Past, present, and future: A synthesis of paleontological resource monitoring and management at Badlands National Park

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ABSTRACT

Paleontological monitoring at Badlands National Park is extremely complex. The monitoring program has steadily evolved from its formalization in 1994 with the hiring of the first park paleontologist. Changing regulations, increases in protections for paleontological resources, positive interdivisional communication, sympathetic leadership, and the hiring of a full-time monitor have allowed staff to move from being purely reactive to taking an active role in planning park projects. This entails commenting on compliance through the National Park Service's Planning, Environment & Public Comment portal, conducting pre-construction surveys, attending pre-construction meetings, providing resource training for construction personnel, consulting with the Federal Highway Administration as subject-matter experts, and acting as the contracting officer's representative on select projects. The monitoring program strives to hire qualified personnel according to best practice guidelines and provides additional training in documentation, fossil identification, field methods, and effective communication prior to allowing monitors to be onsite. The monitoring program works to add value to projects such as GIS database management for park utilities, assisting with project planning, and acting as additional spotters for issues on the ground during construction. Additionally, monitors are frequently tasked with assisting in law enforcement cases and any other situation in which their skill sets can be brought to bear. The future of paleontological monitoring at Badlands National Park will continue to see the integration of technology, expertise, and communication to ensure that all projects are completed successfully, and resources are handled with the care and respect the public expects of the National Park Service.

INTRODUCTION

The paleontological monitoring program at Badlands National Park (BADL) has changed drastically since its inception in 1994. Increased protections and more comprehensive and specific management policies for fossil resources at both the National Park Service and individual park levels have helped to create a more sympathetic ear for mitigation of damage to fossil resources. A list of federal authorities applicable to mitigation paleontology can be found in Foss (2014). The 2006 National Park Service (NPS) Management Policies document, under the heading "Paleontological Resources and their Contexts," mandates that all construction projects be preceded by a pre-construction survey in which significant fossils are searched for and, if found, are either removed and stored, or else the project is changed so that damage to them is avoided. This mandate also calls for a paleontological monitor to be onsite during construction projects to mitigate any unforeseen paleontological resource problems. At the park level, the General Management Plan for BADL's North Unit, completed in 2006, echoes the stipulations of the Management Policies document. On a national level, the Paleontological Resources Protection Act of 2009 directs NPS to manage and protect paleontological resources on federal lands using expertise and scientific principles. Monitoring of paleontological resources falls directly under this order and supports the goals of both the NPS Management Policies document and the General Management Plan for BADL.

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The paleontological monitoring program at BADL strives to protect and preserve the rich Eocene–Oligocene fossil history found within the park. In doing so, we have adopted strategies to improve efficacy and adaptability to the dynamic nature of mitigation and compliance in NPS, specifically as it applies to paleontological and geological resources.

Hurdles such as inadequate funding sources, lack of available staff, and timing of projects have been issues in the past. During the last 10 years the paleontological monitoring program at BADL has been working to create "added value" to the presence of a monitor on a construction site. Increased involvement in the National Environmental Policy Act (NEPA) and project planning phases of construction at the park level, utilization of ArcGIS to develop a geodatabase for utility systems at BADL, and acting as the contracting officer's representative (COR) on projects appropriate for the skillset of a paleontologist have provided more incentive for maintenance managers to place a higher value on monitors to the point of offering funding for them, rather than being asked for it. Nonetheless, hiring skilled paleontological monitors is the greatest challenge currently faced by the monitoring program. Prospective seasonal monitors not only have to possess at least an undergraduate degree in a relevant field but also need familiarity with common fossils of the White River Badlands and proficiency with GIS programs and other technology.

HISTORY OF PALEONTOLOGICAL MONITORING AT BADLANDS NATIONAL PARK

BADL's Paleontological Monitoring and Mitigation program was formalized in 1994 following the hiring of a park paleontologist. Before this, there were no permanent paleontological staff at the park. Prior to 2000, only large-scale construction projects included funding for monitoring and smaller projects were monitored when the park paleontologist was aware they were occurring. Often, excavations occurred without the knowledge of the park paleontologist and monitoring occurred after the fact. Expanded NEPA compliance, adopted in 2000, requires the Maintenance Division to communicate with the Resource Management Division on all planned in-house projects no matter their size. Today, the park paleontologist is a core member of BADL's NEPA team and provides oversight for construction work at Agate Fossil Beds National Monument and Scotts Bluff National Monument.

