Monitoring Long Term Trends of Paleontological Site Condition Assessment at Florissant Fossil Beds National Monument, Colorado

MIRANDA, Ariana[1,2] and **MEYER, Herbert W.[1]**

[1]National Park Service, Florissant Fossil Beds National Monument; P.O. Box 185, Florissant, CO 80816; [2]Environment for the Americas, 5171 Eldorado Springs Drive, Suite N, Boulder, CO 80303

Background

The Paleontological Inventory and Monitoring (I&M) project was started in 1992 with 55 sites that were documented using black and white photographs. Photopoints defined specific positions and directions to ensure consistency in documenting disturbances. Since 1992, the number of paleontological sites has grown to 77 and the project has received multiple revisions over the years. Paleontological sites were assigned a monitoring cycle (1 to 10 years) in 1998 in which they would be monitored based on their visibility, how fossiliferous they were, and their fragility. In 2004, quantified scoring criteria were developed to document site conditions. In 2005, the I&M database was updated to Microsoft Access™ from Idealist. These criteria scored disturbance, fragility, fossil abundance, actual loss and site access. In 2008, the I&M project was standardized into a procedure to monitor all paleontological sites on a cyclical basis. The evaluation sheet was expanded to have more scoring options for each criterion and better spatial orientations for baseline photographs to prevent photo migration. Paleontological site locations and their respective photopoints were established and stored in a Garmin GPS 60CSx unit. Paleontological site data were gathered along with the baseline photos to create manuals of the complied information. This is the first study to examine the data collected over 24 years to identify long term trends of condition of paleontological sites at Florissant Fossil Beds National Monument and factors that can affect site condition.

Methods

- 13 years of compiled I&M site evaluation scores were examined for their relation to:
  1. Illegal collecting
  2. Summer precipitation (Jun-Aug)
  3. Animal disturbance
  4. Variations of resolution of scoring criteria
  5. Research excavation/disturbance
- Evaluation of:
  1. Climate data
  2. Estimates of deer population
  3. Elk migration patterns
  4. Records of illegal collecting
- Comparison of baseline photos, starting in 1992/94 to 2016, analyzed for differences in erosion and disturbance patterns

Site 34 being excavated in Jun 2015

Site 40A had illegal collecting in Oct 2015

Burrowing activity at Site 32 in June 2016

Baseline Photo Comparisons

Site 1, 5-30-1998

Site 1, 7-1-2016

Site 17, 6-9-1994

Site 17, 6-20-2016

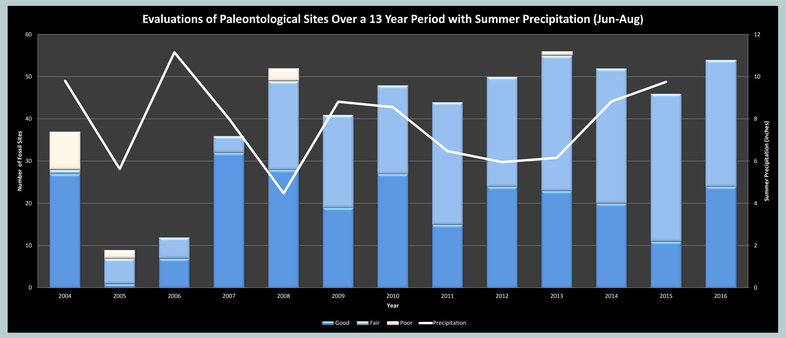


Figure 1: The white line represents the summer (Jun-Aug) precipitation (in.) for the 13 year period. Each bar shows the amount of paleontological sites evaluated for a particular year and within every bar, each has the amount of sites evaluated for good (>90), fair (50-89) or poor (50<). Paleontological sites with summers of heavy rain had an increase in the number of fair sites and decrease in the number of good sites. The number of poor sites from year to year was negligible.

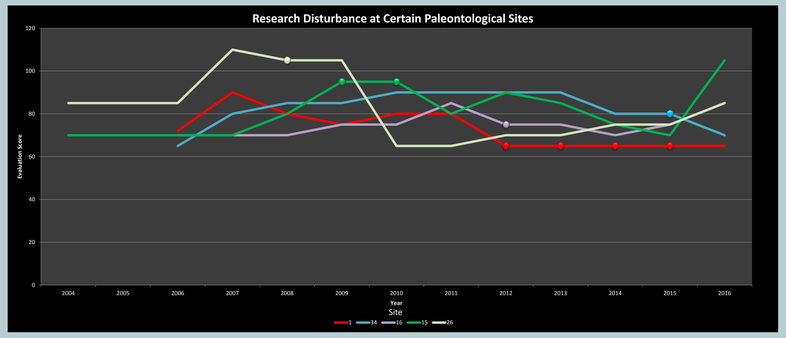


Figure 2: Each line represents a paleontological site's evaluation score for every year during a 13 year period. All of the sites displayed have had frequent excavation and/or ongoing research in the past 13 years. Circles are years of a documented excavation or research activity at that site. Paleontological sites with excavation and research disturbance have a decrease in the evaluation scores or remain static for the following 1 to 3 years before improving again.

