTHER EMPLOYEE	3.66%	10.71%
WORD OF MOUTH (OTHER VISITORS)	18.29%	5.0%
SOCIAL MEDIA	10.37%	0%
NEWS ARTICLE (PRINT OR ONLINE)	20.12%	3.57%
DENA WEBSITE	20.12%	1.43%
OTHER WEBSITE	6.10%	0.71%
OTHER (PLEASE SPECIFY)	15.24%	29.29%

Several observations can be made from the responses to Research Question #2.

First, the survey data shows that bus drivers are an important source of information about fossils at DENA. The bus driver was identified 3 times more frequently as the source for information on DENA fossils than the park ranger. This suggests the importance of the bus driver in disseminating information on park fossils, and likely for other resources as well. Additionally, there seems to be an inverse relationship between the sources of information pre-trip and sources during trip. The numbers reflect something that is predictable given the access to sources of information. For example, there would be less web access to online information and media while in park, due to its remote setting, which would typically be more accessible prior to arriving at the park. Finally, “other” sources of information on fossils are relatively high both pre-trip and during trip. It would be interesting to see the specific information that may be available from these responses.

Research Question #R3: What are visitors’ opinions about hypothetical management actions related to paleontological resources in DENA?

R3: is also explored through measures on the questionnaire. Staff at DENA and the NPS have developed a series of management actions specific for paleontological resources ranging from “light-handed” indirect actions to “heavy-handed” direct actions. Visitor opinions regarding these management actions were measured on a standard Likert scale with opposition and support anchors. The results of this visitor survey may be used in future analyses to assess visitor support for management actions related to paleontological resources.

VISITOR ATTITUDE: This portion of the survey assesses visitor opinions and attitudes regarding park management actions involving DENA fossils. A 7-point Likert Scale was used with the following question: “Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali.” (Select one for each management action) including: 1) Completely oppose, 2) Strongly oppose, 3) Oppose, 4) Neutral, 5) Support, 6) Strongly support and 7) Completely support. Survey results are presented in Table 3-12.

Table 3-12: Denali National Park and Preserve Visitor Fossil Survey responses to the question: “Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali.”

VISITOR RESPONSE	SAMPLE SIZE	MEAN	STD DEV	PERCENT
ESTABLISH MORE EXHIBITS AND DISPLAYS IN THE VISITOR CENTER WHERE PEOPLE CAN LEARN ABOUT FOSSILS IN DENALI	434	5.72	1.10	81.7%
CREATE RANGER-LED TRIPS TO VIEW FOSSILS IN DENALI, BUT RESTRICT ALL OTHER VISITOR USE IN AREAS WITH FOSSILS	435	5.55	1.35	79.3%
PROVIDE INFORMATION TO VISITORS ABOUT WHEN THEY CAN HIKE TO SEE FOSSILS IN THE PARK	435	5.33	1.30	76.1%
PROVIDE ACCESS TO FOSSIL SITES BUT ONLY THROUGH A LIMITED NUMBER OF PERMITS	438	5.11	1.33	73.0%
CLOSE ALL AREAS WITH FOSSILS TO THE PUBLIC	433	3.01	1.47	43.0%

Research Question #R4: How do visitor demographics and trip characteristics relate to paleontological resource measures, like attitudes, interests/motivations, information, and other components measured?

The survey responses related to visitor demographics at DENA are presented in tables 3-5, 3-6, and 3-7, and figure 3-10.

Research Question #R5: What are the salient qualities of visitor experience related to engagement with paleontological resources, and how do DENA's unique wilderness character qualities influence these experiences?

This portion of the visitor fossil survey was explored through semi-structured visitor interviews providing qualitative data and is only briefly described here. This portion of the research was undertaken through a phenomenological approach seeking to explain the subjective nature of experiences. This enabled researchers to be open to a variety of outcomes from the data, including outcomes that may not be previously assumed. The data from the interviews were coded into thematic elements that can be used to describe the unique qualities of viewing paleontological resources in a wilderness setting. Since the BADL visitor fossil survey did not include a qualitative component, the results of the DENA semi-structured visitor interviews will be presented in a separate research publication in the future.

Discussion and Fossil Stewardship Attitudes

Individually and jointly the BADL and DENA visitor fossil surveys provide new and useful information involving the human dimensions of paleontological resources. Although each park preserves globally significant paleontological resources, the parks each present a different historical context and geologic setting relative to their respective park fossils. BADL has been recognized as an important fossil locality for more than 175 years, whereas DENA's paleontological resources have gained scientific attention over the past three decades. Both parks preserve a significant vertebrate fossil record, primarily Eocene and Oligocene mammals at BADL and Cretaceous dinosaur footprints at DENA. From a management perspective, BADL has an unfortunate history of unauthorized fossil collecting by park visitors and commercial fossil dealers, whereas, DENA's fossil tracks have not experienced any noteworthy instances of paleontological resource crimes. At DENA, the lack of fossil resource theft and vandalism may be in part due to the resources being located in remote areas of the park and that fossil tracks are more difficult to collect and transport compared to fossil bones and teeth which are common at BADL.

An important difference between BADL and DENA, based upon the responses to the respective visitor fossil surveys, relates to the visitors' awareness and understanding about the occurrence of fossils at each park. For BADL, 86.6% of the visitors reported that they were aware that the park was an important fossil locality (Table 3-2). Whereas, for DENA, only 3.7% of the visitors participating in the survey reported that viewing fossils in the park was part of the reason for visiting the park (Table 3-9). Although the

survey questions in each of the park surveys were worded differently, the significantly different responses in the questions for each park demonstrate that BADL visitors were more aware of the occurrences of fossils at that park than were the visitors to DENA.

Despite any differences that exist in the paleontological resources and their management at BADL and DENA, both parks are considered “Paleontological Crown Jewels” within the National Park Service and to the paleontological community. Both parks have active paleontological research being undertaken and have fossil-themed exhibits on display within park facilities. BADL and DENA have each been featured in an annual National Fossil Day logo with BADL featured in the 2010 annual logo and DENA featured in the 2021 annual logo (Fig. 3-12a, 3-12b). Although the NPS has documented paleontological resources in 286 different parks, only 15 of these fossil parks have been featured in annual National Fossil Day logos, a testament to the significance of the fossils from BADL and DENA.

The visitor fossil surveys undertaken at BADL and DENA yield interesting data associated with visitor interests and their participation in fossil-related activities or experiences during their visit to each park. For the BADL study design Research Question #R6: (Recreational Choice) “What fossil related activities do visitors participate in during their visit to Badlands National Park?” and the BADL Visitor Survey questions #2 and #3 relate directly to visitor interests and their participation in fossil-related activities or experiences during the park visit. Similarly, for DENA study design Research Questions #R1: “What are park visitors’ attitudes, interests, and motivations related to paleontological resources, both generally and specifically to DENA?”, #R5:

“What are the salient qualities of visitor experience related to engagement with paleontological resources”, and DENA Visitor Survey questions #3 and #4 relate directly to visitor interests and their participation in fossil-related activities or experiences during the park visit.

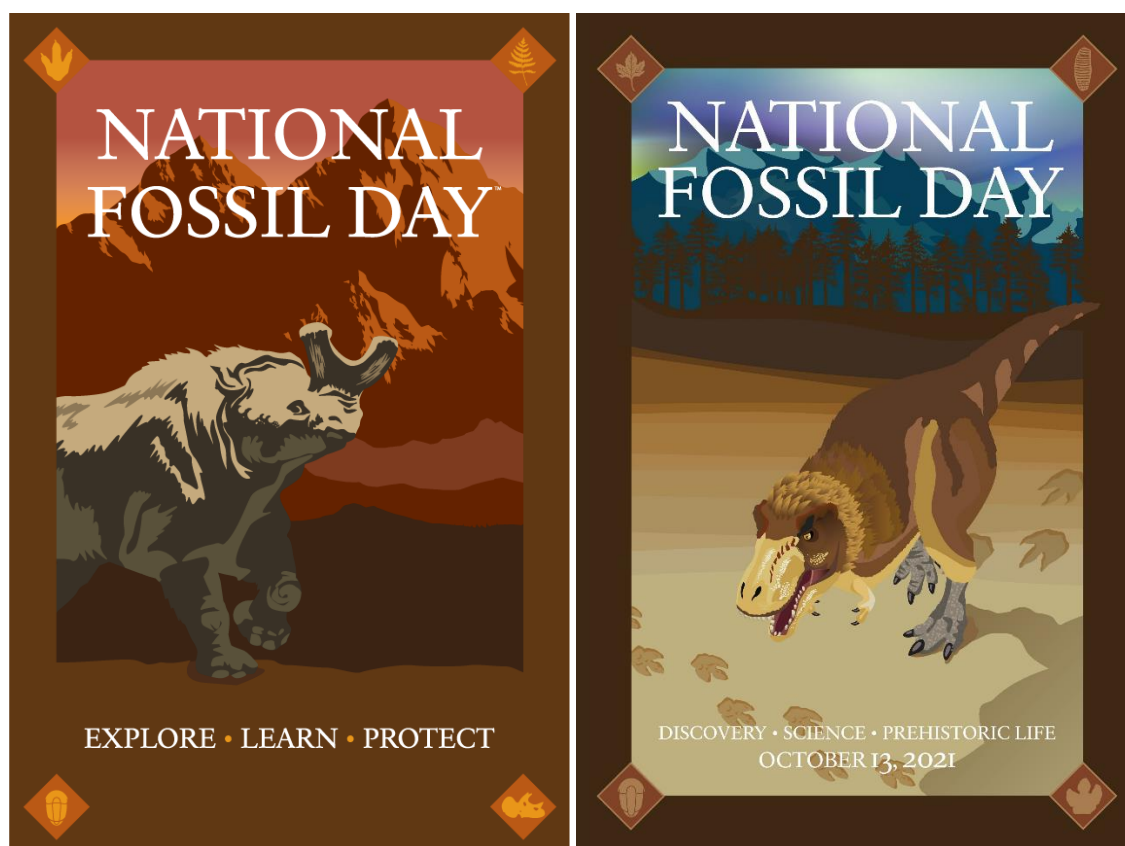


Figure 3-12: a. (left) 2010 annual National Fossil Day logo depicting an Eocene brontothere from Badlands National Park. b. (right) 2021 annual National Fossil Day logo depicting a large feathered theropod dinosaur from Denali National Park and Preserve. (NPS Photos).

Table 3-13 shows a comparison between visitor responses in the BADL and DENA surveys pertaining to visitor interest in fossil-related activities or experiences during their visit to each park. Although the questions in the BADL and DENA visitor

survey used a different Likert Scale scoring for the questions (BADL = 7 point and DENA = 5 point) related to visitor interest in fossil related activities and experiences during their visit to the park, the respective mean scores for the responses were remarkably similar (Table 3-13). For both the BADL and DENA visitor surveys, “Seeing Fossils Preserved in Rock in a Natural Setting” was shown to have the highest response rate compared to all other interests in fossil related activities and experiences during their visit to the park. The mean responses for the preferences on other fossil related activities and experiences generally were similar for both the BADL and DENA visitor surveys. These two park visitor fossil surveys provide the first available data pertaining to visitor interests in fossil related activities and experiences and the similarity of responses in both surveys will be important to share with NPS staff in these two parks.

Table 3-13: Comparison between the visitor responses in the Badlands National Park and Denali National Park and Preserve surveys pertaining to visitor interest in fossil related activities or experiences during their visit to each park.

VISITOR RESPONSE	BADL	DENA
N =	639	475
SEEING FOSSILS PRESERVED IN ROCKS IN A NATURAL SETTING	81.6%	67.4%
VISITING A MUSEUM OR VISITOR CENTER TO SEE FOSSILS	73.7%	59.0%
INTEREST IN OR LEARNING ABOUT FOSSILS	72.0%	59.2%
ATTENDING MOVIES FEATURING DINOSAURS OR OTHER FOSSILS	67.3%	55.2%
COLLECTING FOSSILS AS A HOBBY	52.9%	36.8%

Based on the visitor fossil survey responses for both BADL and DENA, park visitors are reporting their greatest interest in fossil-related activities or experiences is seeing fossils preserved in rocks in a natural setting during their visit to the park (Figure 3-5 and Table 3-8). This is extremely valuable information for park managers and interpreters to support their planning and programming at the park. Since many parks provide the opportunity to view fossils in a natural state, within a geologic context, parks provide a different experience for the public compared to seeing fossils in a museum, on social media, or in other settings (Fig. 3-13). Viewing and experiencing fossils by the public in a natural state (within a geologic context in rock strata) has important educational values to broaden a greater understanding of fossils, their occurrence and preservation in the geologic record, and the processes used by scientists to collect, study, and understand these non-renewable remains of life from the past. The geologic context enables the visitor to learn about and better understand the fossil's occurrence within the ancient environment in which it was preserved, along with the sediments, sedimentary features, and other organisms which are part of a collective paleoecosystem.

The experience of discovering and observing fossils in a natural setting, in a sense “in the wild”, presents park visitors with a “cool”, memorable, and perhaps unforgettable experience during their park visit. Seeing a fossil in the wild equates to an analogy comparing the viewing a Bald Eagle in a cage in the National Zoo is one experience; however, observing an eagle soaring above the Madison River in Yellowstone National Park is an entirely different experience. National parks provide park visitors the opportunity to discover, observe, and learn about fossils in a natural setting enhancing

effective resource stewardship and protection messaging during these important park experiences. The survey data obtained in both the BADL and DENA studies support the current belief that providing visitors the experience of observing fossils in a natural setting (geologic context) is an important resource stewardship practice employed by NPS staff in the fossil parks.



Figure 3-13: Historic photo showing the in situ exhibit of Jurassic fossils exposed for the public to view in the Douglass Quarry at Dinosaur National Monument. (NPS Photo)

Within the paleontological community, most paleontologists are aware that the public tends to synonymize the terms “fossil” and “dinosaur”. Whereas there is an extensive fossil record that preserves a tremendous diversity of prehistoric life that are not dinosaurs. This includes the fossil remains of plants, invertebrates, and non-dinosaurian vertebrates. Despite a wonderfully diverse fossil record of organisms, the

common interpretation of the word “fossil” by the public frequently translates to “dinosaur”, which is a widespread misunderstanding.

The BADL visitor fossil survey provides the first empirical data which supports the common misunderstanding and confusion that the word “fossil” does not always translate to “dinosaurs”. This is an extremely important topic to the rangers at BADL, who have recognized this visitor misunderstanding about the types of fossils preserved in the park. There are no known dinosaurs preserved at BADL however, the park preserves one of the richest and globally significant deposits of fossil mammals from the Eocene and Oligocene from anywhere on Earth. This is a scientific fact that the BADL staff and the interpretive media and exhibits in the park attempt to convey to the park visitors and address in the park’s foundation document (NPS, 2017).

