Breaking out of the fishbowl: Integrating paleontological resource management and public engagement while inspiring stewardship through an open-door fossil preparation lab at Badlands National Park

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ABSTRACT

Badlands National Park has been implementing an experimental "open door" concept to their fossil preparation lab, where visitors are allowed into the workspace to experience paleontological work behind the scenes. The combined effort of Resource Education and Resource Management divisions have addressed safety and security issues to optimize the maximum benefits towards resource stewardship as well as public education and enjoyment. These efforts have manifested through various interpretive opportunities combined with strategies towards visitor inclusion into the scientific realm, through encouraging citizen science. The efforts supporting the "open door" lab concept has provided significant, measurable impacts towards inspiring public engagement and stewardship. Since the lab's opening, there has been a 400% increase in Visitor Site Reports, the parks fossil reporting citizen science program. The past decade of having an "open door" lab has led to the revelation that if the park ever changed their lab setting to the classic "fish-bowl" lab, seen in several museums, the significant gains that have been made would be lost. Paleontology prep labs that facilitate wider public engagement can be a major boon towards resource management strategies for paleontological resources.

INTRODUCTION

The Big Badlands of South Dakota is arguably the birthplace of paleontology in western North America, with previous notable discoveries concentrated in areas east of the Mississippi River. Since the first reported discoveries in the 1840s, there have been hundreds of thousands of specimens collected from the Badlands area that are housed in museums all over the world, accompanied by 175 years of study. Badlands National Park (BADL) continues to foster paleontological discovery today through projects focused on field surveys, quarry excavations, monitoring, mitigating ground disturbance activities, and managing a citizen science program. Fossils collected through these endeavors require preparation and conservation so they can be utilized for scientific study, education, and/or display. Previously, fossil preparation at BADL was rarely done on-site. No permanently dedicated lab space existed, so all equipment was staged in a storage room, when needed, where limited space was available.

A major quarry operation next door to the Ben Reifel Visitor Center in 2012 changed everything. Field work focused on a site that had recently produced an exceptional specimen of the saber-toothed nimravid *Hoplophoneus primaevus*. Due to this sudden influx of fossils in need of preparation, the paleontology program of the BADL Resource Management

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Division teamed up with the Resource Education Division to refurbish an under-utilized classroom space in the visitor center into a fossil preparation laboratory. Natural history museums across the country incorporate fossil preparation labs into their exhibit space, making the lab part of the exhibits, something a visitor looks in on through a glass window (Figure 1). These "fishbowl" labs invite visitors to observe fossil preparation work, with some limited potential for interaction and engagement with lab staff, if available. However, when first establishing the fossil preparation lab at BADL, staff members went well beyond the fishbowl and applied a novel approach to create a lab where visitors are allowed to enter the workspace, view each working project up-close, and interact with park scientists with ease (Figure 2). Interpretive park rangers also frequently staff the lab to facilitate visitor engagement and, if needed, buffer conversations so lab staff can focus on their work. At the Badlands Fossil Preparation Lab, visitors are no longer spectators separated from the action by walls and windows, gazing into a fishbowl, but instead are welcome guests in a fully immersive professional workspace designed with the explicit intent to be an interpretive keystone to the park experience. This behind-the-scenes take on fossil preparation has created both challenges and opportunities for park staff as they continually test and improve upon this unique concept.

ADDRESSING HEALTH, SAFETY, AND SECURITY

Ensuring staff and visitor health and safety was the primary concern in this experimental venture. Though not nearly as hazardous as a typical chemistry lab, fossil preparation labs still pose some risks in that they are typically noisy and dusty, with an open floor plan. To mitigate the health and safety issues that come with working in a fossil preparation lab, these spaces require proper use of personal protective equipment (PPE), and only workers wearing appropriate PPE are allowed

FIGURE 1. A view of the public fossil preparation lab at the Carnegie Museum of Natural History. This photo was taken on a weekend in October. There were numerous visitors in the museum that day, but little attention was being given to the unstaffed lab.

