INTEGRATING PALEONTOLOGICAL RESOURCE MANAGEMENT INTO THE EDUCATIONAL CURRICULUM FOR UNDERGRADUATE AND GRADUATE PROGRAMS IN PARKS AND RESOURCES MANAGEMENT

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Abstract—The enactment of the Paleontological Resources Preservation Act in March 2009 identified specific mandates involving the management of non-renewable paleontological resources for federal land managing agencies in the U.S. Department of Agriculture and Department of Interior. The widespread occurrence of fossils on federal lands, especially in the American West, presents challenges to land and resource managers who may not possess background education or training pertaining to paleontological resources management. The need for increased training opportunities involving fossils and their management is important for students preparing to enter the work force in parks and resources management for federal agencies.

INTRODUCTION

The management of paleontological resources has become an increasingly important responsibility of federal land managing agencies, given the mandates and guidance identified in the Paleontological Resources Preservation Act (PRPA) enacted in March 2009. To meet the resource-specific needs and requirements associated with non-renewable fossils, training programs in paleontological resources management address a growing need for staff and students involved with resources management.

Since the Archaeological Resources Protection Act (ARPA) was enacted in 1979, thirty years before PRPA, training programs for students in archeology programs generally include basic principles of archeological resources management. This focused training prepares students in archeology to understand and be prepared for the important aspects of laws and practices associated with archeological resources management which are required by archeologists working for federal agencies. Equivalent training programs for paleontological resources management are currently limited but are in increasing demand. A brief overview of current training opportunities and academic programs that offer students the basic information pertaining to paleontological resources and their management can be very beneficial.

This overview defines and highlights the importance of paleontological resources management and the associated training involving the legal authorities, scientific principles, and resource management practices applied to fossils. There is a need for expanded training opportunities for professional and student natural and cultural resource managers to support the stewardship of non-renewable paleontological resources.

WHAT IS PALEONTOLOGICAL RESOURCES MANAGEMENT?

Paleontological resources or fossils are the non-renewable remains of past life preserved within a geologic context. Fossils represent physical evidence or traces of life on Earth with the earliest known record of life extending back at least 3.95 billion years (Tashiro et al., 2017). The science of paleontology, and associated fields of study, strives to document and understand the history of life through research involving fossils and the rocks in which they are preserved. Paleontology is the scientific discipline focused on the study of fossils with many subdisciplines to assess a myriad of taxonomic, phylogenetic, paleoecologic, biostratigraphic, and other categories of information fossils possess. Consequently, fossils are of great public and media interest involving a diversity of human dimensions associated with how individuals view and value fossils (Santucci et al., 2016).

Museums throughout the United States and around the world curate and maintain fossil collections to support scientific research and public education. In the United States, countless numbers of fossil localities have been documented on lands administered by federal, state, or local agencies. The U.S. government manages approximately 610 million acres of lands primarily administered by the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), U.S. Fish and Wildlife Service (FSW), National Park Service (NPS), and U.S. Forest Service (USFS) (Vincent et al., 2020). These federal bureaus within the Department of Interior and the Department of Agriculture are responsible to manage all cultural and natural resources, including paleontological resources, based on each agency's authorizing legislation and a variety of other federal laws (Archaeological Resources Protection Act, Federal Cave Resources Protection Act, NPS Omnibus Management Act of 1998, etc.).

The Paleontological Resources Preservation Act (PRPA) (16 USC 470aaa) was enacted into law on March 30, 2009. The PRPA is the primary federal authority for paleontological resources and mandates specific management responsibilities and actions for the BLM, BOR, FWS, NPS, and USFS to undertake with fossils under their respective jurisdiction. The PRPA directs agencies to manage and protect fossils on federal lands using scientific principles and expertise; to develop plans for inventory, monitoring, and the scientific and educational use of fossils; to establish a program to increase public awareness about the significance of paleontological resources; to require a permit for the collection of fossils; to ensure that all fossil specimens and associated records shall be deposited and curated in an approved museum repository; and several other provisions.

Paleontological resource management (PRM) is a specialized approach for the comprehensive stewardship of non-renewable fossils on public lands. PRM integrates the resource-specific directives within applicable laws, regulations, policies, and guidance documents in combination with scientific principles for paleontology and best management practices applied to non-renewable resources. This scenario is similar to how federal bureaus approach the management of archeological resources, threatened and endangered species, and other natural, cultural, and environmental resources. This approach to management of non-renewable fossils ensures stewardship of these fragile resources which are cared for in the public trust.

WHY IS PALEONTOLOGICAL RESOURCES MANAGEMENT IMPORTANT?

The management of paleontological resources on federal and other public lands is a fundamental responsibility for land managing agencies often directed by laws enacted on behalf of the American public. The increased understanding related to the scope, significance, distribution, and management issues associated with fossils places greater demands on those involved with fossil stewardship and management.