All projects that occur within BADL are reviewed and evaluated for their impact on paleontological resources, including projects large enough to require Environmental Assessments under NEPA and small enough to be evaluated as Categorical Exclusions. Until recently, the main weakness of BADL's NEPA process was the lack of extensive review for paleontological resources on the Environmental Screening Form (ESF). Paleontological resources can now be selected as a standalone resource on the ESF, adding weight to the importance of fossil resources within the NEPA process. The lead paleontological monitor stays in close communication with the Maintenance Division and the park's NEPA coordinator concerning the completion of the compliance requirements and the priority and timing of projects on the ground. Much of this work requires careful diplomacy with park management who may have no background in paleontology or comprehension of the significance of fossil resources.

The last 2–3 years have seen a culture shift at Badlands. New leadership in the Maintenance Division has given us the opportunity to erase old interdivisional barriers to cooperation. These barriers have been overcome through communication and mutual understanding of the roles the individual park divisions play in the compliance process. Members of the Maintenance Division have been consulting with the paleontology team before starting on a project. Often this will involve meeting at the location to walk through the proposed work, identify problems, and discuss potential solutions. This idea has also been carried through into the NEPA process with site visits by the entire NEPA team as well as park management to discuss projects while they are still in the planning stage. This level of attention to projects

helps alleviate problems such as those in the past in which projects proceeded without input from the Resource Management Division (Figure 1). This is a level of trust that has taken years to cultivate.

FIGURE 1. ABOVE A box culvert and associated drainage along Old Interior Road that was cleaned and shaped by the Maintenance Division in 2011. A system of box channels was created by subsequent precipitation. BELOW The same drainage system in 2023. The box channels are still present but erosion at the inlet of the culvert has abated, allowing vegetation to proliferate.

One of the biggest changes for the paleontological monitoring program was gaining a full-time monitor. The timing of many in-house and contracted projects has frequently occurred during the shoulder and off-seasons when no seasonal staff were available. The lack of a monitor during these times was problematic as it had the potential to stall work until one could be hired. The 2016 NPS Centennial Challenge created the need for a full-time paleontological monitor to be on-site during the entire three-year construction period of a large-scale project to replace more than 160 km (100 miles) of BADL's perimeter fencing. A temporary monitor position whose term was the duration of the project was created to handle this need. Due to the success of having a monitor on call, Resource Management staff and the park were able to push for a full-time, permanent paleontological monitor, hired in 2018, to meet future shoulder and off-season monitoring needs.

Nonetheless, funding for monitors remains a point of contention at times. Under BADL superintendent's orders, funding for construction projects must include the cost of paleontological monitoring, mitigation of damage to fossils, and pre-construction surveys. Over the years, there has been much tension between park divisions over such policies. The park paleontologist also has access to PMIS (NPS's project management system) information from other divisions so that she can comment on the dollar amounts requested and make sure enough funding is set aside for compliance before a project is approved. While funding for paleontological monitors is required, previous maintenance supervisors refused to see the value in paying for the monitor's down time on a project. This issue has abated in the last few years as maintenance managers have realized the added value of having a paleontological monitor on the job site. Funding for surveys prior to prescribed burns is also difficult to attain because of resistance from fire managers faced with shrinking fire budgets that they want to go toward fire crews rather than compliance as much as possible.

The timing of large-scale construction projects is often difficult to predict. Contractors often do not begin projects so that they coincide with the onboarding of seasonal monitoring staff. Larger projects, such as those overseen by the Federal Highway Administration (FHWA), are now contracted out to paleontology mitigation companies. There are numerous reasons why this is preferable to having the work be done by NPS paleontology staff. The management of day-to-day field and lab operations at BADL during the summer field season, coupled with the data intake for projects with multiple monitors working simultaneously over the course of several months, is difficult. Onboarding qualified staff is a faster process for outside mitigation companies than for NPS. This is especially relevant at the end of the summer season when NPS seasonal staff, who often are graduate students, return to their respective programs for the fall semester. Requirements for hiring a paleontological mitigation firm with the appropriately trained staff have been written into all contracting language and documents since 2018. These requirements echo those called for by Moses et al. (2014) and Murphey et al. (2014, 2019). This helps to ensure that the contractors will hire qualified paleontological monitors for the fieldwork along with a qualified principal investigator to manage the project and communicate with the prime contractor.