FIGURE 2. A view of the BADL fossil preparation lab with visitors. This photo was taken in September, when visitation has significantly slowed compared with the height of the summer season.

into the lab. In setting up an "open-door" lab space, BADL staff needed to find a way to partition the wide-open workspace into smaller, individually contained workspaces to allow hundreds to thousands of people into the area over the summer season without the need for every visitor to gear up in PPE. The solution came in the form of specially fabricated, enclosed plexiglass work chambers that allow close viewing of ongoing fossil preparation while controlling dust. To protect lab workers and the public, a large vacuum filter unit was installed in work chambers to remove dust. Though some chemicals are used in conservation efforts, none produce fumes that are any more harmful than fingernail polish remover (acetone). Any chemicals used, mainly acetone- and alcohol-based glues, are kept inside the well-ventilated work chambers and then stored inside a sealed fire cabinet when not in use. To muffle potentially high noise levels from pneumatic tools, a virtually noiseless air compressor also was installed. This, in combination with the isolated work chambers, has proven to be more than enough to keep noise at an appropriate decibel level. Geiger counters have also been used to test specimens for radioactivity, and—so far—no specimen in the lab has even come close to the threshold of dangerous levels of radiation.

Being a separate, lockable room, the visitor-center-classroom-turned-fossil-preparation-lab is also conveniently set up for ensuring specimen security. Inside the room, a locking specimen cabinet was installed to add an additional level of security for securing specimens currently being worked on as well as those retrieved from the field. In recent years, several locking specimen display cases have been installed to exhibit prepped specimens and other specimens of interest, both ensuring security and significantly adding to the educational and interpretive opportunities provided by the lab. In its 11 years of operation, the Badlands Fossil Preparation Lab has never had an incident where fossil security was compromised.

INTERPRETIVE OPPORTUNITIES

Park interpreters have taken advantage of a smorgasbord of educational opportunities in the lab to enhance the visitor experience. Armed with the knowledge that an increased understanding of or connection to a resource inspires people to work to protect it, BADL interpretive staff have implemented a variety of strategies and techniques to engage visitors and facilitate a deeper understanding of the resource. Tangible objects are frequently used for hands-on learning: they can help to demonstrate comparative anatomy, allow visitors to visualize what specimens in the process of preparation will look like when fully prepared, and provide opportunities for visitors to actually touch or handle specimens. Park interpreters utilize replicas as well as specimens that have no collateral field data, provided by the paleontology program. For example, some replicas of lab or museum specimens exhibit pathologies that can be demonstrated through storytelling and demonstration. Real specimens that visitors can access also enrich the visitor experience, deepening connections with the resource. Some interpreters have used ultraviolet (UV) flashlights to demonstrate fossil fluorescence to facilitate dialogue on the fossilization process.

One of the park's interpreters created a Visitor Site Report (VSR) Wall of Fame (Figure 3). This wall showcases visitors who have "done the right thing" by reporting fossils to park staff rather than collecting them. Visitors

who turn in a VSR have the option to sign a photo waiver and have their photo added to the wall. They can also share a photo of the fossil for the wall to give other visitors a sense of what their predecessors have seen in the field, like scenting fossil bloodhounds. This concept has expanded to showcase lab specimens that were discovered through the VSR program. Specimens are actively advertised as VSR discoveries while being prepared, and prepared specimens on display have a gold star attached to their specimen tags if they were recovered through a VSR. This helps the audience to become the center of engagement, demonstrating their value in participating in citizen science. This transforms visitors from audience members into active participants in a resource management program. This is also a major factor into the significant increase of VSRs since the lab's opening in 2012. From 1995 to 2012, the VSR program averaged 65 reports per year, with only 2011 and 2012 receiving more than 100 VSRs. From 2012 to 2023, the VSR program averaged 261 reports per year, or a 400% increase. It should also be noted that the lab was not open during the 2020 pandemic, and only 60 VSRs were received that year, bringing down the past decade's average. These numbers coincide with lab visitation. The lab has steadily climbed from 40,522 visitors in 2012 to 87,756 visitors in 2023.

FIGURE 3. The Visitor Site Report Wall of Fame.

Another important aspect of the open-door lab includes discoveries that are not made behind closed doors. Specimens that might provide new information on the area's natural history are revealed in open view of the public. Resource experts can make identifications of, realizations about, and revelations into a specimen's significance in real time, often including visitors into the discussion. Visitors are actively learning about the resource with resource experts rather than through passive interpretive media, such as exhibit signage, rehearsed ranger programs, social media, and other media.

Visitors frequently express their appreciation for having the lab open to visitors. Lab staff and interpreters collaborated to create a visitor comment wall. Visitors have access to pens and sticky notes they can use to express themselves with comments, drawings, or other artistic expressions. They can leave their mark to exhibit that the scientific space is also their space. Visitors have also expressed that other labs are viewable, but not as impressive as a lab that allows them inside. Science communication has always struggled with public perception due to the appearance of "ivory tower" exclusivity or elitism. The open-door concept of the Badlands Fossil Preparation Lab, along with the previously mentioned interpretive strategies, creates an aura of welcoming inclusion. All of this fosters a cooperative partnership among park educators, resource managers, and the public.