Although there is a need for basic paleontological resources management training for students in parks and resources management, this in no way implies for this training to include the in-depth principles associated with the science of paleontology. Rather, the focus should be directed toward the laws and resource management practices relevant to fossils. The objective of the basic paleontological resource management training is to enable the student to recognize when consultation with a professional paleontologist may be warranted.

Fossils in geologic strata are subjected to both natural and anthropogenic factors which may impact the stability and condition of these resources. The development of various paleontological resource monitoring strategies is designed to inform park managers about threats to fossils in order to mitigate the factors leading to impairment of non-renewable fossils. The unfortunate history of the abolished Fossil Cycad National Monument, South Dakota, highlights the need for park managers to be aware of the fragile nature of non-renewable fossils (Santucci and Ghist, 2014).

FEDERAL PALEONTOLOGICAL RESOURCE LAW

Several federal laws specifically identify paleontological resources; they are presented below in chronological order for their date of enactment. Knowledge of these basic laws is essential for effective management of non-renewable paleontological resources by federal land managing agencies.

In 1906, the Antiquities Act (54 U.S.C. § 320301–320303) was enacted to help protect any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the government of the United States. The act further authorizes the President of the United States to declare national monuments by public proclamation of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. The Antiquities Act was used to proclaim several national monuments based upon significant paleontological resources, including Petrified Forest National Park, Dinosaur National Monument, Fossil Cycad National Monument (now abolished), and most recently Waco Mammoth National Monument.

The Archaeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. 470aa-mm) includes within the definition of an archeological resource the following statement, “Non-fossilized and fossilized paleontological specimens, or any portion or piece thereof, shall not be considered archeological resources, under the regulations under this paragraph, unless found in an archeological context.” Several other federal laws consider paleontological resources in cases where they are associated with other cultural resources including archeological, historic, or ethnographic resources. In these circumstances, paleontological resources may be considered within the scope of the National Historic Preservation Act of 1966 (NHPA) (16 U.S.C. § 470 et seq.) or the Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. § 3001 et seq.).

The Federal Cave Resources Protection Act of 1988 (FCRPA) (16 U.S.C. § 4301 – 4309) defines the term “cave resource” to include any material or substance occurring naturally in caves on federal lands, such as animal life, plant life, paleontological deposits, sediments, minerals, speleogens, and speleothems. Therefore, any reference to “cave resource” in the law applies to paleontological resources.

The National Parks Omnibus Management Act of 1998 (54 U.S.C. § 100101) authorizes the NPS to consider the risks associated with the public release of sensitive resource information. Section 207 of the act addresses the confidentiality of information concerning the nature and specific location of a National Park System resource which is endangered, threatened, rare, or commercially valuable, of mineral or paleontological objects within units of the National Park System. The act further states that a determination should be made whether the disclosure of the information would further the purposes of the unit of the National Park System in which the resource or object is located and would not create an unreasonable risk or harm, theft, or destruction of the resource or object, including individual organic or inorganic specimens, and disclosure is consistent with other applicable laws protecting the resource or object.

The primary legislation pertaining to fossils from NPS and other federal lands is the Paleontological Resources Preservation Act of 2009 (PRPA) (16 U.S.C. § 470aaa 1-11) which was enacted on March 30, 2009, within the Omnibus Public Land Management Act of 2009. The PRPA directs the Department of Agriculture (U.S. Forest Service) and the Department of the Interior (National Park Service, Bureau of Land Management, Bureau of Reclamation, and Fish and Wildlife Service) to manage and protect paleontological resources on federal land using scientific principles and expertise. The Secretary shall develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources, in accordance with applicable agency laws, regulations, and policies. These plans shall emphasize interagency coordination and collaborative efforts where possible with non-federal partners, the scientific community, and the public.

SCIENCE, STEWARDSHIP, AND MANAGEMENT OF PALEONTOLOGICAL RESOURCES

Paleontological resources are documented on lands administered by the Department of Interior (DOI), Department of Agriculture (USDA), Department of Defense (DOD), and other federal agencies. Five federal agencies are specifically identified in the Paleontological Resources Preservation Act (2009) which mandates specific provisions involving the management, protection, research, curation, and public education pertaining to fossils. Museum collections throughout the United States, and in a number of countries around the world, maintain fossil collections acquired over the past two hundred years from lands now administered as federal public lands.

The Bureau of Land Management (BLM) employs seven permanent paleontologists to support fossil related needs and issues across 244,378,573 surface acres. On average over the past three years, BLM issued between 350 to 450 permits involving paleontological resources. In 2021, the BLM reported nearly 350,000 cataloged fossils specimen from BLM lands are maintained in outside repositories (S. Foss, personal communication, March 2022).