One other somewhat humorous factor likely contributes to the public misunderstanding about the occurrences of dinosaurs at BADL. Along Interstate 90 (I-90) near Wall, South Dakota, and the access to the western entrance (Pinnacles Entrance) of BADL, is a large sauropod dinosaur sculpture visible to travelers along the interstate (Fig. 3-14). We currently have no data to conclude whether the prominent display of this dinosaur sculpture has any influence over the public’s misunderstanding about the occurrence of dinosaur fossils at BADL. This question could be assessed in a future visitor survey.

The BADL visitor fossil survey is the first empirical research to report on actual data that confirms the suspicions, observations, and anecdotal perspectives of park staff

that many park visitors assume when they hear there are fossils at BADL, this is often inferred by park visitors to imply dinosaurs are preserved in the park.



Figure 3-14: Dinosaur sculpture along Interstate 90 in Wall, South Dakota. Visitors to Badlands National Park who view this dinosaur sculpture may mistakenly conclude that the notable fossils preserved in the park include the remains of dinosaurs. (V. Santucci Photo)

Finally, the data obtained through the responses obtained in the two visitor fossil surveys at BADL and DENA present both a need and opportunity to propose a new concept associated with the human dimensions of paleontological resources. As introduced in this article, we propose the concept of Fossil Stewardship Attitudes be defined as the beliefs and perspectives that individuals possess towards the resource management practices associated with fossils as expressed with some degree of favor or disfavor. The resource management practices applied to fossils by the National Park

Service are derived from federal laws, regulations, and policies and based upon scientific principles and methodologies.

Conclusion

The data derived from the visitor fossil surveys at BADL and DENA provide important new insights to visitor perspectives towards resource management practices associated with fossils, which we propose in the concept of Fossil Stewardship Attitudes. The BADL visitor fossil survey questions #5, #7, and #8 and DENA visitor fossil survey questions #5, #6, and #7 all were designed to capture visitor responses related to paleontological resource management practices. These responses are presented in Table 3-4 (BADL) and Table 3-12 (DENA). Each of the tables presents data which would be park-specific in value and based on how these questions are presented differently in each park's visitor fossil survey. Future visitor fossil surveys should seek to present more uniform questions to gain equitable data related to Fossil Stewardship Attitudes for multi-park assessments and interpretations.

This visitor fossil surveys at BADL and DENA represent two of the most comprehensive research studies involving the relationships between park visitors and paleontological resources. The surveys provide new information to help park staff to better understand park visitor attitudes, perspectives, and recreational choices related to park fossils. This includes information about visitor understandings and misunderstandings pertaining to NPS paleontological resources. This information will in turn help to inform and guide future planning, programming, and stewardship activities to

enhance visitor fossil-related experiences at the park and to potentially counter and redirect misunderstandings, misinformation, and inappropriate behaviors by park visitors. Finally, the visitor fossil surveys at BADL and DENA can provide baseline data to help inform future research involving fossil stewardship attitudes and the human dimensions of non-renewable paleontological resources within and outside of NPS areas.

Chapter 4

National Fossil Day: Celebration and Partnership Promoting the Scientific and Educational Values of Fossils

A Day to Celebrate Fossils

National Fossil Day (NFD) is a nationwide celebration promoting the scientific, educational, and recreational values of fossils. This contribution provides a brief history of development and implementation of NFD, and then provides a summary of a widely distributed survey of NFD partner organizations addressing the value and utility of NFD. The results show that NFD is highly successful achieving its statutorily defined goals providing unique opportunities for learning about and interacting with fossils. This knowledge of the success of NFD activities may prove useful to other organizations interested in partnering with NFD, and to continuing partners maintaining their commitment to the project.

The first National Fossil Day was celebrated on Wednesday, October 13, 2010, during Earth Science Week in collaboration with the American Geosciences Institute. National Fossil Day is a partnership consisting of more than 400 partners including: museums, professional science and teacher organizations, universities, libraries, federal and state agencies, fossil sites, amateur fossil groups, and other groups. NFD partners span all 50 states, and many provide local and regional opportunities for the public to participate in NFD events. The National Park Service has help to establish and coordinate the NFD partnership, maintain the NFD website, encourage and support education

outreach involving fossils, produce the annual NFD logo art, host the NFD Art Contest, and other activities. NFD has been recognized by the National Research Council as an important federal earth sciences education program which increases public awareness (National Research Council, 2013). NFD has firmly established itself in American society; despite government shutdowns or limitations associated with pandemics (e.g., Covid), NFD has continued to thrive, expand, and increase public awareness about America's rich paleontological heritage.

Most paleontologists proudly share the positive experiences they have had meeting with a classroom of excited children to talk about dinosaurs or responding to comments and questions after delivering a public presentation on their paleontological field work adventures and important fossil discoveries. Movie makers and members of the media are keenly aware of the popularity of dinosaurs and other prehistoric life and sometimes feature them in their productions and news articles (e.g., science articles with “T-rex” in the headline on subjects that have little to nothing to do with this iconic Cretaceous predator). A few paleontologists attain some level of celebrity status with the public based on effectively communicating with a dinosaur-loving public, including kids of all ages. The opportunity to engage the public and promote the concept of National Fossil Day was a relatively safe investment, as supported on the results obtained through the NFD partner survey.

Public, scientific, and media discussions related to the management and protection of fossils occurring on U.S. federal lands emerged during the 1990s, in part because of the legal issues associated with the excavation and collection of a tyrannosaur skeleton

nicknamed “Sue” on Native American tribal lands in South Dakota (Fiffer, 2001). The collection of the dinosaur skeleton by a commercial fossil business from lands designated as Tribal Trust lands resulted in both criminal and civil litigation. Both cases were overshadowed by the dinosaur, which was the focus of the civil case to determine the ownership of the fossil collected from tribal lands held in trust by the Department of Interior. The “Sue” controversy was further complicated by unrelated criminal charges pursued against the commercial fossil business for other activities. Confusion involving the separate civil and criminal cases, associated misinformation propagated by media and limited public understanding of the legal issues focused on the dinosaur, led to widespread misunderstanding of the facts that has persisted to the present.

The sale of the dinosaur skeleton of “Sue” through an auction by Sotheby’s on October 4, 1997, for \$8.36 million dollars garnered further widespread attention from both the national and international media. Public interest and media attention resulting from the “Sue” investigation and the large amount the auction realized increased public awareness about the need for greater protective legislation for fossils, especially when these non-renewable resources are being sold for such high dollar values.

The challenges and limitations faced by the U.S. Attorney’s Office in Pierre, South Dakota, which was responsible for both the civil and criminal investigations, clearly demonstrated there was a lack of specific federal laws to protect fossils from federal lands. Federal fossils did not have an equivalent to the Archaeological Resources Protection Act (1979) that was enacted to help protect archeological resources on federal lands. Several bills were introduced to Congress during the 1990s that were attempts to

enact a federal law to specifically support the management and protection of fossils on federal lands.

Report to Congress (2000)

During the Congressional hearings related to the Fiscal Year 1999 Department of Interior Appropriations, Senate Report 105-227 stated, “Secretary of the Interior, in consultation with appropriate scientific, educational and commercial entities, should develop a report assessing the need for a unified Federal policy on the collection, storage and preservation of . . . fossils.” The Senate Report further stated “the report should evaluate the effectiveness of current methods for storing and preserving fossils collected on public lands . . .” The Senate Report additionally recommended that the Secretary of the Interior assess the need for standards that would “. . . maximize the availability of fossils for scientific study.”

In conjunction with Senate Report 105-227, a letter dated November 5, 1998, was sent to the Secretary of the Interior from Senator Tom Daschle (D-South Dakota) and Senator Tim Johnson (D-South Dakota). In this letter the Senators requested “recommendations as to how to structure . . . a [unified Federal] policy” including necessary “legislative action.” Furthermore, the Senators urged the Secretary to include “recommendations to improve our ability to preserve and study fossils collected on public lands.” The federal agencies identified in the letter to assist the Secretary of the Interior in preparing this report (consulting agencies) include the Bureau of Land Management (BLM), the Forest Service (FS), the National Park Service (NPS), the Fish and Wildlife

Service (FWS), the Bureau of Reclamation (BOR), the Bureau of Indian Affairs (BIA) and the Smithsonian Institution (SI). The U.S. Geological Survey (USGS) also contributed to the report because of its special expertise in the earth sciences (DOI 2000).

In May 2000 a response to Congress was incorporated into a publication titled *Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands* (DOI 2000) (Fig. 4-1). The Executive Summary of this report recognized “Fossils on federal lands are managed for their scientific, educational and, where appropriate, recreational values.” The report also stated that comments received from the public indicated that “an overwhelming number of people expressed the view that fossils are part of America’s natural heritage.”

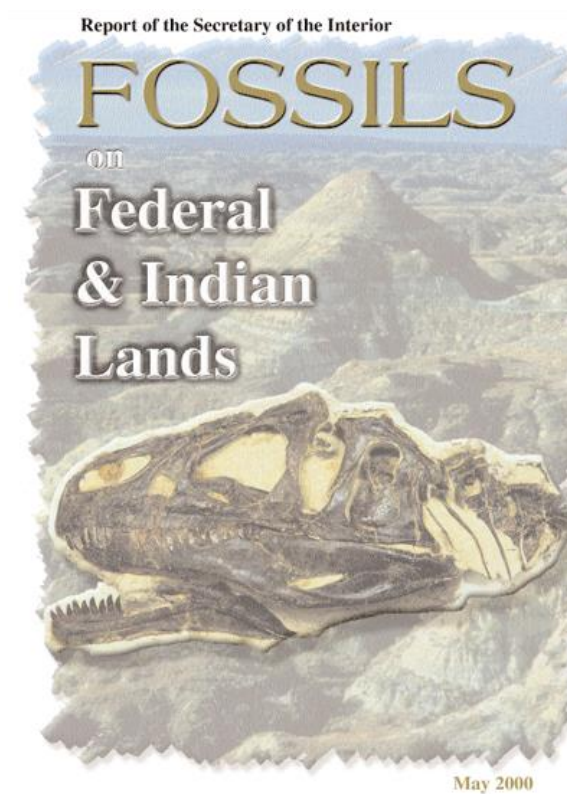


Figure 4-1: Cover of the May 2000 Report of the Secretary of Interior: Assessment of Fossil Management on Federal and Indian Lands. (NPS Photo).

The DOI Report to Congress included a series of principles and recommendations (Tables 4-1, 4-2). The principles and recommendations acknowledged that fossils are often rare and non-renewable resources, fossil inventories will inform and enhance management and stewardship, standards for fossil collections should support science and education, and penalties for fossil theft should be strengthened. Principle #1 and #7 directly relate to public engagement and educational opportunities to increase public interest and awareness in fossils and are presented below with the corresponding recommendations.

Table 4-1: Table outlining Principle 1 with four components and a recommendation published within in the Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands.

Principle 1: Fossils on Federal Lands are a Part of America's Heritage
Fossils are unique resources. Without fossils, human beings would have little understanding of the development of ancient life on earth.
Of all the organisms that have ever lived, only a tiny proportion have been preserved, exposed to view, discovered and appropriately collected.
The condition, availability and scientific significance of the fossils on federal lands are among the best in the world.
Federal agencies' current management practices further the paramount scientific and educational values of fossils.
Principle 1 Recommendation
Future actions should reaffirm the current use of federal fossils for their scientific, educational and, where appropriate, recreational values.

Table 4-2: Table outlining Principle 7 with two components and a recommendation published within in the Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands.

Principle 7: Federal Fossil Management Should Emphasize Opportunities for Public Involvement
The public, including properly trained amateurs and volunteers, have been and should continue to be a critical part of the management of fossils on federal lands.
Public education is critical in the management of fossils on federal lands.
Principle 7 Recommendation
Future actions should include an emphasis on public education and participation in the stewardship of fossil resources. Future program approaches should emphasize the use of technology to increase public education and awareness of the importance and benefit of fossil resources.

The Report To Congress can be viewed as a “watershed moment” marking an important historical change in how federal agencies and the public view salient issues involving the management of fossils on some federal lands. This report also represents the type of information that may be considered for incorporation into planning for any federal legislation pertaining to paleontological resources.

Paleontological Resources Preservation Act (2009)

Several versions of bills were introduced into Congress during the 1990s and 2000s. Once the *Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands* was submitted to Congress in May 2000, the draft legislation began to integrate some of the principles and recommendations outlined

in the 2000 Report to Congress. The Society of Vertebrate Paleontology (SVP) strongly supported legislation for paleontological resources on federal lands and actively lobbied Congress in support of the bill.

On March 30, 2009, approximately thirty years since the enactment of the *Archaeological Resources Protection Act* in 1979, Congress passed the *Paleontological Resources Preservation Act* (PRPA), signed into law by President Barrack Obama. Public Law 111-11 establishing the Paleontological Resources Preservation Act was codified as 16 U.S. Code 470aaa – 470aaa-11. PRPA was enacted as the primary authority for the management and protection of paleontological resources on lands administered by five federal agencies: Bureau of Land Management (BLM), Bureau of Reclamation (BOR), Fish and Wildlife Service (FWS), National Park Service, and the U.S. Forest Service (USFS).

Within PRPA Section 6303, “Public Awareness and Education Program”, consists of one sentence which states “The Secretary shall establish a program to increase public awareness about the significance of paleontological resources.” This one simple sentence in the law captures and embodies two important principles and recommendations (#1 and #7 in the 2000 Report to Congress) presented in the *Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands*, tied to public awareness and education pertaining to fossils. This provision represented a foundational stepping-stone in the establishment of National Fossil Day.

Paleontology Education and Outreach

After the Paleontological Resources Preservation Act was enacted, two National Park Service employees with the Geologic Resources Division reached out to schedule a meeting with representatives of the American Geosciences Institute (AGI). American Geosciences Institute founded and coordinates Earth Science Week (ESW), which is hosted annually during the second week of October. The NPS had participated in ESW for several years and worked closely with AGI to promote this highly successful geoscience educational outreach event. Vincent Santucci and Jim Wood (NPS Geologic Resources Division) proposed to Ann Benbow and Geoff Camphire (American Geosciences Institute) the concept of establishing one day during Earth Science Week dedicated to fossils. Ann and Geoff immediately recognized this proposal as an outstanding opportunity to expand the education outreach of ESW. The discussion included a suggestion to host a fossil-focused day on a school day during the week, to enable engagement of classrooms during the school week. Wednesday, being in the middle of ESW, was proposed as the day to host the new idea, which was to be known as “National Fossil Day” (NFD).

The NPS, AGI, and several new partners embracing the concept of National Fossil Day began to develop and define the purpose, mission, and goals set forth to establish NFD and begin to build a partnership. The following statement was designed to define National Fossil Day in a way consistent with the language set forth in Section 6302 of the Paleontological Resources Preservation Act: “National Fossil Day is an annual celebration and partnership that aims to promote public awareness and

stewardship of fossils, as well as to foster a greater appreciation of their scientific and educational values.”