BOONS TO RESOURCE MANAGEMENT

Significant benefits have been gained from the open-door lab concept, thanks to the combined enthusiasm of park scientists, interpreters, and an engaged public. The most impactful benefit was the increase in reported fossils by visitors through the VSR program. Prior to the lab's opening in 2012, the paleontology program received approximately 50–80 VSRs per year. The year the lab opened, the number increased to around 300, and have remained at a level of 200–400 VSRs per year. The increase in VSRs also increases the odds of discovering significant fossils that help fill knowledge gaps within the local fossil record. Numerous discoveries have confirmed taxa that had never been documented in the park, stratigraphic and biochronologic range extensions or clarifications, as well as rare or unique taxa (see Welsh 2014).

Visitors certainly made significant discoveries prior to the lab's opening. However, the frequency of such discoveries has increased dramatically within the past decade. Numerous examples of visitor contributions to the science can be documented. A college student from Missouri discovered a rare specimen of hesperocyonine dog, *Osbornodon renjiei*, which is one of eight known specimens as well as the oldest occurrence of the genus (Welsh 2014). A mother

and son duo discovered a tiny jaw belonging to the rare feliform carnivoran *Palaeogale*, which only five specimens have been cited from White River badlands deposits in South Dakota (see Welsh 2021). Two separate VSRs helped narrow stratigraphic ranges for faunal overturn between two peccary species, *Perchoerus nanus* (older) and *P. probus* (younger). Students from the United Kingdom on a field trip discovered the first known anthracothere skull from the North Unit of the park, where all previous specimens in good condition are nearly exclusive to the more distant Palmer Creek Unit. A Geologists-in-Parks intern reported a small, hornless deer (Leptomerycidae) skull that is currently being described as a new genus (Shreero et al., in prep.). Finally, every one of these discoveries has been through the Badlands Fossil Preparation Lab, with discussions and revelations shared in real time with visitors.

However, one outcome that is not beneficial is the increase in visitors bringing specimens to the Visitor Center. Non-permitted collection of fossils is strongly discouraged by park staff, so the increase points to a need for more effective communication of the message that fossils should be left in place. However, there are instances where visitors have retrieved fossils, regardless of being instructed on not removing fossils from their site. This suggests that the message is heard but not necessarily heeded by some. The sudden increase of visitor-collected specimens also suggests the potential level of inadvertent theft of fossils by non-cognizant visitors prior to 2012. Before the opening of the lab, those fossils most likely ended up as souvenirs. The immersive lab experience demonstrates the active attention and care given to fossil resources by the park, as well as the interest in visitor discoveries. A passive exhibit would likely not have such an impact.

The paleontology program has also made massive efforts to make field work more accessible through the lab. Field crews are utilizing satellite internet and a webcam feed to broadcast active field work on a large screen in the lab. Visitors are able to interact with field paleontologists, asking questions or giving comments (Figure 4). Altogether, visitors can have an interactive experience from field, to lab, to display and study.

TAKEAWAYS

This new paradigm of active science and public inclusion has proven to be so beneficial that there are no plans to revert to older, more conventional methods of operating a public paleontology preparation lab. We do not aim to understate the importance of exhibits or denigrate how other paleontology labs are integrated into exhibits with various levels of public interaction in a fishbowl setting. Yet we have not seen a demonstration of other labs inspiring such a large volume of impactful citizen scientists. There are some takeaways from BADL's open-door lab concept that are too substantial to dismiss. Increased invitation to and immersion in a scientific workspace may be a strategy to combat a suddenly increasing animosity towards science among some quarters of the public. Creating a welcoming, educational atmosphere will encourage public stewardship of paleontological resources, participation in the science, and advocacy of paleontology and support of scientists in general.

If BADL ever returned to a "fishbowl" lab setting, there would be significant diminishment in stewardship with measurable, negative impacts. In the 2023 summer season, the fossil lab at Badlands had more than 87,000 visitors. Having the room separated from the public by a wall would deflect visitors away from lab space, reducing interaction. The chain reaction from visitor loss would also be a major blow against the park's citizen science VSR program. There would also be negative impacts on inspired visitor stewardship through the loss of multipath interaction with park resource experts and educators. We feel that the Badlands Fossil Preparation Lab has been a profound success that should encourage other parks and institutions to emulate or find similarly creative ways to engage professionals and non-professionals that share a resource interest. To everyone, we invite you to visit us at the Badlands Fossil Preparation Lab and be part of the science with us.

FIGURE 4. Visitors interacting with the field work livestream in the lab.

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