The National Park Service (NPS) employs ten permanent paleontologists to support paleontological resources across the 85 million acres. Paleontological resource inventories have been documented from within at least 283 different NPS units. The NPS has issued between 114 to 141 paleontological resource permits annually over the past three years. The NPS reports there are more than 620,000 cataloged fossil specimens from NPS lands that are in park museum collections or in outside museum repositories.

The U.S. Forest Service (USFS) employs three permanent paleontologists to support fossil needs across 193 million acres. During 2021, the USFS reported issuing approximately 60 paleontological resource permits (B. Schumacher, personal

communication, March 2022). The USFS does not maintain any internal museum collections with fossils. The U.S. Fish and Wildlife Service (FWS) and Bureau of Reclamation (BOR) do not employ any full-time paleontologists.

ACADEMIC TRAINING IN PALEONTOLOGY AND PALEONTOLOGICAL RESOURCES MANAGEMENT

Paleontological resource management training at the university or collegiate levels is significantly less common than equivalent training in archeological resources management. The potential academic programs where paleontological resources management curriculum may be presented to students include: 1) Geology, Biology, or Anthropology programs offering introductory courses in paleontology; 2) Parks and Conservation programs offering natural and cultural resources management courses; and 3) Park Ranger Law Enforcement Academies (PRLEA), formerly known as the Seasonal Law Enforcement Training Program (SLETP).

Based on the interdisciplinary foundations of the science of paleontology, the content of courses generally integrates principles, concepts, and information from the studies of biology and geology. Undergraduate and graduate courses in paleontology are traditionally offered through Geology, Geoscience, and Earth Science departments; however, introductory courses in paleontology are sometimes available through Biology or Anthropology departments. The focus of the typical "Introduction to Paleontology," sometimes listed as "Paleobiology" or "Geobiology" or other similar titles, highlights the principles and concepts for the science of paleontology. Courses in paleontology are often required for undergraduate geology programs, but a variety of courses focused on "fossils," "dinosaurs," or "prehistoric life" have become popular courses available for non-science majors to fulfill college or university requirements in either liberal studies or elective areas.

A typical course curriculum for an introductory paleontology course would examine the history and evolution of life on Earth through geologic time. This includes in-depth review of the major taxonomic groups of living and extinct organisms, and their relationships, known from the fossil record. The assessment of the paleobiological record is integrated into a temporal framework in consideration of geologic events and processes throughout Earth's history. Topical discussions would include systematics, the evolution of paleoenvironments, the biogeographic distributions of past life, biostratigraphy, and events which may have shaped evolution or extinction of ancient flora and fauna.

Paleontological resource management training is not normally presented in traditional undergraduate "Introduction to Paleontology" course curriculum at the university level. There are infrequent presentations to students in these courses by an invited guest lecturer. By comparison, undergraduate students in Archeology and Anthropology programs are introduced to information and concepts associated with archeological resource management. This includes information on cultural resource laws, policy, practices, permits, inventory, monitoring, and other related archeological resource management topics. This academic focus on archeological resource management integrated to undergraduate education programs helps to prepare students for potential positions with federal, state, and local agencies seeking individuals with this relevant knowledge and understanding.

An assessment of Parks and Conservation programs for content related to paleontological education, protection, and management was undertaken, with very few programs found which include paleontological resources management in the course curriculum. The Eppley Institute for Parks and Public Lands (Indiana University) provides various courses in both archeological and paleontological management as they relate to wilderness areas and the Wilderness Act. These courses are offered through *ProValens*, an online learning platform that partners with Indiana University and several federal land managing agencies including the National Park Service. While the Paleontological Resource Preservation Act (PRPA) of 2009 is included in Eppley Institute training, it is limited to aspects of the law which relates to paleontological resources on designated wilderness lands.

An assessment of universities in the State of Pennsylvania shows that paleontological resources management training has been presented to students in academic programs at three universities. Through the Parks and Conservation Program in the Biology Department at Slippery Rock University (SRU), students are introduced to paleontological resources and PRPA in the curriculum of the required Cultural Resources Management course. SRU is used as a case study for one of the universities in the United States that fully incorporates paleontological resources management into the department's curriculum. The ProRanger Program at Temple University provides students with introductory information of paleontological resources management. Students in the Department of Parks, Recreation and Tourism Management at Penn State University (PSU) have utilized an invited guest speaker to address paleontological resources and PRPA.