The purpose and mission resonated well and were congruent with those in place for some institutions, organizations, and other entities that have tangible connection to fossils. National Fossil Day’s dual focus on science and education captured the interests of both scientists and teachers, some of whom already participated in Earth Science Week. The number of NFD partners grew from the NPS, American Geosciences Institute, Smithsonian Institution, and National Science Foundation to more than 400 hundred partners across the U.S., in all 50 states (Fig. 4-2). Some of the other notable partners endorsing NFD during the first year included: Paleontological Society, Society of Vertebrate Paleontology, Paleontological Research Institute, Geological Society of America, National Earth Science Teachers Association, and National Science Foundation, greatly expanding opportunities for educational outreach.



Figure 4-2: Composite of graphic logos representing some of the National Fossil Day partners. (NPS)

The first National Fossil Day celebration was scheduled for Wednesday, October 13, 2010, during the middle of Earth Science Week. The kick-off event for NFD was planned to take place in Washington, D.C., on the National Mall. The National Park Service coordinated significant advance planning for the event on the National Mall, as well as providing support to NFD partners planning public events across the U.S. The development of the NFD website hosted by the NPS was valuable in sharing information with the partners and the public. The NPS and Smithsonian National Museum of Natural History helped with advance communication with the media and prepared issue press releases, to inform the public about NFD events and celebrations.

A graphic identity logo was created for NFD that proved to be an effective tool for capturing attention from the public. The plan for the first NFD logo was to feature an identifiably prehistoric creature, but one which was lesser known rather than something already used extensively such as a *Tyrannosaurus rex* or a mammoth. The large rhino-like titanothere (brontothere), preserved in Eocene strata at places such as Badlands National Park, was chosen as well-suited to entice members of the public to react with the question “What is that animal featured in the logo?” (Fig. 4-3). This was the hook to advance a “teaching moment” and expand public awareness of some of the other lesser-known prehistoric life that inhabited Earth, often overshadowed by the public focus on dinosaurs.

Inaugural National Fossil Day (2010)

The first National Fossil Day celebration was scheduled for Wednesday, October 13, 2010, during the middle of Earth Science Week. The kick-off event for NFD was planned to take place in Washington, D.C., on the National Mall. The National Park Service coordinated significant advance planning for the event on the National Mall, as well as providing support to NFD partners planning public events across the U.S. The development of the NFD website hosted by the NPS was valuable in sharing information with the partners and the public. The NPS and Smithsonian National Museum of Natural History helped with advance communication with the media and prepared issue press releases, to inform the public about NFD events and celebrations.

A graphic identity logo was created for NFD that proved to be an effective tool for capturing attention from the public. The plan for the first NFD logo was to feature an identifiably prehistoric creature, but one which was lesser known rather than something already used extensively such as a *Tyrannosaurus rex* or a mammoth. The large rhino-like titanotheres (brontotheres), preserved in Eocene strata at places such as Badlands National Park, was chosen as well-suited to entice members of the public to react with the question “What is that animal featured in the logo?” (Fig. 4-3). This was the hook to advance a “teaching moment” and expand public awareness of some of the other lesser-known prehistoric life that inhabited Earth, often overshadowed by the public focus on dinosaurs.

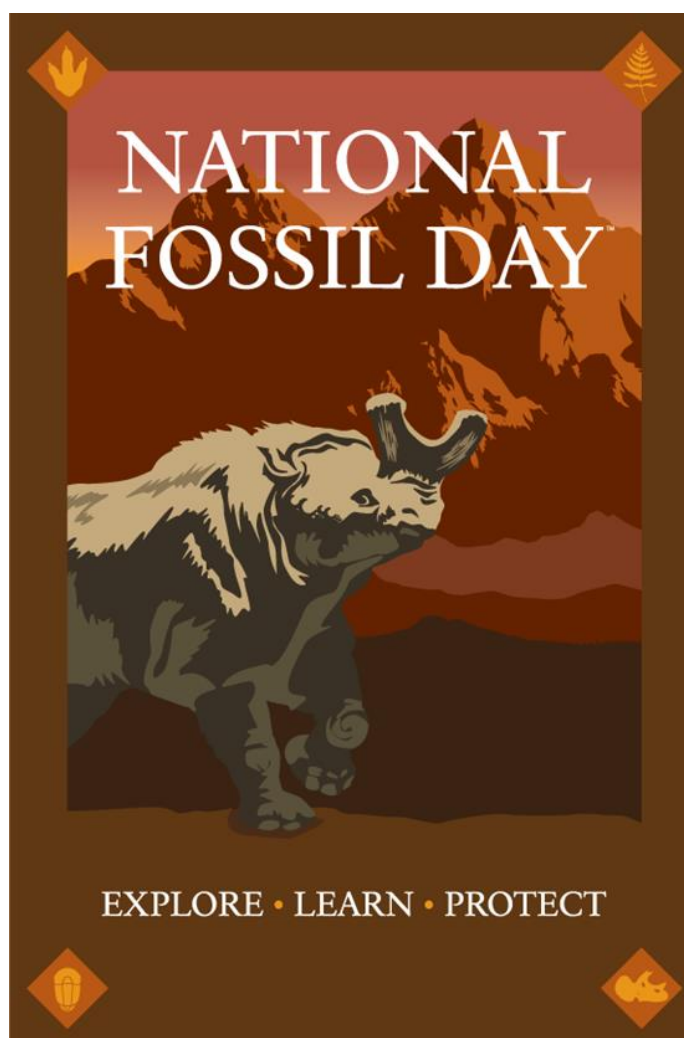


Figure 4-3: The first National Fossil Day logo, featuring a titanotherium (brontothere) from the Eocene of Badlands National Park. (NPS)

The reactions and feedback from the public regarding the NFD logo was extremely positive resulting in the titanotherium becoming the mascot or icon for NFD. The decision was made to create a different NFD logo each year which could be effectively used by the partners to promote NFD and to expand the public awareness about the rich diversity of life preserved as fossils.

The Chief of Public Affairs for the NPS in 2010 was Dave Barna. Dave majored in geology as an undergraduate student and was very interested in helping to promote

National Fossil Day. The Friday before Earth Science Week, Dave announced that he planned to attend the first NFD event on the National Mall and had a surprise to share.

On the morning of October 13, 2010, people representing the NPS, Smithsonian, and other partners arrived early in the morning to set up tents and educational displays. Park rangers unpacked boxes of fossils and educational materials including the popular Junior Paleontologist Activity booklets and prepared to celebrate the first National Fossil Day with the public. Starting at approximately 9:30 am, busloads of school children, teachers, and family members arrived at the National Mall. In the shadow of the U.S. Capitol, Washington Monument, and Smithsonian National Museum of History, a memorable fossil-themed party kicked off the first National Day Fossil celebration.

At 11:00 am the NPS scheduled a Junior Paleontologist ceremony for the hundreds of local school children attending the event (Fig. 4-4). Moments before the children were to be administered the Junior Paleontologist oath, an individual wearing a NPS Class A dress uniform with a “Smokey Bear” flat hat was sprinting across the National Mall, waiving and shouting for us to wait. It turned out this person was Dave Barna. Dave arrived at the speaker’s podium out-of-breath, handed off an envelope, and stated “You need to read this, you need to read this to these Junior Paleontologists”. Inside the envelope on White House stationery was a proclamation for National Fossil Day from President Barrack Obama (Figure 4-5). As this letter was read to the children, teachers, and others attending the first NFD celebration on the National Mall, everyone stood and cheered. The organizers of this event looked at each other and agreed, “We need to do this again next year!”



Figure 4-4: The first National Fossil Day celebration was hosted on the National Mall in Washington, D.C. on October 13, 2010. Hundreds of school children participated in the event and were recruited as Junior Paleontologists at the event. (NPS)

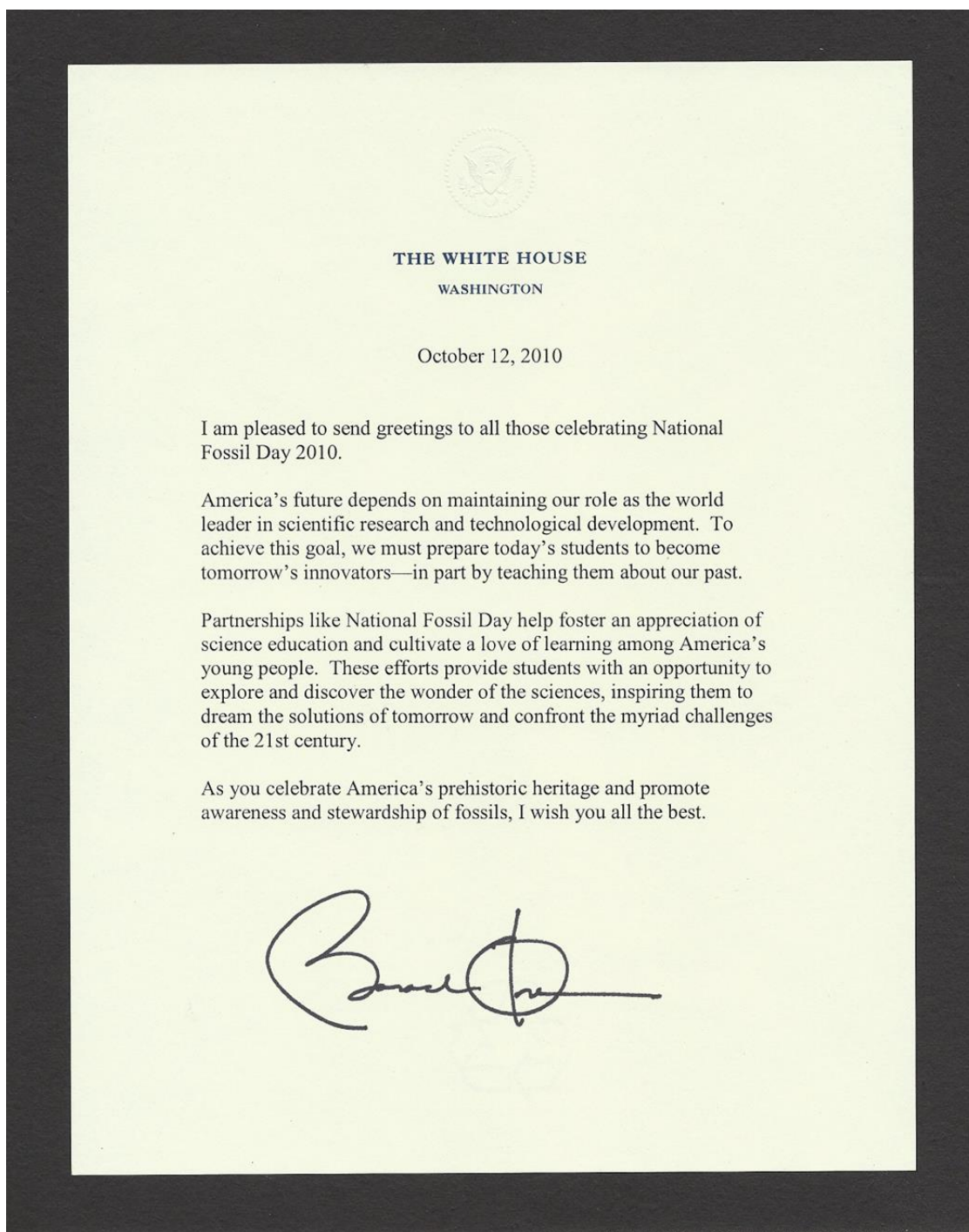


Figure 4-5: White House letter from President Barrack Obama proclaiming National Fossil Day in 2010. (NPS)

National Fossil Day has thrived since the kick-off event in 2010. With more than 400 partners across the U.S., there are fossil-themed activities for the public at the local level in all 50 states. Hundreds of website articles report on NFD events each October, which often include special announcements related to new fossil discoveries, unveiling of new fossil exhibits, and notable paleontologists presenting talks or engaging in “meet and greet” events with the public. New annual logos are kept “top-secret” until they are premiered on the NPS National Fossil Day website each January 15th. In 2013 the National Research Council and the National Academy of Sciences recognized NFD as an important earth science education program in the U.S. During years when weather conditions were not conducive for hosting the NFD event outside, the Smithsonian National Museum of Natural History hosted the event in the museum to celebrate NFD among the skeletons of prehistoric animals and plants. Despite bad weather, federal government shutdowns, and even a pandemic, National Fossil Day is here to stay as a nationwide celebration of “America’s Paleontological Heritage”.

2016 National Fossil Day Partner Survey

During 2016 the National Park Service and the American Geosciences Institute (AGI) contracted a private social science firm (P.S. International) to coordinate a survey of NFD partners, addressing seven research questions (Coulson, 2016). The survey was designed to help inform the NPS and AGI on future planning and programs for NFD. The survey was administered online through a website maintained by PS International. NFD

partners were invited to participate in this voluntary information collection. Below are the seven research questions and the corresponding results from the surveys.

R#1: What types (categories) of organizations, institutions, agencies, and other groups participate in National Fossil Day?

This research question was designed to better understand the types or categories of NFD partners actively participating in NFD. This data would enable us to compare the numbers of partners within each category (Fig. 4-6). This information would support NFD planning, outreach, and communication with partners. An increased understanding of the diversity of partners would also help to inform targeted outreach to recruit new NFD partners in specific categories. This approach would presumably broaden the range of the outreach by engaging specific potential partners in new categories. This also enabled focused communication to specific groups of partners with shared missions, interests, and other characteristics in common, not necessarily important to other categories of partners.

Based on the responses to the NFD survey of 2016, the partner categories with the highest percent response include MUSEUMS (27.8%), TEACHER ORGANIZATIONS (17.4%), and GOVERNMENT AGENCIES (13.4%). Given the mission of NFD related to the scientific and educational values of fossils, the diversity of partners was well represented by both scientists and educators.

