



Grand Canyon National Park

2019 Paleontology Project After Action Report

Natural Resource Report NPS/GRCA/NRR—2020/2054



ON THE COVER

Top left: A trackway of eight prints preserved in a slab of Coconino Sandstone rests on the edge of the Grand Canyon (NPS/DIANA BOUDREAU).

Top right: A Park Ranger and a young visitor stand behind a table of fossils at National Fossil Day Celebration at Grand Canyon National Park (NPS/ERIN EICHENBURG).

Center: 2019 National Fossil Day logo featuring Grand Canyon National Park cave paleontology (NPS).

Bottom: Two paleontology Geoscientists-in-the-Parks interns document a vertebrate trackway along the Bright Angel Trail (NPS/JACK WOOD).

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Diana M. Boudreau¹

¹National Park Service
Grand Canyon National Park
Science and Resource Management
17 S Entrance Road Box #129
Grand Canyon, AZ 86023-0129

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Summary

The 2019 Paleontology Project reflects a pivotal time in the development of a paleontology program at Grand Canyon National Park. Each component of the 2019 project aided in creating a baseline for paleontological resources that will allow future resource managers to better preserve, manage, and provide outreach materials for paleontological resources at GRCA. The 2019 Paleontology Project team was able to accomplish many things during the 2019 Paleontology Project (Appendix A) including the compilation of the largest Paleontological Resources Inventory Report to date, conducting the second ever NPS PaleoBlitz event, and coordinating the National Fossil Day 10th anniversary celebration. These accomplishments were achieved due to the strong collaboration between team members, regular communication via phone calls and emails, foresight and planning to account for potential roadblocks, and positive affirmations for completed components. Having a central team dedicated to supporting the paleontology project was a crucial part of the success of the 2019 Paleontology Project.

The work completed this year also highlighted the extensive nature of paleontological resources at GRCA. Each PaleoBlitz survey revealed new paleontological resources, sites, and localities. The wealth of information reported during these focused, short one- or two-day surveys indicates that conducting additional focused surveys for longer periods of time will produce many new paleontological resources. With the recent finalization of the Paleontology Programmatic Categorical Exclusion, GRCA staff are able to continue surveying for and preserving the park's paleontological resources.

The 2019 Paleontology Project at GRCA has also left a lasting impression on the interpretation, education, and outreach staff. Members of the staff continue to promote the Junior Paleontology Program, hand out fossil trading card sets, and incorporate paleontology resource information into ranger programs long after the National Fossil Day Celebration. Paleontology will be further promoted through a new Xanterra project. In 2019, the Maswick South Lodges were demolished to prepare for the construction of new lodges. Xanterra staff and members of the PSET team voted to name each lodge for four types of fossils: Trilobite (invertebrates), Shasta (vertebrates, for Shasta ground sloth), Fern (plants), and Burrow (trackways). In addition, Xanterra staff plan to incorporate interpretive elements into the design and landscaping of these new lodges.

From the tiniest trilobites in the Bright Angel Shale to the *Megactenopetalus* shark teeth of the Kaibab Limestone, fossils of Grand Canyon National Park capture the imagination of visitors and scientists alike. The projects developed and executed during 2019 are just the beginning for the next 100+ years of paleontological exploration and discovery at Grand Canyon National Park.

Dedication

We dedicate this report to NPS Senior Paleontologist and Paleontology Program Coordinator, Vincent Santucci. Over the past 34 years, Vince has dedicated his time and efforts to supporting geology and paleontology projects at over 200 national park areas such as Badlands National Park, Petrified Forest National Park, Grand Canyon National Park, Yellowstone National Park, Fossil Butte National Monument, and Tule Springs Fossil Beds National Monument. His tireless commitment to protecting, preserving, and educating the public about fossil resources has led to a well-established and robust NPS paleontology program. His passion for fossil resources at NPS units, such as Grand Canyon National Park, has led to the creation of invaluable interpretive programs, such as the Junior Paleontologist Program and National Fossil Day (established in 2009), and provided federal protection of fossil resources through the signing of the Paleontological Resources Preservation Act in 2009. Vince has also mentored numerous individuals across the NPS and partner agencies. The completion of the 2019 Paleontology Project at Grand Canyon National Park is a dream fulfilled from Vince's early days as a Paleontologist at Petrified Forest National Park. It was his vision and guidance throughout each phase of this project that ensured the success of the first comprehensive paleontological inventory report for Grand Canyon National Park, the large celebration of National Fossil Day at the park, and the continued paleontological exploration within the marvelous cliffs of the Grand Canyon.