Pre-construction surveys can now be scheduled ahead of most projects to ensure that paleontological resources are not damaged during start-up and allow resource staff to plan and prioritize where and when paleontological monitors will be needed on a job site. Additionally, paleontological monitors attend pre-construction meetings with contractors, contracting officers and CORs to gain insight concerning timing, projected goals, and expectations of site supervisors and operators. Attendance at these meetings provides the paleontology team an opportunity to explain the purpose and process of resource monitoring and the processes involved if resources are discovered during construction. Often this will lead to discussions about providing a contractor's ground crew with basic resource training that provides a "buy-in" incentive to notify park staff when paleontological resources are encountered. The pre-construction meetings are also used to assure contractor staff that if resources are discovered

in a quantity too large for a single monitor to handle, the park can execute an "all hands-on deck" approach. This response allows the park to pull additional personnel into a project, ensuring that the contractor's work is not slowed or stopped by large, unexpected finds that may require excavation or additional resources to mitigate potential damage. Monitors onsite also act as additional spotters for utility lines and other hazards during construction work.

Paleontology staff at BADL have also been called upon to provide expertise during project planning by FHWA and NPS's Denver Service Center (DSC). BADL and DSC have worked cooperatively over the years to overcome the challenges presented by the dispersive soils found in the park. This process did not happen overnight and was a result of finding a sympathetic ear in DSC that welcomed the expertise brought to the table by in-house paleontologists. The last 10 years have seen the construction of two large-scale buttresses to preserve the integrity of State Highway 240 (the Badlands Loop Road) in the Cedar Pass Slide area. The paleontology staff were assigned numerous boots-on-the-ground tasks such as monitoring the disposition and propagation of roadway and curbing cracks and measuring and mapping fault structures in the Cedar Pass Slide area, in addition to assisting FHWA personnel with engineering solutions for major roadway failures. These data have been instrumental in planning for the future of the Badlands Loop Road as changing weather patterns and precipitation have remobilized the Cedar Pass Slide in the last five years.

All fossils salvaged during a project are taken to the fossil preparation lab, logged, and entered into an ICMS (Department of the Interior Collection Management System) spreadsheet for curation following preparation. GIS data are stored and added to existing databases. Currently databases exist for paleontological localities, which are secured by limiting access to the park geologist/paleontologist, the lead paleontological monitor, and the survey lead. The paleontological locality database was built in Microsoft Access in 2004 and has been updated every summer as new localities are discovered. This database is one of the most important and protected information sets managed by the paleontology program at BADL. There are also separate geodatabases for maintenance utility systems and the Cedar Pass cultural area. The maintenance geodatabase is new and built in ArcGIS Pro; while currently a work in progress, it consists of all known records of utility systems in the park. Before this geodatabase, all utility information records came from as-built construction blueprints and the memories of long-term maintenance division employees. The new database is built from data gathered by paleontological monitors with high-accuracy GPS devices, along with observations, field notes, photographs, and in situ measurements during construction. Smaller projects are completed in the same manner, except memos are sent to the park paleontologist for record-keeping and archived in the park's central files rather than a large monitoring report.

CURRENT MONITORING PRACTICES AT BADLANDS NATIONAL PARK

The monitoring program at BADL is built on communication. Communication is between the paleontological monitor(s) and the park paleontologist as well as between the monitor(s) and the Maintenance Division. A monitor is always present at the morning maintenance meeting so that Resource Management staff will have an idea on any given day what projects are occurring as well as what are planned. The monitors will then report any immediate or future monitoring needs to the park paleontologist. The monitors typically leave for the field with the maintenance crew and remain with them for the day or the duration of the project if necessary.

NPS does not have a specific set of regulations for paleontological monitors; however, BADL has always required at a minimum:

1. Bachelor's degree in geology or biology;
2. Completion of a minimum of two semesters of course work towards an advanced degree, including courses in vertebrate paleontology; and

3. A minimum of one year of field and/or museum experience working with vertebrate fossils and geology from the White River Badlands or equivalent.

All new seasonal paleontological monitors receive training in taxonomy, geology, and stratigraphy unique to BADL and the surrounding area. Additionally, they are trained in the use of Samsung tablets running ArcGIS Pro with Fieldmaps and the use of a Leica GG04 or Trimble R1 portable GPS receiver. Monitors are also instructed in acceptable field documentation of fossil resources and construction activities, proper use of field equipment, and personal safety on the job site. Field training is done onsite as projects occur to ensure that monitors are comfortable with all equipment, safety regulations, and documentation procedures. Because documentation is the most important aspect of the paleontological monitor's time on the job site, BADL has adopted strategies from the private sector in response to the changing scale of monitoring projects. The park will occasionally use a paleontological monitoring form for large projects requiring multiple monitors over a long period. These forms can be used to create a final report documenting all aspects of the project from a paleontological perspective. It should be noted that these forms are not substitutes for onsite notetaking. All monitors are expected to keep thorough notes in a field book daily. New monitors are also given the monitoring form to assist in collecting information during a project in their field notebooks. This serves the dual purpose of ensuring that notes are uniform among monitors and helps to focus the documentation to pertinent project information. Final reports include a sensitive resources map as well as an appendix with fossil information (field number, collector, UTM (Universal Transverse Mercator) coordinates, description, etc.). Finally, sensitive data can be expunged so reports can be viewed by personnel outside of BADL.