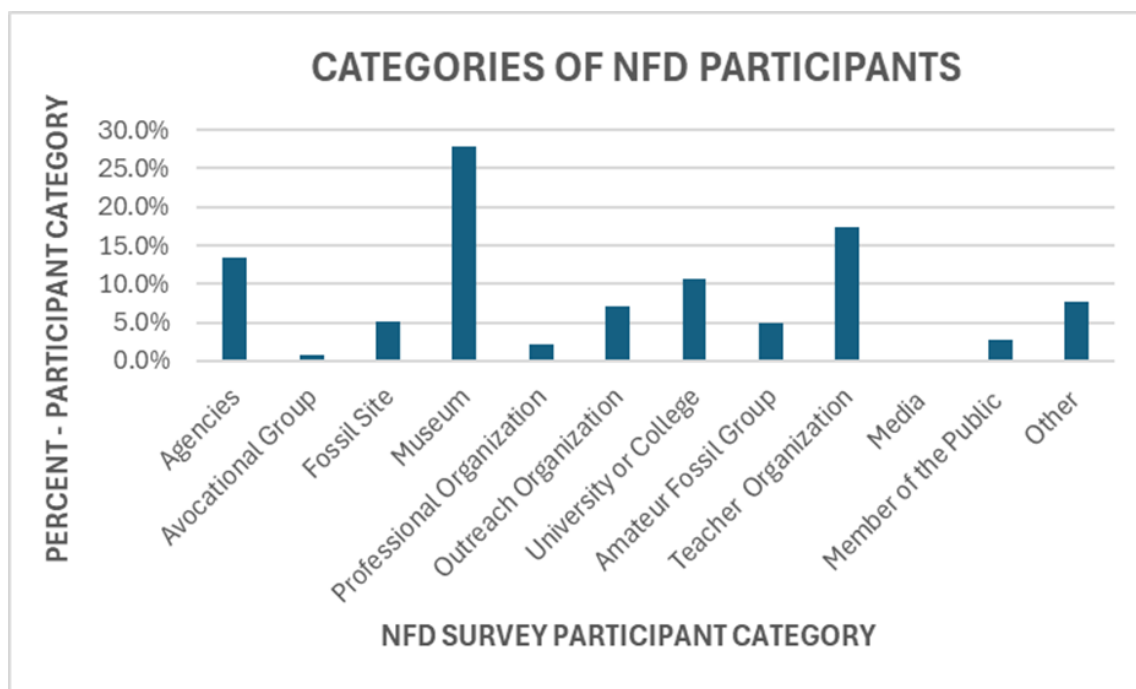


Figure 4-6: Bar chart showing responses to the 2016 National Fossil Day survey question #1: “What types (categories) of organizations, institutions, agencies, and other groups participate in National Fossil Day?” (NPS and P.S. International)

R#2: What is the geographic distribution of partners across regions of the United State who host National Fossil Day events?

This research question was intended to capture demographic information regarding which geographic regions of the country were partners hosting NFD events. The decision was to group partners into 4 regions (Northeast, Midwest, South, West) across the U.S. (Table 4-3). The survey question also allowed for international partners to respond.

The results of the survey for this question revealed that despite there being higher populations in the Northeast Region (#1), there were fewer NFD partners in this region

hosting NFD events than others (Fig. 4-7). This resulted in the NFD interns focusing outreach to potential new partners within the Northeast Region states.

Table 4-3: The regional organization of partners by states used for National Fossil Day planning.

REGION #	GEOGRAPHIC AREA	STATES	# STATES IN REGION
1	Northeast U.S.	CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT	12
2	Midwest U.S.	IA, IL, IN, KS, MI, MN, MO, NE, OH, WI, WV	11
3	Southern U.S.	AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA	13
4	Western U.S.	AK, AZ, CA, CO, HI, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY	15
International	Outside of U.S.		

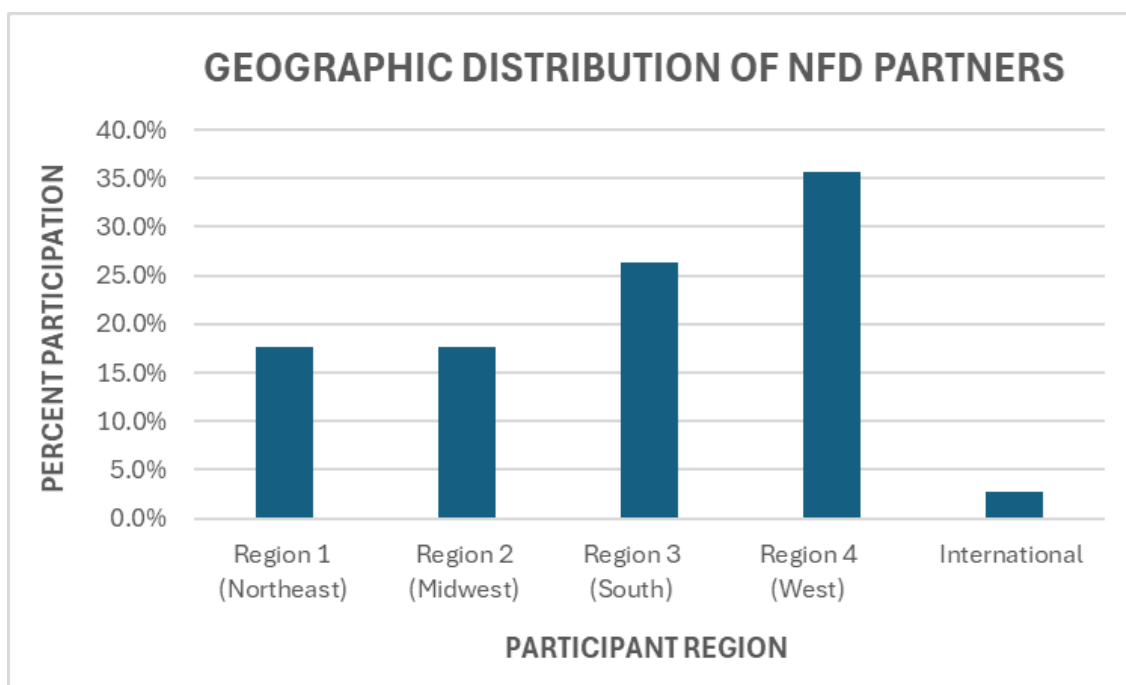


Figure 4-7: Bar graph showing responses to the 2016 National Fossil Day survey question #2: “What is the geographic distribution of partners across regions of the United States who host National Fossil Day events?” (Demographic Information) (NPS and PS International)

R#3: Which categories of National Fossil Day activities did the public participate? (NFD activities)

This research question focused on NFD activities and which of the activities the public were participating in. The nine categories of NFD activities identified in the research question included: 1) NFD Art and Photo Contest; 2) Junior Paleontologist Program; 3) NFD activities hosted during the National Mall Event on NFD; 4) NFD Monthly article on the NPS website; 5) NFD websites; 6) NFD activities at a museum; 7) NFD activities at a park or fossil site; 8) NFD activities at schools and in classrooms; 8) NFD online Gift Shop; and 9) other (Fig. 4-8).

Based on the responses obtained in the 2016 NFD survey, participation in the NFD activities at a museum (37.2%) and participation in the NPS Junior Paleontologist Program (16.8%) received the highest percentages of responses. The high percentage of responses received for the participation in the NFD activities in a museum is likely proportional to museums being the most common category of NFD partner based on responses to Research Question #1 (Figure 4-6). The NPS distributed Junior Paleontologist activity booklets to NFD partners requesting supplies of this fossil-themed education program for children, which likely contributed to the high percentage of responses for Research Question #3.

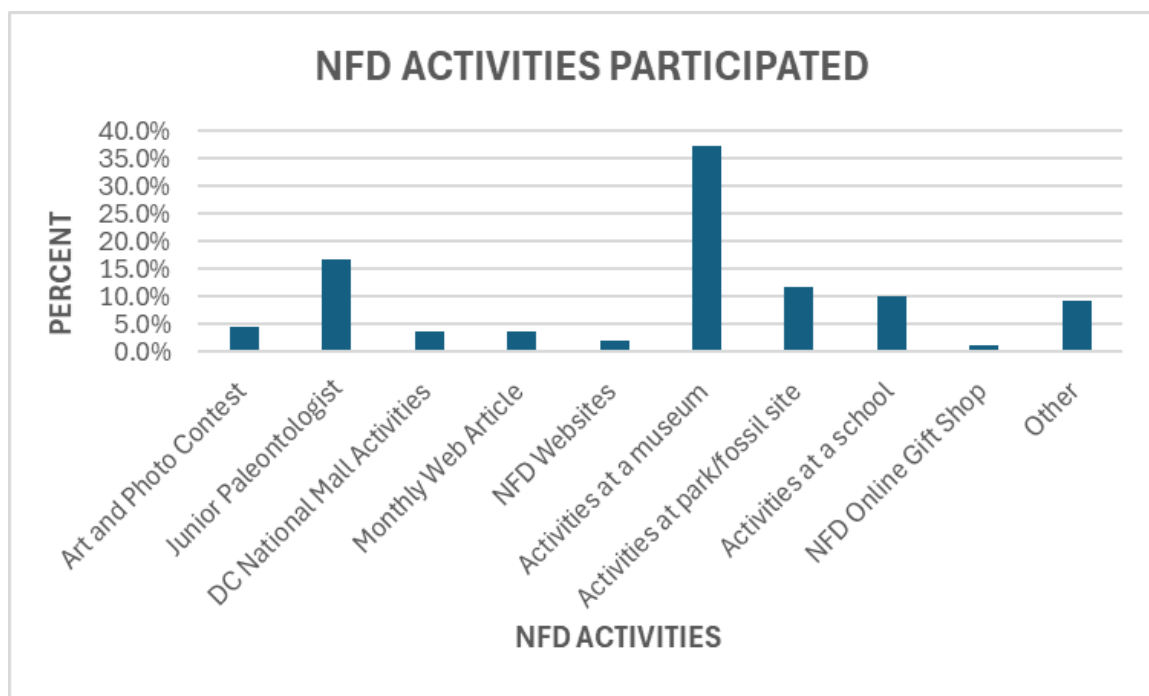


Figure 4-8: Bar graph showing the relative percentages of responses to the 2016 National Fossil Day survey question #3: “Which categories of National Fossil Day activities did the public participate in?” (NPS and P.S. International).

R#4: Does National Fossil Day offer opportunities for teaching, learning, and promoting awareness about paleontology and the significance of fossils that are not available otherwise?

This was an important research question to assess whether the NFD partners had a positive impact on promoting public awareness about paleontology and the significance of fossils. This research question is directly associated with principles and recommendations contained in the *Report of the Secretary of the Interior: Assessment of Fossil Management on Federal and Indian Lands* (DOI, 2000) and within PRPA Section 6303 “Public Awareness and Education Program”, which mandates “The Secretary shall

establish a program to increase public awareness about the significance of paleontological resources.”

The responses to this research question indicated 87.6% of the partners participating in the 2016 survey indicated that NFD offers opportunities for teaching, learning, and promoting awareness about paleontology and the significance of fossils that are not available otherwise (Fig. 4-9).

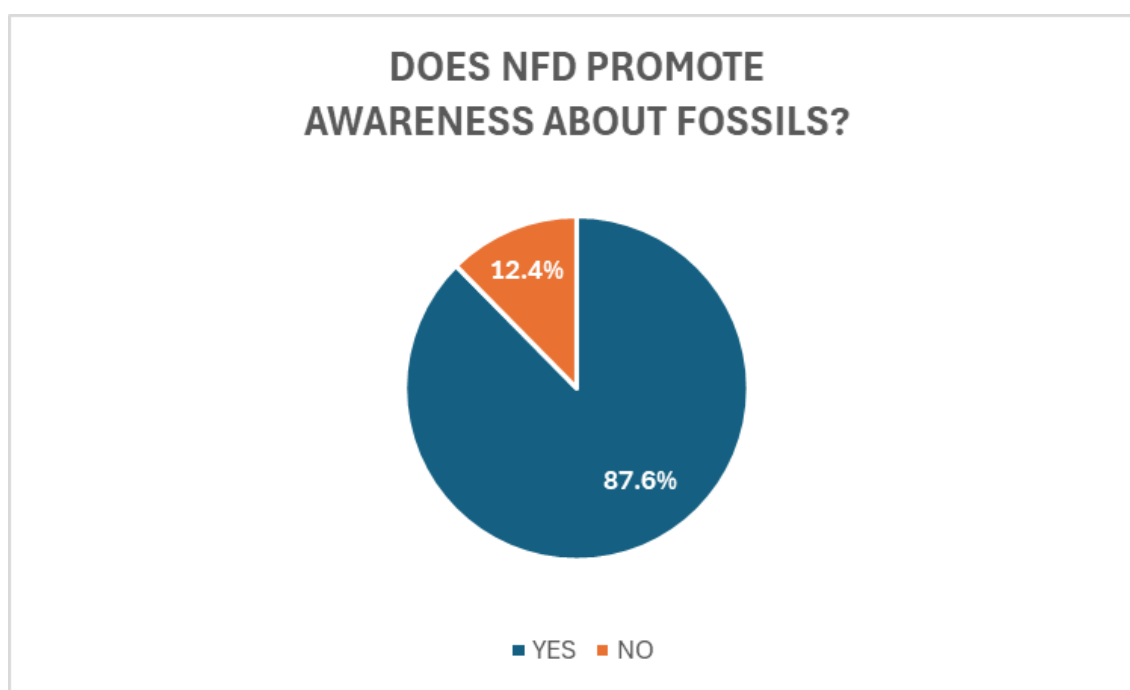


Figure 4-9: Pie chart showing responses to the 2016 National Fossil Day survey question #4: “Does National Fossil Day offer opportunities for teaching, learning, and promoting awareness about paleontology and the significance of fossils that are not available otherwise?” (NPS and P.S. International)

R#5: How important are National Fossil Day resources and activities for educating students, visitors, or other audiences about paleontology and the significance of fossils?

This research question focused on assessing the importance of NFD activities for educating the public about paleontology and the significance of fossils. This question complements Research Question #4, but seeks feedback related to how important NFD resources and activities are in educational outreach related to paleontology and fossils. Participants in the survey were provided four options for response, including: 1) Very Important; 2) Somewhat Important; 3) Somewhat Unimportant; and 4) Not Important (Fig. 4-10).

Based on the responses to this research question 47% selected Very Important and 41% selected Somewhat Important regarding the use of NFD resources and activities to promote awareness about fossils. This question ties directly to PRPA Section 6302, which mandates federal agencies “. . . to establish a program to increase public awareness about the significance of paleontological resources” and indicates that NFD resources and activities are promoting awareness about fossils.