Background

During 2019, Grand Canyon National Park (GRCA) celebrated its 100th anniversary as a national park, in addition to National Fossil Day celebrating its 10th anniversary. The juxtaposition of these two events provided the perfect opportunity to coordinate a park-focused paleontological resource project at Grand Canyon National Park. Therefore, the NPS Paleontology Program (Vincent Santucci) initiated communication with GRCA staff (Jeanne Calhoun) in early 2018 proposing the development of a park specific paleontological resource inventory for GRCA in conjunction with the park's centennial. The proposed paleontology project was composed of three elements: the publication of a comprehensive paleontological resources inventory report, execution of the second ever NPS PaleoBlitz, and a celebration of National Fossil Day during a special event at Grand Canyon National Park. Since that initial communication in 2018, WASO and GRCA staff have launched the paleontology program at GRCA into a new era of managing fossil resources.

The work completed in 2019 built on the past 130 years of previous work at GRCA. Earlier work has documented extensive paleontological resources at GRCA and includes the work of multiple interns and researchers over the past decade. In addition, the NPS Senior Paleontologist, Vincent Santucci, began compiling GRCA paleontological information and archives in 1991, during his tenure as the Paleontologist at Petrified Forest National Park. During 1994, Santucci worked for GRCA, developing the last Integrated Resource Management Plan for the park, and obtained substantial paleontological resource information through this process. Over the course of 27 years, Santucci has compiled an archive of scientific publications, resource management information, photographs, and maps related to GRCA paleontology. This archive set the stage for continued paleontology work at GRCA.

In 2019, a team of paleontologists, based in the GRCA and WASO offices, was assembled to manage this large paleontology project. The core paleontology team included Vincent Santucci (GRD), Justin Tweet (GRD), Mark Nebel (GRCA), Anne Miller (GRCA/NAU), Ronda Newton (GRCA), Diana Boudreau (GRCA/GIP/ACE), and Klara Widrig (GRCA/GIP). Other important members of the core team included Interpretive Park Ranger, Ronnie Colvin (GRCA), John-Paul Hodnett (National Fossil Day Coordinator), and GRCA Museum Specialists, Kim Besom and Colleen Hyde. These individuals served as key players in various aspects of the 2019 Paleontology Project including reviewing paleontological resources inventory report chapters, collecting data and/or specimens during PaleoBlitz surveys, and coordinating the National Fossil Day Celebration. The early establishment of this team and frequent communication ensured each aspect of the project ran smoothly and efficiently.

Due to the federal government shutdown during December 2018 and January 2019, scheduling for all aspects of the GRCA paleontology project were impacted, primarily the PaleoBlitz activities. Initially scheduled to occur during the spring of 2019, PaleoBlitz events were shifted to occur during late September 2019 instead. This shift coincided with the annual Geological Society of America Meeting held September 22–25, 2019 in Phoenix, Arizona, which allowed GSA participants to easily attend National Fossil Day and PaleoBlitz events at Grand Canyon. Additionally, the start date for

the two paleontology interns was delayed by two weeks. Despite these setbacks, the effective communication and flexibility of the core paleontology team allowed for a seamless transition to the updated schedule.

Paleontological Resources Inventory Report

An inventory of paleontological resources is one of the most fundamental resource management activities that can be undertaken by a park. Baseline paleontological resource inventories help identify the scope, significance, distribution, and resource management issues associated with fossil resources. The information gained through the inventory of park fossils enables park management to incorporate this information into park planning, programming, and decision-making.

Paleontological resource inventories are specifically identified in Section 6302 of the Paleontological Resources Preservation Act of 2009 (16 USC 470aaa–1) and in NPS policy. The NPS Paleontology Program provides assistance to parks, including GRCA, by documenting and preserving paleontological resource information in the NPS Paleontology Archives and Library.