There are currently six institutions in the United States that offer the Park Ranger Law Enforcement Academy (PRLEA) formerly known as the Seasonal Law Enforcement Training Program (SLETP). Within the accredited curriculum, there are approximately four hours dedicated to natural and cultural resource laws. The Paleontological Resource Preservation Act (PRPA) is included in this block of instruction, and the primary objective for students is that they understand how the PRPA applies to the protection of natural resources located on National Park System lands. In a typical offering, approximately one hour of coursework would be dedicated to present an overview on PRPA to the academy students. While at one time there were as many as 23 SLETP programs, there are currently six under the accredited curriculum for Type II (seasonal) commissions. The PRLEA is offered at Colorado Northwest Community College, Northern Arizona University, Skagit Valley Community College in Washington, Southwestern Community College in North Carolina, Temple University in Pennsylvania, and Vermillion Community College in Minnesota.

CASE STUDY: SLIPPERY ROCK UNIVERSITY'S APPROACH TO PALEONTOLOGICAL RESOURCE MANAGEMENT EDUCATION

Slippery Rock University has a long history of providing coursework related to both cultural and paleontological education for parks and conservation majors. Detailed instruction in the National Park Service Organic Act of 1916, The Antiquities Act of 1906, The Historic Preservation Act of 1966, The Archaeological Resource Protection Act (ARPA) of 1979, and the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 have long been components of the undergraduate and graduate courses dedicated to cultural resource management. The Paleontological Resources Preservation Act is the most recent addition to the course. While paleontological resources have always been included in the cultural resource course, it has grown to be a larger area of study since PRPA.

The Parks and Conservation Program at Slippery Rock University offers a Bachelor of Science degree in Park and Resource Management (on campus), a Master of Science in Park and Resource Management (online), and a Master of Education in Environmental Education (online). The primary course dealing with cultural and paleontological resources at the undergraduate level is PCRM 377 Cultural Resource Management, which is required for all undergraduate students. At the graduate level, a

similar course (PCRM 677 Cultural Resource Management) is offered as an elective for both graduate degrees. In the Park and Resource Management graduate program, there is a required course, PCRM 654 Natural and Cultural Resource Law, that covers the major laws relating to natural and cultural resources. This course is an intensive study of various natural resource laws and is offered over a 15-week semester.

In addition to the cultural resource topics including cultural resource legislation, archeology, historic preservation, the built environment, and conservation easements, approximately 20% of class instruction is dedicated to paleontological education. Within this coursework, PRPA is discussed in considerable detail, and students gain understanding of how the legislation applies to all applicable federal lands. Students gain knowledge of the purpose and intent of the laws relating to paleontological resources and the criminal and civil penalties for those who violate them. Students are required to read several articles relating to paleontological resource protection in natural areas and participate in guest lectures from professional paleontologists. These sessions are valuable in that they provide an initial introduction to the vast array of paleontology-focused projects and unique collections throughout the NPS. Students are also required to: review NPS paleontology websites; read articles pertaining to paleontological resources in natural areas; view the documentary titled "*Dinosaur 13*" which provides a platform of discussing "Sue" the *Tyrannosaurus rex* and the court findings regarding property and discovery rights; attend a virtual or in-person National Fossil Day event to learn and understand paleontology's role in public outreach (Figure 1); and participate in additional opportunities such as class trips to various NPS fossil parks (Figure 2). To demonstrate how cultural and paleontological resources are related, students are given a project in which they select and study a historic structure of significance that is then presented to the class in a presentation at the end of the semester (Santucci, et al. 2020).

The academic curriculum at SRU ensures that all students graduating from the Parks and Resources Management program will have a solid understanding of the cultural and paleontological resources before entering the profession. Many students are able to use this knowledge during their summer practicum or internship experiences with federal agencies during their required seasonal employment as a student.

SUMMARY: ADVOCACY FOR EXPANDED PALEONTOLOGICAL RESOURCE TRAINING AND EDUCATION

The enactment of the Paleontological Resources Preservation Act of 2009 has helped to increase awareness about the importance of managing non-renewable fossils on federal lands. Each year, paleontological resource inventories expand our knowledge of the fossils record, add new locations where fossils occur, and inform us about the management issues associated with fossils. The increased demands and mandates within PRPA now require the BLM, BOR, FWS, NPS, and USFS to manage paleontological resources with scientific principles and expertise.

Students obtaining paleontological resource management training during their academic education will have fundamental understanding of the needs and challenges associated with managing fossils on federal lands. Federal land management agencies that preserve and are mandated to protect non-renewable fossils will likely identify these basic skills as necessary for employment. Students gaining these skills at the university level will likely be better able to compete for seasonal and permanent positions. Adopting paleontological resource management training in academic and educational programs is helping to prepare our next generation of resource managers. These managers will be the stewards for federal lands, guardians of priceless resources, and informed educators of all those interested in our paleontological treasures.



FIGURE 1. National Fossil Day Celebration hosted by the Parks and Conservation students at Slippery Rock University during October of 2019. (NPS Photo)



FIGURE 2. Slippery Rock University Parks and Conservation students on field trip to Petrified Forest National Park in May of 2016. (John Lisco Photo)

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