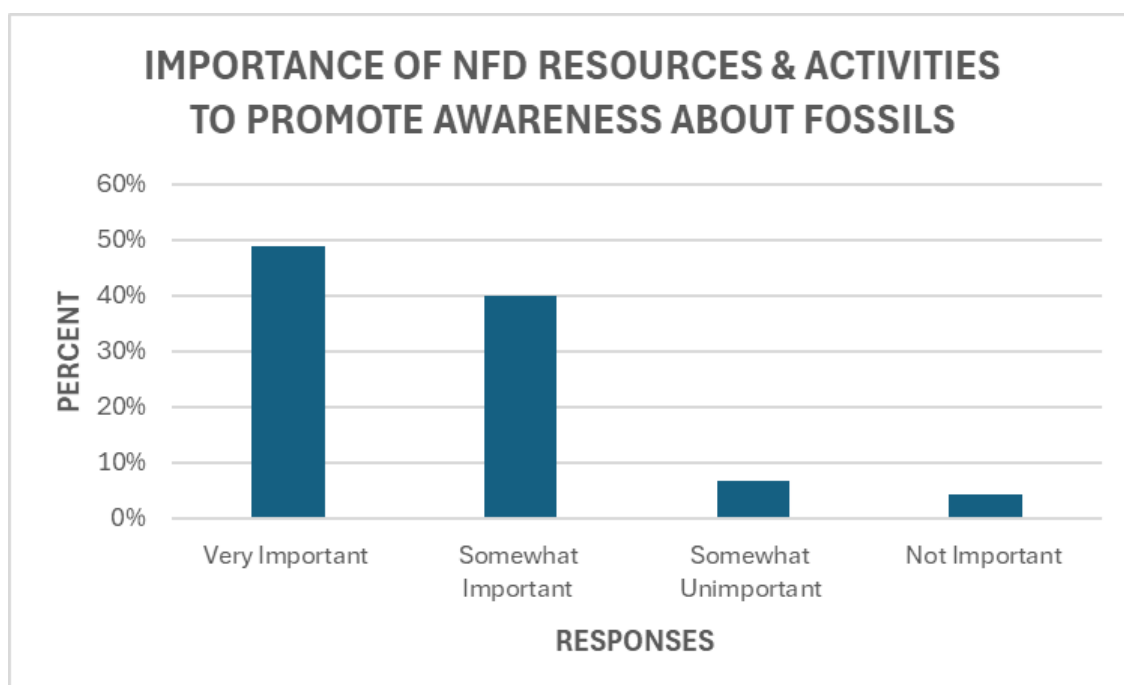


Figure 4-10: Bar graph showing responses to the 2016 National Fossil Day survey question #5: “How important are National Fossil Day resources and activities for educating students, visitors, or other audiences about paleontology and the significance of fossils?” (NPS and P.S. International)

R#6: How do visitors to the National Fossil Day website rate the overall usefulness of the website in terms of information available for teaching or learning about paleontology and the significant of fossils?

This research question was designed to seek feedback from participants on the NFD website designed and maintained by the NPS. The research question included five options for responses, including: 1) Excellent (32%); 2) Good (34.8%); 3) Fair (5.8%); 4) Poor (0.6%); and 5) Did Not View Website (26.6%) (Fig. 4-11). The results of the survey showed that more than a quarter of the respondents did not view the NFD website. However, of those who reported to have visited the NFD website, 41% responded Excellent, 51% responded Good, 7% responded Fair, and less than 1% reported Poor.

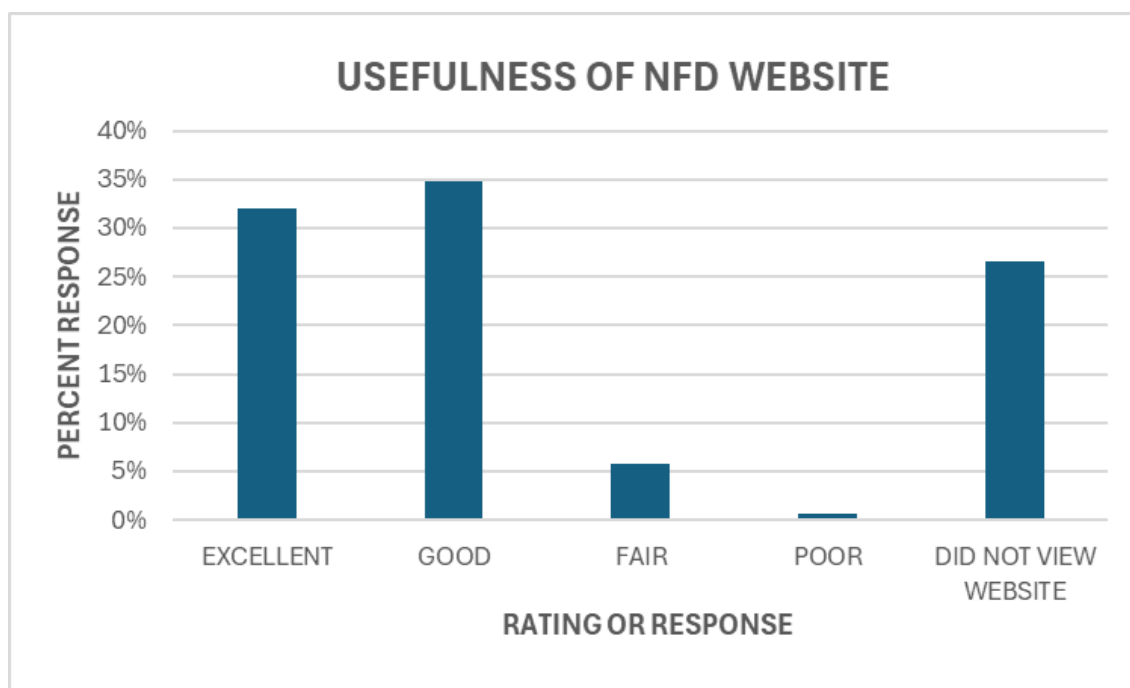


Figure 4-11: Bar graph showing responses to the 2016 National Fossil Day survey question #6: “How do visitors to the National Fossil Day website rate the overall usefulness of the website in terms of information available for teaching or learning about paleontology and the significance of fossils?” (NPS and P.S. International)

R#7: Where did NFD participants find or obtain information about National Fossil Day?

This research question was included in the 2016 NFD survey to better understand which sources were being used by NFD participants and partners to obtain information about NFD. The following options were provided in the survey for participants to select, and the percent of responses for each option are provided in parentheses: National Fossil Day website (33.5%); Other websites (7.8%); Facebook (13.1%); Twitter (3.1%);

Newspapers (2.2%); TV or Radio (0.9%); Meeting / Presentation (6.4%); Word of Mouth (19.9%); and, Other (13.1%) (Fig. 4-12).

One-third of the responses to this research question indicated the National Fossil Day website was their source for NFD information. Since the NPS maintains and updates the NFD website, this information was important to ensure that the website is regularly updated to incorporate new and current information.

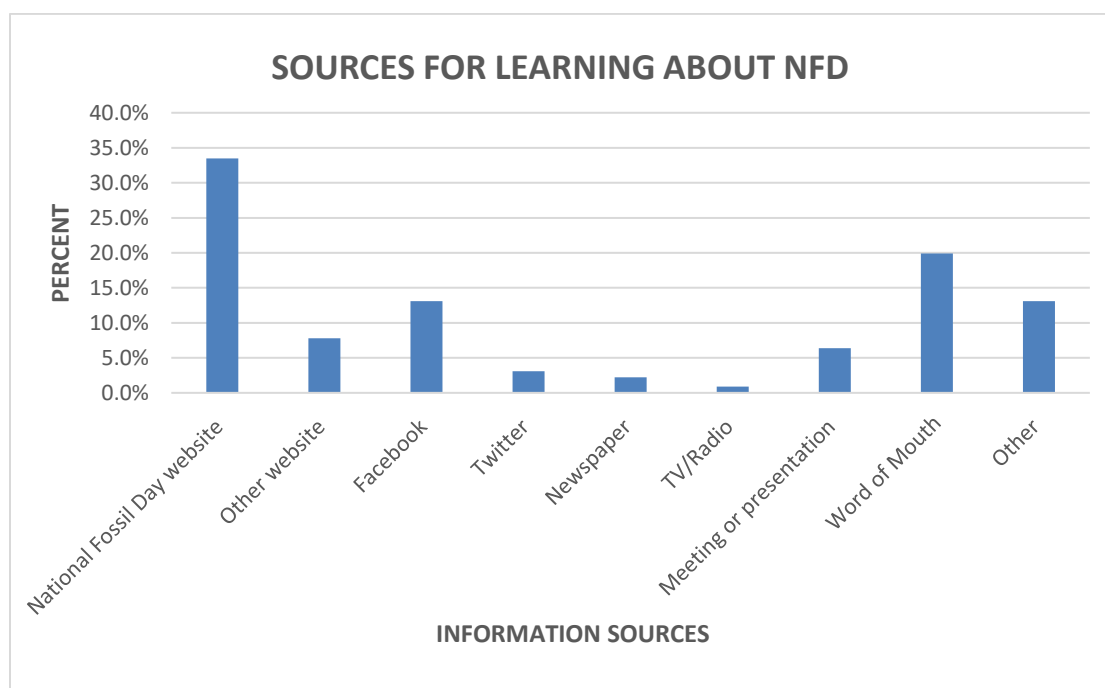


Figure 4-12: Bar graph showing responses to the 2016 National Fossil Day survey question #7: “Where did NFD participants find or obtain information about National Fossil Day?” (NPS and P.S. International)

Reflecting on the Fossil Celebration

The establishment of National Fossil Day and the associated partnership, today incorporating more than 400 partners, represents a successful educational outreach program designed to increase public awareness about the significance of paleontological resources. This is precisely congruent with the mandate presented in Section 6303 of PRPA. The results of the 2016 survey, especially research questions #4 and #5, indicate that NFD has had success in achieving its public outreach goals. Research question #4 indicated that almost 90% of the NFD partners who participated in the 2016 survey found that NFD offers opportunities for teaching, learning, and promoting awareness about paleontology and the significance of fossils that are not available otherwise. Similarly, research question #5 indicated that almost 90% of survey participants found that NFD resources and activities were either “Very Important” or “Somewhat Important” in promoting public awareness about fossils.

The NFD mission of establishing a partnership to promote the scientific and educational values of fossils has led to hundreds of partners joining this fossil-focused celebration. The diversity of partners representing museums, professional science and teacher organizations, government agencies, universities, libraries, amateur groups, and other categories of partners has helped to reach and engage different audiences, in some cases quite large. A partner such as National Parks Conservation Association has 1.6 million members who receive information regarding NFD. Similarly, the National Teacher Association has 3 million members, primarily educators who have direct access to students and classrooms

National Fossil Day strives to tap into the extraordinary and powerful connection that many people have with fossils, particularly children. The concept of the human dimensions of paleontological resources strives to understand the relationships between humans and fossils, along with the values that people associate with fossils. A conceptual framework for the human dimensions of paleontological resources recognizes the variety of human values people ascribe to fossils including scientific, educational, recreational, commercial, spiritual, aesthetic, and other values (Santucci et al., 2016). The NFD mission focuses on the scientific and educational values of fossils and has drawn partners who share these values.

The concepts of paleontological heritage and paleontological resource conservation, both which represent connections between humans and fossils, have gained national and international identity over the past several decades (Endere & Prado 2015; Larwood et al., 2022). Heritage resources are viewed from the perspective of their inheritance from previous generations to future generations, which is an important concept and responsibility that can be applied to non-renewable paleontological resources. Paleontological resource conservation and preservation are components of paleontological heritage and directly tied to the human dimensions and values associated with fossils. In the U.S., significant fossil localities have been protected as national monuments through the authority of the Antiquities Act (1906). Similarly, several World Heritage Sites have been formally recognized based upon globally significant paleontological resources.

The increased public awareness of fossils and their significance resulting from National Fossil Day is intended to help promote the stewardship of non-renewable

paleontological resources and fossil localities. Improved stewardship is an extremely important goal supporting the mission of the NPS. Consequently, the NPS has taken a leadership role in the establishment and coordination of the NFD partnership to ensure the highest level of stewardship for “America’s rich paleontological heritage”.

Chapter 5

Fostering a Strategic Vision for National Park Service Paleontology

The vision of this research is derived from the belief that park rangers and paleontologists have a responsibility in the conservation, preservation, and stewardship of non-renewable paleontological resources preserved on lands administered by the U.S. NPS. The fundamental understanding of humans and their relationships with fossils is essential in planning for the management, protection, interpretation, research, and other activities involving park fossils.

Defining and understanding a conceptual framework for the human dimensions of paleontological resources was the first element of this research (Santucci, et al., 2017). This framework identifies the scope of human values associated with fossils, which may shape individual attitudes, perspectives, motivations, and perhaps even behaviors. This baseline information allows an assessment of these human values and whether they are aligned with or in conflict with the views of the scientific community, the laws, regulations and policies of public land managing agencies. Sometimes park visitor behaviors may extend outside of the norms aligned with NPS laws, regulations, policies, and practices. Theft, vandalism, and other depreciative behaviors by park visitors have adversely impacted NPS fossils and fossil localities. The simple awareness about the range of visitor values, influencing their attitudes and maybe even their behaviors, is an important benefit from considering the human dimensions of paleontological resources.

Once the conceptual framework for the human dimensions of paleontological resources was presented, several research questions were identified and incorporated into exploratory visitor surveys that were designed and undertaken in two national parks with significant paleontological resources. Visitor surveys were undertaken at Badlands National Park, South Dakota, and Denali National Park and Preserve, Alaska, capturing demographic and descriptive data from the respective park's visitors. The research questions were designed to gain information and responses from park visitors related to demographics, awareness, knowledge, and understandings related to fossils, values associated with fossils, fossil stewardship attitudes, and recreation choices during visit in the respective parks.

The responses within each visitor survey were most beneficial to each of the individual parks with park specific information and issues. In some cases, the survey questions were derived through communication with park staff prior to the survey. A few of the questions in the surveys were similar enough to compare the responses obtained in each park survey. Table 3-13 shows a comparison between visitor responses in the BADL and DENA surveys with a remarkable similarity pertaining to visitor interest in fossil-related activities or experiences during their visit to each park. For both park surveys visitors reported "Seeing fossils preserved in rocks in a natural setting" received the highest percentage of scores with BADL totaling 81.6% and DENA totaling 67.4% of visitor responses. Conversely, for both park surveys visitors reported "Collecting fossils as a hobby" received the lowest percentage of scores with BADL totaling 52.9% and DENA totaling 36.8% of visitor responses.

Park rangers at BADL have claimed for many decades that many park visitors have the misunderstanding that the park preserves dinosaur fossils. Although BADL is one of the most fossil-rich units of the NPS, to date no dinosaur fossils have been documented from the park. However, the park does preserve an important record of fossil mammals and other vertebrates from the Eocene and Oligocene epochs, time periods after the dinosaurs became extinct. Redirecting the visitors understanding of BADL has an important non-dinosaurian fossil record is one of the most common interpretive topics encountered at the park. The data shown in Table 3-2 is the first reference source based on scientific data that confirms the BADL ranger's observations that many visitors think the park fossils are dinosaurs. It is even more interesting to see that the survey results show more visitors reported that BADL was an important dinosaur locality than the park is a home to buffalo (which are very iconic to the park). It is worth noting that many individuals, more frequently in high paid bureaucrats than 3rd graders, synonymize the words "fossil" and "dinosaur", which may account for the misunderstanding about the fossils at BADL.

The basic demographic data obtained from the two visitor surveys generated discussion and feedback among NPS staff who reviewed this data. This is the type of information that is not easily obtained by the NPS and is quite useful for planning programming based on visitor demographics. In 2013, the NPS Paleontology Program printed Spanish-language versions of the Junior Paleontologist activity books to distribute to parks with Spanish speaking visitors or live near Hispanic communities (Fig. 5-1).