The final element of training is less tangible and involves instructing the monitor in learning to talk to and gain information from both park maintenance staff as well as contractors. This skill requires time, practice, experience, and the ability and willingness to look forward on a project and anticipate project needs and adjust to changing schedules. This aspect is often the most difficult to teach and the last lesson learned. Many seasonal employees do not have the training or experience to anticipate changes, a side effect of the nature of temporary employees often having no buy-in or connection to the projects they are working on. Additionally, monitoring is often thought of as the least glamourous paleontological job one can do in a park where there are active quarries, locality surveys, and fossil salvage operations occurring every day. Finding individuals who are willing to stand for long hours under extremes of hot and cold, precipitation, and wind is difficult.

The success of the current paleontological monitoring program has paid out in dividends beyond the mitigation of damage to fossils found during construction projects. Additional paleontological localities have been discovered during extensive monitoring projects that would not have been otherwise. The discovery of the Big Pig Dig (a find of *Archaeotherium* and other fossil species) in 1993 was a result of ditch grading on Conata Road during which no monitors were onsite. Luckily, park visitors reported the original exposure, a spinal column, to park staff and the site was not lost. The frequent construction work on the Cedar Pass Slide area has required pre-construction surveys of the areas adjacent to the roadway. These surveys have discovered two significant paleontological localities. The first, discovered in 2015 during construction of the second buttress on Cedar Pass, is located in an area that was later completely filled in by construction activities (Figure 2). The second lies adjacent to work done to create a new buttress near the top of Cedar Pass in order to support a failing road prism. Monitors also discovered and alerted park managers to the presence a large void filled with water uncovered by a bulldozer below the roadway on the same project. Had paleontological monitors not been onsite during this work, the void would have been ignored and covered by the contractor which could have led to further roadway damage or collapse (Figure 3).

▼ **FIGURE 2.** View of the cavern formed by water traveling outside an old steel culvert beneath the Badlands Loop Road.

▼▼ **FIGURE 3.** A paleontological monitor locating fossils directly adjacent to an active construction site.

A successful mitigation plan was enacted by the project engineer, park management, FHWA, and the contractor to fill the void correctly and avoid future problems. Monitors in this case were essential to keeping the contractors in compliance.

CONCLUSION

Mitigation paleontology in NPS, and specifically at BADL, is constantly evolving. Funding, lack of personnel, project timing, poor communication, and lack of support from other divisions have been challenging obstacles to overcome. In the last 20 years, the paleontology team at BADL has learned a number of lessons that may be valuable to colleagues in other parks:

- The chief lesson learned is that we must demand a seat at the table. Maintenance supervisors, contracting officers, contractors, operators and other non-resource management staff are not primarily concerned with paleontological resources and will not always remember to acknowledge them. Attending all pre-construction and construction planning meetings is paramount.
- Additionally, we must remember that we are subject-matter experts and shouldn't be afraid to express our concerns to maintenance managers, FHWA engineers, contracting officers, and park administration when it appears that solutions brought to the planning table are not feasible.
- We have created a subheading for all contracting office statements of work detailing the requirements of a qualified paleontological monitor. This can be used as standard contracting language for all projects going forward that would require an independent compliance and mitigation firm as a subcontractor.
- Paleontological resource managers must be prepared to provide a list of reputable consulting firms for the NPS contracting office to pass on to the contractor when a paleontological mitigation subcontractor is required.
- Communication and trust are key elements in the success of any monitoring program. This includes interactions at the paleontological monitor/operator level, all the way up to the park paleontologist/contracting office/contractor level.

Communication and cooperation are the keys to moving forward. The success of the paleontological monitoring program at BADL or anywhere in the National Park Service depends entirely on the ability of different divisions to work in tandem, bringing their respective expertise to the table.

Modern tools such as GPS/GIS systems and survey stations will continue to be integrated with traditional tools to prepare paleontological monitors for the continually changing demands in the field. Individuals seeking a career in paleontological monitoring will have to be proficient with both old and new technologies to meet the standards set forth by NPS as well as mitigation companies seeking to do work for NPS. The success of paleontological monitors, regardless of affiliation, will be determined by their ability to be flexible in the face of a dynamic work environment.

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