Unlike paleontological resources inventory reports for other park units, which are usually stand-alone documents geared towards science and resource management use, Grand Canyon National Park's Paleontological Resources Inventory Report will be published as a monograph composed of 11 focused chapters for a wide audience. Selection of lead authors for each chapter was an evolving process that varied from chapter to chapter. A pilot chapter on Precambrian paleontology was completed first by Justin Tweet to set a standard for the formatting and content of future chapters. The Precambrian paleontology chapter was provided to each lead author to aid in chapter development and organization. Authors were selected for each chapter by the NPS Paleontology Program based on author's paleontological specialty and availability to undertake the project. Communication between the authors and the GRCA Paleontology Team was continuous during the drafting, editing, and reviewing process. The core team provided support for each contributing author by obtaining journal articles, photographing specimens, and providing an internal team review. Involvement by the GRCA Paleontology Team ensured contributing authors felt supported during the writing process and guaranteed consistency in formatting between chapters.

The final Paleontological Resources Inventory Report will be published in three versions. Two versions, sensitive and non-sensitive, will be submitted as a Natural Resources Report and will be posted on the Integrated Resource Management Applications (IRMA) Portal. The sensitive version will be maintained as restricted access, since it will contain locality information available to paleontology resource managers at GRCA and WASO. The non-sensitive version will have locality information redacted and be used by other members of the NPS staff, such as Law Enforcement, Interpretation, or Education staff. The non-sensitive version will also be submitted to the open access journal, *Geology of the Intermountain West*, published by the Utah Geological Association. This version is intended for the general public interested in paleontological resources at Grand Canyon National Park. Expected publication date is early 2020.

Peer Review Process

Each chapter submitted for inclusion in the Paleontological Resources Inventory Report was first reviewed by the internal team (Vincent Santucci, Justin Tweet, Anne Miller, Diana Boudreau, and Klara Widrig). Once the first draft was revised based on comments from the internal review, the

chapter was submitted to two external peer reviewers. Each external peer review process was coordinated by the Peer Review Manager, Don Weeks (NPS Intermountain Region).

Report Outline and Contributing Authors

Report authors

Topic	Author(s)
History of Paleontology	Earle Spamer
Stratigraphy of GRCA	Tim Connors, Justin Tweet, & Vincent Santucci
Precambrian Paleontology	Justin Tweet
Paleozoic Invertebrate Paleontology	Linda Lassiter, Justin Tweet, Fred Sundberg, John Foster, & P. J. Bergman
Paleozoic Invertebrate Ichnology	Anne Miller, Lorenzo Marchetti, Heitor Francischini, & Spencer Lucas
Paleozoic Vertebrate Paleontology	John-Paul Hodnett & David Elliot
Paleozoic Vertebrate Ichnology	Lorenzo Marchetti, Heitor Francischini, Spencer Lucas, Sebastian Voigt, Adrian Hunt, & Vincent Santucci
Paleozoic Paleobotany	Cassi Knight
Mesozoic Paleontology	Adam Marsh, Bill Parker, & Anne Miller
Pleistocene/Holocene Cave Paleontology	Jim Mead, Justin Tweet, Vincent Santucci, Benjamin Tobin, Carol Chambers, Shawn Thomas, & Mary Carpenter
Paleontological Resource Management	Diana Boudreau, Vincent Santucci, Klara Widrig, Mark Nebel, Anne Miller, Veronica Colvin, Kim Besom, & Colleen Hyde

Inventory Report Outcomes

Paleontologists and naturalists have been studying the unique fossils of GRCA for more than a century. However, this Paleontological Resources Inventory Report represents the most comprehensive paleontology-focused literature review and museum collection assessment conducted for the park. As a result of compiling this report, many of the authors reported the following important new discoveries and impactful outcomes.

History of Paleontology

Earle Spammer updated the GRCA paleontology bibliography online in preparation for National Fossil Day (October 16, 2019). Updates will continuously occur to this bibliography in the future. <https://ravensperch.org/bibliography-of-paleontology-of-the-grand-canyon-region/>.