Figure 5-1: The NPS Junior Paleontologist Activity Booklet. (Bianca Santucci Photo)

Sharing the stewardship principles related to fossils has been effectively undertaken by the NPS at all levels. One child or visitor at a time, one classroom at a time, one community at a time, and ultimately one nation has almost become possible through the success of the NFD partnership. Spanning all 50 states, the NFD partnership engages the public at the local level and often inspiring curiosity, increasing understandings, and fostering pride of the resources in our backyards.

Look at partnership to expand educational outreach for paleo – provide resource stewardship messaging NFD presents the opportunity to communicate with a large and

diverse audiences drawn to NFD. NFD has a captive audience of people who have interest in learning about fossils. The opportunity to share with the public the unfortunate story about Fossil Cycad National Monument is both eye opening and unsettling. The story is a lesson learned on how we lost a unit of the NPS because the fossils were essentially completely removed from the surface at the monument due to unauthorized and uncontrolled collecting. The typical reaction is summed up in the question “How can this happen?” The NPS can effectively tell this story outlining the permanent loss of non-renewable fossils at a unit of the NPS that the public will never be able to take their family to see, experience, and learn about.

The National Fossil Day partnership extends across the U.S. with partners in every state. The partners host NFD events and activities at the local level that include fossil hikes, fossil talks, fossil preparation demonstrations, the announcement of new discoveries, unveiling of new fossil exhibits, etc. Partners can outreach to their constituents, members, local communities and schools.

The NPS distributes Junior Paleontologist Activity booklets and badges (similar to the ones worn by park rangers) to parks and partners celebrating NFD which is an effective resource for promoting fossil stewardship. Rangers and paleontologists often visit classrooms on NFD and host NFD art contests with themes to promote awareness and stewardship. NFD incorporate Leave No Trace principles as part of the fossil outreach.

The media interest in NFD is exceptional in helping to promote this fossil celebration and providing information on where events are being hosted. During October 2024 more than 700 online media posts featured some story related to NFD. The positive

impact of media has been priceless in helping to increase awareness about NFD by increasing public interest with individuals and organizations who want to be part of the fossil celebration.

The 2016 NFD partner survey is also presented as part of this research. The information obtained through this survey has helped to shape the planning and programming that has expanded to be included in the annual NFD celebration.

The research components and information presented here pertaining to the human dimensions of paleontological resources has been synthesized to help train and inspire future generations of NPS rangers, paleontologists, and NFD partners. We collectively are committed to promote positive fossil stewardship attitudes through a celebration of our wonderful fossil record, including dinosaur and non-dinosaur fossils!

Appendix A

Badlands National Park Visitor Fossil Survey

BADLANDS NATIONAL PARK – VISITOR FOSSIL SURVEY

SURVEY # _____ DATE: _____ LOCATION: _____

This survey is designed to help inform the National Park Service on visitor perspectives and experiences pertaining to fossils. Participation in this survey is totally anonymous and voluntary. Thank you for your assistance.

1. Please indicate how strongly you AGREE or DISAGREE with each of the following statements about Badlands National Park.

	Strongly Disagree			Neutral		Strongly Agree		
a. The park is home to a herd of bison (buffalo)	1	2	3	4	5	6	7	
b. The park has world renowned geologic formations and features	1	2	3	4	5	6	7	
c. The park manages an important prairie ecosystem	1	2	3	4	5	6	7	
d. The park is an important dinosaur fossil locality	1	2	3	4	5	6	7	
e. The park is historically and spiritually important to Native Americans	1	2	3	4	5	6	7	
f. The park represents the first national park established in the U.S.	1	2	3	4	5	6	7	
g. The park preserves important fossil localities	1	2	3	4	5	6	7	
h. The park scenery was primarily shaped by ice age glaciers	1	2	3	4	5	6	7	

2. Please indicate whether you participated in any of the following activities during your visit to Badlands National Park.

a. View any fossils exhibits in the Ben Reifel Visitor Center?	Yes	No	Not Sure
b. Participate in a ranger-led talk or hike which presented information about fossils?	Yes	No	Not Sure
c. See any fossils while you were hiking in the park?	Yes	No	Not Sure
d. Observe fossil preparation activities at the visitor center?	Yes	No	Not Sure
e. Collect any fossils during your visit to the park?	Yes	No	Not Sure
f. Hike the Fossil Exhibit Trail in the park?	Yes	No	Not Sure
g. Anyone in your group participate in the Junior Paleontologist Activity?	Yes	No	Not Sure
h. Purchase any fossil themed book or souvenir during your visit to the park?	Yes	No	Not Sure

3. Please rate your interests and knowledge related to fossils.

	Low		Medium			High	
a. Rate your general interest in fossils.	1	2	3	4	5	6	7
b. Rate your knowledge about fossils.	1	2	3	4	5	6	7
c. Rate your knowledge about rocks and geology.	1	2	3	4	5	6	7
d. Rate your knowledge about the fossils at Badlands NP.	1	2	3	4	5	6	7
e. Rate your interest in attending a movie featuring dinosaurs or other fossils.	1	2	3	4	5	6	7
f. Rate your interest in visiting a museum to see fossils.	1	2	3	4	5	6	7
g. Rate your interest in seeing fossils preserved in rocks found at the park.	1	2	3	4	5	6	7
h. Rate your interest in participating in a fossil dig.	1	2	3	4	5	6	7
i. Rate your interest in collecting fossils as a hobby.	1	2	3	4	5	6	7

4. People value fossils for different reasons. For each of the following potential values of fossils, please rate how important you think that value is.

	Low			Medium			High	
a. Fossils have scientific value	1	2	3	4	5	6	7	
b. Fossils have educational value	1	2	3	4	5	6	7	
c. Fossils have recreational value	1	2	3	4	5	6	7	
d. Fossils have monetary or commercial value	1	2	3	4	5	6	7	
e. Fossils have spiritual value	1	2	3	4	5	6	7	
f. Fossils have aesthetic value	1	2	3	4	5	6	7	
g. Fossils have entertainment value	1	2	3	4	5	6	7	

5. Please indicate how strongly you AGREE or DISAGREE with each of the following statements.

	Strongly Disagree			Neutral			Strongly Agree	
a. Fossils are renewable resources	1	2	3	4	5	6	7	
b. Fossils are common	1	2	3	4	5	6	7	
c. Fossils are rare	1	2	3	4	5	6	7	
d. Fossils are non-renewable resources	1	2	3	4	5	6	7	
e. Fossils in national parks are protected by law	1	2	3	4	5	6	7	
f. Visitors are allowed to collect common fossils in national parks	1	2	3	4	5	6	7	
g. Visitors are not allowed to collect any fossils from national parks	1	2	3	4	5	6	7	
h. Visitors are allowed to collect rare fossils which may potentially be destroyed by erosion or other natural processes	1	2	3	4	5	6	7	
i. Educational groups are allowed to collect fossils if the fossils will be used for education of students	1	2	3	4	5	6	7	
j. Fossils can only be collected when a scientific research and collecting permit has been issued by the park	1	2	3	4	5	6	7	
k. Visitors should report the location of fossils found in the park to a park ranger	1	2	3	4	5	6	7	

6. Briefly describe any new information that you learned about fossils during your visit to Badlands National Park.

(PLEASE PROCEED TO THE NEXT PAGE)

7. Please rate how strongly you AGREE or DISAGREE with each of the following statements.

	Strongly Disagree		Neutral		Strongly Agree		
a. Fossils are common and the removal of one or a few will not be noticed	1	2	3	4	5	6	7
b. Visitors are unaware that removing a fossil is not permitted in a national park	1	2	3	4	5	6	7
c. A rare fossil must be collected to save the scientific information it holds	1	2	3	4	5	6	7
d. If a fossil is not collected it will weather away and be destroyed	1	2	3	4	5	6	7
e. It is okay to take fossils if they will be used to train and educate others about fossils	1	2	3	4	5	6	7
f. All fossils must be collected and the National Park Service is allowing fossils to disappear	1	2	3	4	5	6	7
g. The visitor is a fossil expert and knows more about fossils than the National Park Service	1	2	3	4	5	6	7
h. If a fossil is not collected, then someone else will likely take it	1	2	3	4	5	6	7
i. Some fossils can fetch high dollar amounts on the commercial fossil market and someone may need money to support their life	1	2	3	4	5	6	7
j. It may be a family tradition to collect a fossil from a park and there is a need to continue this important family tradition	1	2	3	4	5	6	7
k. A visitor's desire to take a fossil is greater than their concern about any potential risk or penalty	1	2	3	4	5	6	7

8. Please rate how strongly you believe each statement below may influence a visitor's decision to COLLECT a fossil in a national park.

	Strongly Disagree		Neutral			Strongly Agree	
a. The removal or collection of fossils by visitors is not allowed in a national park	1	2	3	4	5	6	7
b. Any collection of fossils in a national park can only occur if an approved scientific research and collecting permit is issued by the park	1	2	3	4	5	6	7
c. Fossils must be carefully excavated by a professional in order that any associated scientific information is obtained at the time the fossils are collected	1	2	3	4	5	6	7
d. The decision on whether a fossil should be collected or left in place is often based on factors to prevent negative impacts to other resources	1	2	3	4	5	6	7
e. Unauthorized fossil collecting in parks could result in a fine or other penalties	1	2	3	4	5	6	7
f. Some fossils should be preserved in the field to provide visitor's the opportunity to view and experience fossils in a natural state in parks	1	2	3	4	5	6	7
g. Not every fossil can be collected and some fossils will eventually be destroyed by natural processes	1	2	3	4	5	6	7
h. Removal or illegal collection of fossils in a national park may result in "bad luck"	1	2	3	4	5	6	7

9. Is Badlands National Park your travel destination? ☐ Yes ☐ No ☐ Not Sure

10. How many times have you previously visited Badlands National Park? _____

11. How many individuals are in your group visiting Badlands National Park (include yourself in total)? _____

12. How would you characterize the group you are traveling to Badlands National Park?

- ☐ Traveling alone ☐ Family Group ☐ Friends Group ☐ Work Group
☐ Educational Group ☐ Social Group ☐ Organized Tour ☐ Other _____

(PLEASE PROCEED TO THE NEXT PAGE)

13. What is your gender? ☐ Female ☐ Male ☐ Prefer not to respond

14. In what year were you born? _____

15. What is your home STATE (in USA) or FOREIGN COUNTRY? _____

16. What is your highest level of education completed?

- ☐ some high school
- ☐ high school graduate
- ☐ some college courses completed
- ☐ 2 year associated degree
- ☐ 4 year undergraduate degree
- ☐ Master's Degree
- ☐ Doctoral Degree or equivalent

17. Which of these categories best describes your racial identity?

- ☐ Hispanic or Latino
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Caucasian
- ☐ Other

(THE END)

Appendix B

Denali National Park and Preserve Visitor Fossil Survey

DENALI NATIONAL PARK and PRESERVE – VISITOR FOSSIL SURVEY

TOPIC AREA 9: KNOW10					
1. Please rate how aware you are about Denali's fossil resources. (Select one)					
Not at all aware	Somewhat aware	Moderately aware	Very aware	Extremely aware	
1	2	3	4	5	

TOPIC AREA 2: INFOSOURCE12			
2. We would like to know what sources of information you used to get information about fossil resources in Denali. We would also like to know when you obtained each type of information. (Check one box for each item) (DISPLAY LOGIC. QUESTION ONLY DISPLAYS IF VISITOR'S RESPONSE TO QUESTION 1 IS ≥2.)			
Source	Did not use	Used <u>before</u> arriving in the Denali area	Used <u>after</u> arriving to the Denali area
Personal communication with national park ranger	☐	☐	☐
Personal communication with a bus driver			
Personal communication with other employee in the Denali area	☐	☐	☐
Word of mouth (talking with other visitors or friends)	☐	☐	☐
Social media	☐	☐	☐
News article, either in print or online	☐	☐	☐
Denali National Park website	☐	☐	☐
Another website	☐	☐	☐
Please specify _____			
Other	☐	☐	☐
Please specify _____			

TOPIC AREA 9: KNOW11					
3. <u>In general</u> , how interested are you in the following activities? (Select one for each item)					
Activities	Not at all interested	Somewhat interested	Very interested	Extremely interested	Completely interested
Visiting a museum or visitor center to see fossils.	1	2	3	4	5
Seeing fossils preserved in rock in a natural setting.	1	2	3	4	5
Collecting fossils as a hobby.	1	2	3	4	5
Learning about fossils.	1	2	3	4	5
Attending movies featuring dinosaurs or other fossils.	1	2	3	4	5
Searching for or finding fossils.	1	2	3	4	5

TOPIC AREA 8: PREF5					
4. Below is a list of possible experience you may prefer to have while visiting Denali. <u>Specifically for this trip to Denali</u> , please indicate how important the experience is to your visit. (Select one for each item)					
Experience	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Access to information about fossils in Denali at the visitor center.	1	2	3	4	5
Seeing fossils during hike in Denali.	1	2	3	4	5
Attending a ranger-led hike to view fossils in Denali	1	2	3	4	5
Attending a ranger interpretive talk about fossils in Denali.	1	2	3	4	5

Seeing fossils in the visitor center in Denali.	1	2	3	4	5
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TOPIC AREA 8: BELIEFS2

5. Please rate your level of agreement for each of the following statements.

Statement	Completely disagree	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Completely agree
Fossils in national parks should be preserved for scientific research.	1	2	3	4	5	6	7
Parks should keep the locations of fossils confidential if damage or harm is possible.	1	2	3	4	5	6	7
Fossils in national parks should be managed for public education/interpretation.	1	2	3	4	5	6	7
Parks should take action to prevent damage to fossils.	1	2	3	4	5	6	7
Fossils in national parks should be protected from collection or theft.	1	2	3	4	5	6	7

TOPIC AREA 9: OPMGMT4

6. Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali. (Select one for each management action)

Management action	Completely oppose	Strongly oppose	Oppose	Neutral	Support	Strongly support	Completely support
Provide access to fossil sites but only through a limited number of permits.	1	2	3	4	5	6	7
Establish more exhibits and displays in the visitor center where people can learn about fossils in Denali.	1	2	3	4	5	6	7
Provide information to visitors about where they can hike to see fossils in the park.	1	2	3	4	5	6	7
Create ranger-led trips to view fossils in Denali, but restrict all other visitor use in areas with fossils.	1	2	3	4	5	6	7
Close all areas with fossils to public access.	1	2	3	4	5	6	7

TOPIC AREA 8: VALUES1

7. Below are statements representing different ways that people might think about nature. Please rate how much you disagree or agree in general with the statements below. Even if you don't know or care much, we are interested in your *opinion*. (Select one number for each statement)

Statement	Completely disagree	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Completely agree
Human should manage nature so that humans benefit.	1	2	3	4	5	6	7
Nature has as much right to exist as people.	1	2	3	4	5	6	7
Nature exists primarily for people to use.	1	2	3	4	5	6	7
The need of humans should take priority over nature protection.	1	2	3	4	5	6	7
Nature is only valuable if it produces jobs and incomes for people.	1	2	3	4	5	6	7
Nature has value, whether people are present or not.	1	2	3	4	5	6	7