Results

- Precipitation had the largest effect on site conditions. During years of heavy summer precipitation, the proportion of paleontological sites evaluated as fair (50-89) increased and the proportion of good sites (>90) decreased. Years of heavy summer rainfall decreased the criteria scores of actual loss and disturbance as well.
- Illegal collecting was shown to impact site condition with a decrease or static overall evaluation score for the following 2 to 3 years. Research disturbance showed similar trends but varied from 1 to 3 years of decrease or staticity.
- Revisions of site condition scoring criteria did not have an effect on annual evaluation scores. Average evaluation scores maintained consistency with an average annual score of 84.5.
- Animal disturbance showed inconclusive results. Neither annual deer populations nor burrowing behavior affected site condition. Elk migration patterns did show that elk pass through the western side of the Monument, likely affecting site condition.
- Comparisons of '92-'94 photos to the most recent photos showed that the majority of paleontological sites remained mostly unchanged in the 24 year period. Paleontological sites of petrified stumps showed the least change due to their resistance to weathering. Shale outcrops, especially those that were situated in gullies, excavated, or subject to heavy rainfall, suffered the highest rates of erosion. Site 1 had severe erosion and weathering of shale over time because of past excavations. Others, such as site 17, had drastic changes to the locality due to construction and excavations.

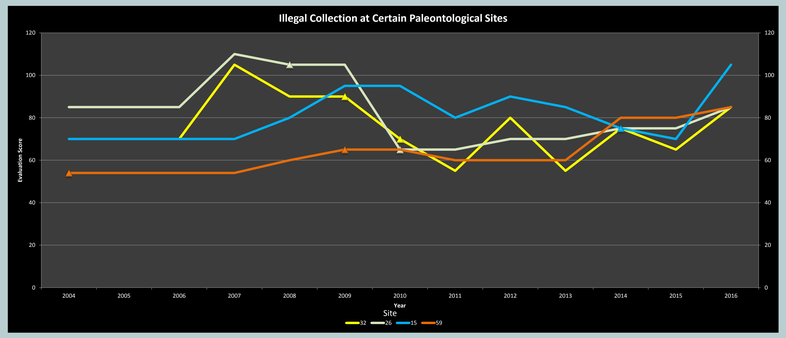
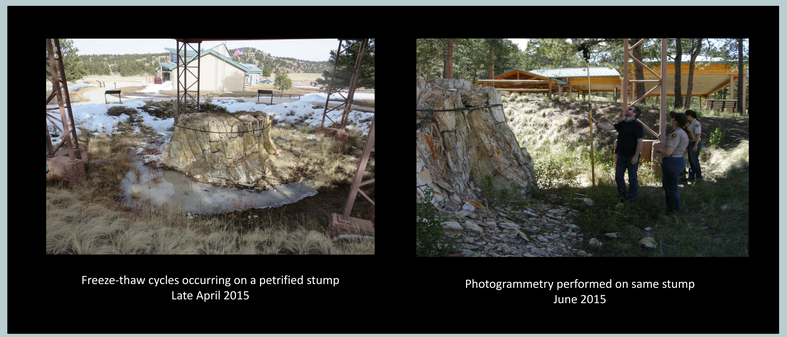


Figure 3: Each line represents a paleontological site's evaluation score for each year in a 13 year period. All of the sites displayed have had documented or suspected illegal collection in that period. Triangles represented years of documented or suspected illegal collection at that particular site. Paleontological sites with illegal collection have a decrease in the evaluation scores or remain static for the following 2 to 3 years before improving again.



Freeze-thaw cycles occurring on a petrified stump
Late April 2015

Photogrammetry performed on same stump
June 2015

Discussion

The factors most affecting site condition were precipitation, theft, and research disturbance. There is little to be done to mitigate precipitation, but frequent collection of float fossils at sensitive shale sites could be effective in preventing the loss of specimens to erosion. To mitigate theft, more frequent patrols must take place at the Monument, especially on popular trails. Law enforcement should coordinate better with paleontology staff to focus on paleontological sites that suffer the highest theft and sites that are located in the backcountry. Soil nets could be used as a way to mitigate shale erosion from site excavations.

Photogrammetry has produced promising results as a technique to document changes of paleontological sites. The Monument has already developed 3-D models of 2 petrified stumps which has enabled the paleontology staff to identify strategies to prevent theft and preserve the petrified stumps. This is very effective for the petrified stumps as they can be heavily affected by freeze-thaw cycles in the spring and are subject to illegal collecting.

The comparisons of the photos over 24 years revealed that many paleontological sites probably do not need to be monitored as frequently and their monitoring cycles should be changed to longer cycles (i.e. 2yr to 3yr). Four sites have been deactivated because they do not produce fossils and are not visible to the public. The I&M project should have certain paleontological sites, particularly the most publically visible stumps, monitored more than once a year to assess when the most damage occurs during the calendar year.

Acknowledgements

Photographs taken in 2015 were taken by Emily Thorpe and Kelly Hattori. Eleven Mile Elk Study 1997 Final Report by Scott Roush. Inventorying and Monitoring in 2016 was done in conjunction with Gwen Antell and Carolyn Thornton. Many thanks to the other 50 interns that have worked on I&M during the past 20 years at FLFO. Information and materials provided by Conni O'Connor. Funding provided by Environment for the Americas and Mosaics in Science internship program for the National Park Service.