I view all living things as part of one big family.	1	2	3	4	5	6	7
I feel a strong emotional bond to the natural world	1	2	3	4	5	6	7

TOPIC AREA 2: TPURPOSE1

8. Is viewing fossils in Denali a main/large reason for your trip to the park today? (Check one) (DISPLAY LOGIC: QUESTION ONLY APPEARS IF ANSWER ≥ 2 FOR QUESTION 1)

☐ NO ☐ YES

TOPIC AREA 1: RES2

9. Are you a permanent resident or citizen of the United States? (Please respond "yes" or "no")

☐ NO - What is your country of origin? _____

☐ YES - What is your primary zip code
Zip code _____

TOPIC AREA 1: GROUP1

10. Please select the choice below that best describes your traveling party. (Please select only one choice)

☐ Individual ☐ Family only ☐ Friends only
☐ Family plus friends ☐ Tour or other group

TOPIC AREA 1: AGE 1

11. In what year were you born? (Please respond in the blank below)

TOPIC AREA 1: GEND 1

12. What is your gender? Please select one.

☐ Female ☐ Male

Bibliography

- Anderson, L., Manning, R. E., Valliere, W. A., & Hallo, J. C. (2010). Normative standards for wildlife viewing in parks and protected areas. *Human Dimensions of Wildlife*, 15(1), 1–15.
- Bradford, L. (2005). *Off the Beaten Track: Messaging as a Means to Reducing Depreciative Behavior in a National Park*. Master's Thesis, Lakehead University, Canada, 146 p.
- Bennett, M. R., Bustos, D., Odess, D., Urban, T. M., Lallensack, J. N., Budka, M., Santucci, V. L., Martinez, P., Wiseman, A., & Reynolds, S. C. (2020). Walking in mud: Remarkable Pleistocene human trackways from White Sands National Park (New Mexico). *Quaternary Science Reviews*, 249, 1-23.
- Bennett, M. R., Bustos, D., Pigati, J., Springer, K., Urban, T. M., Holliday, V. T., Reynolds, S. C., Budka, M., Honke, J. S., Hudson, A. M., Fenerty, B., Connelly, C., Martinez, P. J., Santucci, V. L., & Odess, D. (2021). Evidence of humans in North America during the Last Glacial Maximum. *Science* 373, 1528-1531.
- Brease, P., Stromquist, L., Fiorillo, A. R., & Hasiotis, S.T. (2009). Cretaceous dinosaurs in Denali—a newly discovered resource requires a new management plan. *Geological Society of America Abstracts with Programs* 41(7), 150.
- Brunner, J., Kenworthy, J. P., & Santucci, V. L. (2010). Unauthorized fossil collecting from National Park Service Shorelines: Servicewide Policy and Perspectives. *George Wright Society Forum*, 27, 319-323.

- Browne, M. W. (1994). Clash on Fossil Sales Shadows a Trade Fair: The New York Times, 15 Feb. 1994, p. C9.
- Burroughs, E. R. (1924) The land that time forgot. A.C. McClung Pub., Chicago, IL, 122 p.
- Bustos, D., Jackway, J., Urban, T. M., Holliday, V. T., Fenerty, B., Raichlen, D. A., Budka, M., Reynolds, S. C., Allen, B. D., Love, D. W., Santucci, V. L., Odess, D., Willey, P., McDonald, H. G., & Bennett, M. R. (2018). Footprints preserve terminal Pleistocene hunt? Human-sloth interactions in North America. *Science Advances*, 4, 1-6, eaar7621.
- Bustos, D., Santucci, V. L., Odess, D., Martinez, P. J., & Connelly, C. J. (2024). Incredible discoveries and devastation of paleontological resources in a changing world preserved at White Sands National Park. in Santucci, V.L. and J.S. Tweet (eds.), National Park Service Paleontology Theme Issue, *Park Stewardship Forum*, 40(1), 69-79.
- Capps, D., Knight, C. L., Brease, P., Hilburn, S. R. & Santucci, V. L. (2024). Denali National Park and Preserve paleontological resources management plan. Science Report NPS/SR—2024/119. National Park Service, Fort Collins, Colorado.
- Chambers, C. L., Thomas, S., Santucci, V. L., Oswald, H., & Ballensky, J. (2024). Ancient bat remains illustrate the role of caves as habitat anchors in the temporally dynamic landscape of the Grand Canyon. in Santucci, V.L. and J.S. Tweet (eds.), National Park Service Paleontology Theme Issue, *Park Stewardship Forum*, 40(1), 39-52.

- Chew, A. Z. (2005). Nothing Besides Remains: Preserving the Scientific and Cultural Value of Paleontological Resources in the United States. *Duke Law Journal*, 54, 1031-1060.
- Coleman, T. H., Schwartz, C. C., Gunther, K. A., & Creel, S. (2013). Grizzly bear and human interaction in Yellowstone National Park: An evaluation of bear management areas. *Journal of Wildlife Management*, 77, 1311–1320.
- Crichton, M. (1990). *Jurassic Park*. Alfred A. Knopf Inc., New York, NY, 448 p.
- Coulson, D. 2016. Evaluation Report: National Fossil Day 2016. P.S. International, Unpublished Internal Report to the National Park Service, 73 p., Annapolis, MD.
- Daniels, M.L., & Marion, J.L. (2005). Communicating Leave No Trace ethics and practices: Efficacy of two-day trainer courses. *Journal of Park and Recreation Administration*, 23, 1-19.
- Decker, D. J., Brown, T. L., & Knuth, B. A. (1996). Human dimensions research: its importance in natural resource management. *Natural resource management: The human dimension*, 29-52.
- Decker, D., Brown, R., & Siemer, W. (2001) *The Human Dimensions of Wildlife Management in North America*. Bethesda, Maryland: The Wildlife Society.
- Department of Interior (2000). Report of the Secretary of Interior: Assessment of Fossil Management on Federal and Indian Lands. 50 p., Washington, D.C.
- Druckenmiller, P., Erickson, G., Benowitz, J. A., Capps, D., Knight, C., May, K., & Stewart, D. (2017). Deinonychosaurian trace fossils from the Late Cretaceous (Maastrichtian) Cantwell Formation, Alaska: track maker inferences using coeval,

interinformational comparisons: *Geological Society of America, Abstracts with Programs*, 49(6), unpaginated.

Dussias, A. M. (1996). Science, Sovereignty, and the Sacred Text: Paleontological Resources and Native American Rights. *Maryland Law Review*, 55, 84-159.

Ebeling, A., 2000, Dig It: Forbes Magazine,
www.forbes.com/forbes/2000/0612/6514418a.html (last accessed April 2025).

Enck, J. W., Decker, D. J., Riley, S. J., Organ, J. F., Carpenter, L. H., & Siemer, W. F. (2006). Integrating Ecological and Human Dimensions in Adaptive Management of Wildlife-Related Impacts. *Wildlife Society Bulletin*, 34, 698-705.

Endere, M. L., & Prado, J. L. (2015). Characterization and valuation of paleontological heritage: A perspective from Argentina: *Geoheritage*, 7, 137–145.

Ewert, A.W. (1996a) Human dimensions research and natural resource management. Culture, conflict, and communication in the wildland-urban interface, p. 5-12.

Ewert, A. W. (1996b). Natural resource management: The human dimension. Westview Press.

Fiffer, S. (2001). *Tyrannosaurus Sue: The Extraordinary Saga of the Largest, Most Fought over T-Rex Ever Found*. Macmillan.

Fiorillo, A. R., Hasiotis, S. T., & Kobayashi, Y. (2014). Herd structure in Late Cretaceous polar dinosaurs: a remarkable new dinosaur tracksite, Denali National Park, Alaska, USA: *Geology*, 42, 719-722.

Fiorillo, A. R., Hasiotis, S. T., Kobayashi, Y, Breithaupt, B. H., & McCarthy, P.J. (2011). Bird tracks from the Upper Cretaceous Cantwell Formation of Denali National

- Park, Alaska, USA: a new perspective on ancient north polar vertebrate biodiversity. *Journal of Systematic Paleontology*, 9(1), 33-49.
- Fiorillo, A. R., Hasiotis, S. T., Kobayashi, Y., & Tomsich, C. S. (2009). A pterosaur manus track from Denali National Park, Alaska Range, Alaska, United States. *Palaaios*, 24(7), 466-472.
- Fiorillo, A. R., McCarthy, P. J., & Breithaupt, B.H. (2006). The first record of Dinosauria and fossil Aves from the lower Cantwell Formation (latest Cretaceous), Denali National Park. *Geological Society of America Abstracts with Programs*, 38(5), 81.
- Fiorillo, A. R., McCarthy, P. J., Breithaupt, B. H., & Brease, P. F. (2007). Dinosauria and fossil aves footprints from the lower Cantwell Formation (latest Cretaceous), Denali National Park and Preserve, Alaska. p. 41-43 in *Alaska Park Science – Crossing Boundaries in a Changing Environment. Proceedings of the Central Alaska Park Science Symposium*, Anchorage, Alaska.
- Fiorillo, A. R., & Tykoski, R. S. (2016). Small hadrosaur manus and pes tracks from the lower Cantwell Formation (Upper Cretaceous) Denali National Park, Alaska; implications for locomotion in juvenile hadrosaurs. *Palaaios*, 31, 479-482.
- Fishbein, M., & Ajzen, I. (2010). Predicting and changing behavior: The reasoned action approach. New York, NY: Taylor and Francis.
- Gavin, M. C., Solomon, J. N., & Blank, S.G. (2010). Measuring and monitoring illegal conservation behaviors. *Conservation Biology*, 24, 89–100.

- Gramann, J. H., & Vander Stoep, G. A. (1987). Pro-social behavior-theory and natural-resource protection-A conceptual synthesis. *Journal of Environmental Management*, 24, 247–257.
- Gunckel, K. L. (1994). Research-based geology and paleontology education for elementary-and secondary-school students. *Journal of Geological Education*, 42, 420-423.
- Harmon, D. (2004). Intangible values of protected areas: What are they? Why do they matter. *George Wright Forum*, 21, 9-22.
- Harmon, D., & Putney, A. (2003) The full value of parks: from economics to the intangible. Rowman and Littlefield Publishers, Lanham, MD.
- Henriques, M. H. & dos Reis, R. P. (2015) Framing the Palaeontological Heritage Within the Geological Heritage: An Integrative Vision. *Geoheritage*, 7, 249-259.
- Hippensteel, S., & Condliffe, S. (2013). Profiting from the past: Are fossils a sound investment? *GSA Today*, 23, 27-29.
- Hockett, K. S. (2008). *Influence of Interpretation on Visitors' Knowledge Gain and Respect for Fossil Resources in a National Monument*. Ph.D. Dissertation, Virginia Tech.
- Hockett, K. S., & Roggenbuck, J. R. (2002) Characteristics of Visitors to Fossil Butte NM, and the Influence of the Visitor Center on Fossil Knowledge and Ethics. A final report submitted to Fossil Butte National Monument, National Park Service, Kemmerer, Wyoming: Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 111 p.

- Hockett, K. S., & Roggenbuck, J. W. (2003). Influence of interpretation along a nature trail on visitor attitudes and behavior toward fossils. A final report submitted to Fossil Butte National Monument, National Park Service, Kemmerer, Wyoming: Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Hodges, M., & Capps, D. (2013). Paleontological management and monitoring of fossil resources on public land: An analysis of anthropogenic impacts on dinosaur ichnofossils of the Cantwell Formation, Tattler Creek Valley, Denali National Park & Preserve, Alaska. *2013 Geological Society of America Annual Meeting, Abstracts with Program*, Denver, CO.
- Hodnett, J. P. M., Egli, C., Toomey, R. S., Olson, R., Tolleson, K., Boldon, R., Tweet, J. S., & Santucci, V. L. (2025). Obruchevodid petalodonts (Chondrichthyes, Petalodontiformes, Obruchevodidae) from the Middle Mississippian (Viséan) Joppa Member of the Ste. Genevieve Formation at Mammoth Cave National Park, Kentucky U.S.A. *Journal of Paleontology*, 1-11.
- Hodnett, J. P. M., Toomey, R. S., Egli, C., Ward, G., Wood, J. R., Olson, R., Tolleson, K., Tweet, J. S., & Santucci, V. L. (2024a). New ctenacanth sharks (Chondrichthyes; Elasmobranchii; Ctenacanthiformes) from the middle to late Mississippian of Kentucky and Alabama. *Journal of Vertebrate Paleontology*, DOI: 10.1080/02724634.2023.2292599
- Hodnett, J. P. M., Toomey, R. S., Olson, R., Tolleson, K., Boldon, R., Wood, J. R., Tweet, J. S., & Santucci, V. L. (2024b). Sharks in the dark: Paleontological

resource inventory reveals multiple successive Mississippian Subperiod cartilaginous fish (Chondrichthyes) assemblages within Mammoth Cave National Park, Kentucky. in Santucci, V.L. and J.S. Tweet (eds.), National Park Service Paleontology Theme Issue, *Park Stewardship Forum*, 40(1), 53-67.

- Hodnett, J. P. M., Toomey, R. S., Olson, R. A., Tweet, J. S. & Santucci, V. L. (2023). Janassid Petalodonts (Chondrichthyes, Petalodontiformes, Jannassidae) from the Middle Mississippian (Viséan) Ste. Genevieve Formation from Mammoth Cave National Park, Kentucky, USA. *Historical Biology*, DOI: 10.1080/08912963.2023.2231955
- Johnson, D. R., & Vande Kamp, M. E. (1996). Extent and Control of Resource Damage due to non-compliant visitor behavior: A case study from the US National Parks. *Natural Areas Journal*, 16, 134–141.
- Kenworthy, J. P., & Santucci, V. L. (2006). A preliminary inventory of National Park Service paleontological resources in a cultural context: Part 1: A general overview. in S. G. Lucas, J. A. Spielmann, P. M. Hester, J. P. Kenworthy, and V. L. Santucci, editors, *America's Antiquities: 100 Years of Managing Fossils on Federal Lands. Proceedings of the 7th Federal Fossil Conference, New Mexico Museum of Natural History and Science Bulletin*, 34, 70-76.
- Kim, A. K., & Weiler, B. (2013). Visitors' attitudes towards responsible fossil collecting behaviour: An environmental attitude-based segmentation approach. *Tourism Management*, 36, 602-612.
- Knowles, L. (2013). Walking in Your Footsteps: The Protection of Paleontological Resources in Colorado. *Denver University Law Review Online*, 90, 137-143.

- Krowitz, E. (2001). Could sale of fossils be the key to ending theft? *Nature*, 414 (6863), 485.
- Lawhon, J.B., 2013, Influencing Leave No Trace Behavioral Intentions in Frontcountry Visitors to National and State Parks. M.S. Thesis, Colorado State University, Colorado, 71 p.
- Lawhon, J. B., Newman, P., Taff, D., Vaske, J., Vagias, W., Lawson, S., & Monz, C. (2014). Factor Influencing Behavioral Intentions for Leave No Trace Behaviors in National Parks. *Journal of Interpretation Research*, 18, 23-38.
- Larwood, J. G., & Prosser, C. D. (2019). Managing palaeontological heritage: a brief overview of policy and practice in England. [Gestión del patrimonio paleontológico: una breve revisión de la política y la práctica en Inglaterra]. *Spanish Journal of Palaeontology*, 34 (1), 57-64.
- Larwood, J. G., Santucci, V. L. & Fiorillo, A. R. (2022). Fresh perspectives on paleontological heritage and the stewardship of non-renewable fossil resources. New Perspectives on Geoconservation in Protected and Conserved Areas, Roger Crofts (ed.), *Park Stewardship Forum*, 38(1), 448-457.
- Lazerwitz, D. J. (1994). Bones of Contention: The Regulation of Paleontological Resources on The Federal Public Lands. *Indiana Law Journal*, 69, 601-636.
- Leong, K., van Riper, C. J., McComas, K., Manning, R. E., McCarter, J. & Gramann, J. (2013). Using Research into the Human Dimensions of Natural Resource Management to Enhance Science-Informed Decisions. In Weber, S., (ed.) Protected Areas in a Changing World: *Proceedings of the 2013 George Wright*

Society Conference on Parks, Protected Areas, and Cultural Sites, Hancock,

Michigan: George Wright Society, 87-93.

Leopold, E. B., & Meyer, H. W. (2012) *Saved in Time: The Fight to Establish Florissant Fossil Beds National Monument*, Colorado. New Mexico University Press, 139 pages.

Lipps, J. H. (2009). *PaleoParks - The Protection and Conservation of Fossil Sites Worldwide: Chapter 1; PaleoParks: Our paleontological heritage protected and conserved in the field worldwide. Carnets de Géologie-Notebooks on Geology*, Brest.

Lundgren, G. (1998). Protecting Federal Fossils From Extinction. *Boston College Environmental Affair Law Review*, 26, 225-262.

Malmsheimer, R. W., & Hilfinger, A. S. H. (2003). In Search of a Paleontological Resources Policy for Federal Lands. *Natural Resources Journal*, 43, 587-614.

Mamalis, J. (2012). Historical Resource Crime in the Parks Canada Agency's Protected Areas: An Overview. *Canadian Criminal Law Review*, 17, 41.

Manfredo, M. J. (2008). *Who Cares About Wildlife: Social Science Concepts for Exploring Human-Wildlife Relationships and Conservation Issues*. New York, Springer Press.

Manfredo, M. J., Pierce, C., Vaske, J. J., & Whittaker, D. (2002). An experience-based approach to planning and management for wildlife-viewing recreation. In M. J. Manfredo (Ed.), *Wildlife viewing: A management handbook* (pp. 70–92). Oregon State University Press.

- Manfredo, M. J., Teel, T. L., & Bright, A. D. (2004). Application of the concepts of values and attitudes in human dimensions of natural resources research. *Society and natural resources: A summary of knowledge*, 271-282.
- Manfredo, M. J., Vaske, J. J., Brown, P. J., & Decker, D. J. (2008). *Wildlife and Society: The Science of Human Dimensions*. Washington, D.C., Island Press.
- Manning, R., and More, T. (2002). Recreational values of public parks. *The George Wright Forum*, 19, 21-29.
- Marion, J. L., & Reid, S. E. (2007). Minimizing Visitor Impacts to Protected Areas: The Efficacy of Low Impact Education Programmes. *Journal of Sustainable Tourism*, 15, 5-27.
- Marshall, L.G. (1976). Paleontological Salvage and Federal Legislation. *Journal of Paleontology*, 50, 346-348.
- Mayor, A. (2005). *Fossil Legends of the First Americans*. Princeton University Press. Princeton, NJ.
- Mayor, A. (2007). Fossils in Native American Lands, Whose Bones, Whose Story? Fossil Appropriations Past and Present. Paper presented at History of Science Society annual meeting, 1-2 Nov, 2007, Washington DC, History of Earth Sciences Government and Earth Sciences Panel.
- Mayor, A. (2011) *The First Fossil Hunters: Dinosaurs, Mammoths, and Myth in Greek and Roman Times*. Princeton University Press, Princeton, NJ, 400 p.
- McClain, D. L. (1996). Natural History at Unnatural Prices: The New York Times, 15 Sept. 1996, p. F7, <http://www.nytimes.com/1996/09/15/business/natural-history-at-unnatural-prices.html> (last accessed 12 April 2025).

- Milner, A. R. C., Santucci, V. L., Marsh, A. D., King, M. R., Harris, J. D., Delgalvis, A., Wood, J. R., Buchwitz, J. C., Carter, H. A., Kirkland, J. I., Slauf, D., Charobee, A. L., Bennett, C. J., Rodriguez, M., Tweet, J. S., & Clites, E. C. (2024). Following in the footsteps of Dr. Martin G. Lockley: Another 10 years of paleontological investigations in Glen Canyon National Recreation Area, Utah and Arizona. in L.H. Taylor, R.G. Raynolds, and S.G. Lucas, eds. *Vertebrate Paleoichnology: A Tribute to Martin Lockley*. New Mexico Museum of Natural History and Science Bulletin, 95, 283-326.
- Muth, R. M., & Bowe, J. F., Jr. (1998). Illegal harvest of renewable natural resources in North America: Toward a typology of the motivations for poaching. *Society & Natural Resources: An International Journal*, 11, 9–24.
- National Park Service. (2014). Denali National Park and Preserve Foundation Statement. Denali National Park and Preserve, Denali Park, Alaska. 69 pp.
- National Park Service. (2017). Badlands National Park Foundation Document. Badlands National Park, South Dakota. 59 pp.
- National Research Council, Division on Earth, Life Studies, Board on Earth Sciences, Resources, Committee on Trends, Opportunities in Federal Earth Science Education, and Workforce Development (2013). Preparing the next generation of Earth scientists: An examination of federal education and training programs. National Academies Press.

- Olson, E. C., Bowman, M. L., & Roth, R. E. (1984). Interpretation and Nonformal Environmental Education in Natural Resources Management. *Journal of Environmental Education*, 15, 6.
- Padian, K. (2000). Feathers, fakes, and fossil dealers: how the commercial sale of fossils erodes science and education. *Palaeontologia Electronica*, 3.
- Page, K. N. (2018). Fossils, heritage and conservation: managing demands on a precious resource. In: *Geoheritage: Assessment, Protection and Management* (eds. Reynard, E. and Brilha, J.). Elsevier, 107-128.
- Pages, J. S. (2009). PaleoParks - The Protection and Conservation of Fossil Sites Worldwide: Chapter 3; The GeoPark of Haute-Provence, France-Geology and palaeontology protected for sustainable development.
- Pigati, J. S., Springer, K. B., Honke, J. S., Wahl, D., Champagne, M., Zimmerman, S., Gray, H. J., Santucci, V. L., Odess, D., Bustos, D. & Bennett, M. R. (2023). Independent age estimates resolve the controversy of ancient human footprints at White Sands. *Science*, 382, 73-75.
- Prout, H. A. (1846). Gigantic *Palaeotherium*. *American Journal of Science*, 2, 288-28
- Rea, T. (2001). Bone Wars: The Excavation and Celebrity of Andrew Carnegie's Dinosaur. University of Pittsburgh Press, Pittsburgh, PA.
- Richardson, L., & Enriquez, A. J. (2024). Valuing wildlife sightings at the species-wide and individual animal levels: an approach and application to bear viewing in Yellowstone National Park. *Human Dimensions of Wildlife*, 30(2), 201–219.

- Richardson, L., Gunther, K., Rosen, T., & Schwartz, C. (2015). Visitor perceptions of roadside bear viewing and management in Yellowstone National Park. *The George Wright Forum*, 32(3), 299–307.
- Rogers, C. L. (2011). Digging In: An In-Depth Look at the Archaeological and Paleontological Resource Acts: The Legal Perspective. Mineral Law Institute – Chapter 14, 14A-1 to 14A-20.
- Rohleder, A. (2001). Collecting Dinosaur Bones: Forbes Magazine, <http://www.forbes.com/2001/08/01/0801connguide.html> (last accessed 12 April 2025).
- RoOLF, C. (2012). The Attempted Theft of Dinosaur Skeletons during the German Occupation of Belgium (1914–1918) and Some Other Cases of Looting Cultural Possessions of Natural History. *Bernissart Dinosaurs and Early Cretaceous Terrestrial Ecosystems*, 21.
- Sakurai, D. S. (1994). Animal, Mineral, or Cultural Antiquity?: The Management and Protection of Paleontological Resources. *Loyola of Los Angeles International and Comparative Law Journal*, 1, 197-243.
- Santos, S., Prothero, D. R., & Welsh, E. (2023). A new species of extinct rhinoceros from the late Oligocene of South Dakota. *New Mexico Museum of Natural History and Science Bulletin*, 94, 617-622.
- Santucci, V. L. (2017). Preserving fossils in the National Parks: A History. *Earth Science History*, 36(2), 245-285.

- Santucci, V. L. (2002). Definition of a Fossil. *Ranger: Journal of the Association of National Park Rangers*, 18(2), 7-8.
- Santucci, V. L., Blodgett, R. B., Elder, W. P., & Kenworthy, J.P. (2011). Paleontological Resource Inventory and Monitoring—Central Alaska Network. Natural Resource Technical Report NPS/NRPC/NRTR—2011/510. National Park Service, Fort Collins, Colorado, 111 p.
- Santucci, V. L., & Ghist, J. M. (2014). Fossil Cycad National Monument: A History from Discovery to Deauthorization. *Proceedings of the 10th Conference on Fossil Resources, Dakoterra*, 6, 82-93.
- Santucci, V. L., & Hughes, M. (1998). Fossil Cycad National Monument: A case of paleontological resource mismanagement. In *National Park Service Paleontological Research*, Editors V. L. Santucci, and L. McClelland. Technical Report NPS/NRGRD/GRDTR-98/1.
- Santucci, V. L., Kenworthy, J. P., & Mims, A.L. (2009). Monitoring *in situ* paleontological resources. In Young, R. and L. Norby (eds.), *Geological Monitoring*. Geological Society of America, Boulder, CO., p. 189-204.
- Santucci, V. L., & Koch, A.L. (2003). Paleontological resource monitoring strategies for the National Park Service. *Park Science*, 22, 22-25.
- Santucci, V. L., Newman, P., & Taff, B. D. (2016). Toward a conceptual framework for assessing the human dimensions of paleontological resources. in Sullivan, R.M. and Lucas, S.G., eds., 2016, *Fossil Record 5. New Mexico Museum of Natural History and Science Bulletin*, 74, 239-248.

- Santucci, V. L., Tweet, J. S., & Connors, T. (2018). The Paleontology Synthesis Project and Establishing a Framework for Managing National Park Service Paleontological Resource Archives and Data. *in* Lucas, S.G. and Sullivan, R.M., (eds.), *Fossil Record 6. New Mexico Museum of Natural History and Science Bulletin*, 79, 589-601.
- Sheffield, E. (1988). Managing depreciative behavior. *Parks & Recreation*, v. 23, p.16.
- Shimada, K., Currie, P., Scott, E., and Sumida, S., 2014, The greatest challenge to 21st century paleontology: When commercialization of fossils threatens the science. *Paleontologia Electronica*, 17(1), 4 p; paleo-electronica.org/content/2014/691-greatest-threat-in-21st-century
- Shreero, M., Welsh, E., Marriott, K. & Prothero, D. R. (2024). A tiny deer with big implications: A new genus (*Santuccimeryx*) from Badlands National Park helps bridge the gap between Oligocene and Miocene Leptomerycidae (Mammalia, Artiodactyla). *Proceedings of the South Dakota Academy of Science*, 102, 19-41.
- Sicree, A. A. (2009). Morocco's trilobite economy. *Saudi Aramco World*, 34-39.
- Simmons, T., & Gramman, J. (2001). Badlands National Park Visitor Study: Visitor Services Project Report 123.
- Tweet, J. S., & Santucci, V. L. (2018). An Inventory of Non-Avian Dinosaurs from National Park Service Areas. *in* Lucas, S.G. and Sullivan, R.M., (eds.), *Fossil Record 6. New Mexico Museum of Natural History and Science Bulletin*, 79, 703-730.

- Weimer, D.R. (2004). Paleontological Resources Preservation Act: Proposal for the Management and Protection of Fossil Resources Located on Federal Lands. Report for Congress, Congressional Research Service, The Library of Congress, 12 p.
- Welsh, E. (2021). A New Species of an Enigmatic Carnivore *Palaeogale* (Feliformia: Palaeogalidae) from Badlands National Park, South Dakota. *Proceedings of the South Dakota Academy of Science*, 100, 107-120.
- Widner, C. J., & Roggenbuck, J. R. (2003). Understanding park visitors' responses to interventions to reduce petrified wood theft: *Journal of Interpretation Research*, 8, 67-82.
- Widner, C. J., & Roggenbuck, J. R. (2000). Reducing theft of petrified wood at Petrified Forest National Park: *Journal of Interpretation Research*, 5, 1-18.
- Williams, D. R., Roggenbuck, J. W., Santucci, V. L., Stratton, D.W., & Borrie, W. T. (1993). Social science methods for studying illegal fossil collecting: a case study from Petrified Forest National Park. *Abstracts of 53rd Society of Vertebrate Paleontology Meeting*. Albuquerque, New Mexico.
- Wise, J. (1982). A gentle deterrent to vandalism. *Psychology Today*, September, 31–36.

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Professional Experience

Senior Paleontologist / Geologist, NPS Geologic Resources Division, 2011–date;

Superintendent (detail), Tule Springs Fossil Beds National Monument, 2015;

Chief Ranger, George Washington Memorial Parkway, 2003–2011;

Chief Ranger, Acting Superintendent, Fossil Butte National Monument, 1997-2003;

Vital Signs Monitoring Coordinator (detail), Greater Yellowstone I&M Network, 2002;

Natural Resources Training Manager (detail), Horace Albright Training Center, 2002;

Park Ranger (Law Enforcement), Yellowstone National Park, 1996;

Faculty Instructor, Department of Parks & Recreation, Slippery Rock University, 1994-1995;

Resource Management Specialist (Planning), Grand Canyon National Park, 1993-1994;

Chief Natural / Cultural Resource Mgmt / Paleontologist / Curator, Petrified Forest, 1991-1992;

Park Ranger (Interpretation), Badlands National Park, 1985-1986;

Honors and Awards

Stephen T. Mather Award, 2024

George B. Hartzog, Jr. Award, 2012

Albright – Wirth Grant, 2002

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George Wright Society Natural Resource Award, 2001

Department of Interior Superior Service Award, 2001

Brunton Compass Award, 2000

Intermountain Region Small Park Resource Manager of the Year Award, 1999