Precambrian Paleontology

While working in the GRCA museum collections, Justin Tweet relocated pieces of Dox Formation slabs that Park Naturalist Edwin D. McKee had included in an article in the park's Nature Notes publications from the 1930s, and decided to stage a similar photo including a scale, which McKee had not included. While doing this, Tweet discovered that one of the slabs had been broken, and one of the broken pieces had subsequently been given a catalog number which identified it as a Hakatai Shale specimen collected in 1959, by Raymond Alf, nearly 30 years after the photograph had been

taken. Colleen Hyde, GRCA Museum Specialist, found documentation that indicated someone had later mistakenly appropriated the number of the Alf specimen for the broken McKee specimen. Specimen dimensions had been crossed out and replaced with much larger dimensions corresponding to the broken specimen. Colleen Hyde is currently working to determine exactly what happened. At the same time, Spencer Lucas, who was visiting on the day Tweet was recreating McKee's photograph, took an interest in the specimens as including potential microbially induced sedimentary structures, and encouraged further investigation and publication. While they were taking additional detailed photographs, Lucas discovered that McKee's two specimens were actually part and counterpart, and that a third previously unphotographed specimen was actually another piece of one of the photographed specimens.

Paleozoic Invertebrate Paleontology

While working in the collections of the Museum of Northern Arizona (MNA), Justin Tweet came across old thin sections of bryozoans from the Kaibab Formation at GRCA. Janet Gillette, MNA Natural Science Collections Manager, found accession information in which Edwin McKee recalled, in 1984, that they had been prepared by a Laurence Goebel of the University of Kansas (KU) in the late 1930s. However, KU had informed MNA that they had no record of a student with that name being matriculated at the university during that time frame. Tweet's suspicion was that the student either did not graduate or complete the project (perhaps due to service in World War II, on the horizon in the late 1930s), or that the name or institution was incorrect. When Tweet was working in the GRCA collections, he found that this mystery person was also responsible for the collection of some of the specimens there. Colleen Hyde, GRCA Museum Specialist, provided accessions information which established the student's name as Lawrence Goebels, who had attended the University of Colorado-Boulder. The bryozoans, some of which were denoted as new species, were indeed not published, although there was some interest on the part of John Chronic of CU-Boulder in the late 1960s. Unfortunately, given the deterioration of the slides, further work may not be feasible. It is not entirely clear how the bryozoans ended up at MNA, but from correspondence between Chronic and GRCA (which mentions uncatalogued bryozoans) and correspondence between MNA and McKee, it's possible they were accidentally repositied at MNA instead of at GRCA.

Paleozoic Vertebrate Paleontology

A missing GRCA specimen of fossil fish *Deltodus mercurii* was relocated by John-Paul Hodnett during research for the GRCA Paleozoic Vertebrate Fossil chapter. The specimen was originally discovered by Edwin D. McKee in the 1930s. It is the first Kaibab shark specimen to be figured and mentioned in McKee's 1938 volume titled "The Environment and History of Toroweap and Kaibab Formations of Northern Arizona and Southern Utah". The specimen has long been cited, but never studied in full or figured since McKee's volume in 1938. When John-Paul Hodnett initially requested information from GRCA Museum Specialists about the specimen, no records were found. USGS paleontology collections and Smithsonian Institute were also contacted, but the specimen was not housed in these locations either. A photo of the specimen arose when a batch of Kaibab specimens from the GRCA museum was sent to John-Paul Hodnett. However, the specimen had been mislabeled as "shark tooth" rather than the more descriptive scientific name.

Paleozoic Invertebrate Ichnology

NAU Graduate student, Anne Miller, included her recent discovery of the ichnospecies *Monomorphichnus* aff. *M. lineatus* var. *giganticus* in the GRCA Paleozoic Invertebrate Ichnology chapter from her graduate research of the Bright Angel Shale ichnology. This trace fossil was most likely created by a swimming arthropod that was larger than any known arthropod body fossil from Grand Canyon.

Paleozoic Vertebrate Ichnology

The study of the Paleozoic vertebrate footprints from the Grand Canyon and nearby areas yielded several important results. The oldest vertebrate tracks known from eolian paleoenvironments (Manakacha Formation) were re-interpreted evidencing gait on ancient dune slopes. The oldest tetrapod ichnoassociation from eolian paleoenvironments was described (Wescogame Formation). Four ichnotaxa were reported for the first time from this unit, which shows a similar ichnoassociation with contemporary non-eolian units. The best-preserved ichnoassociation of Grand Canyon (Hermit Shale) includes four more ichnogenera than previously known and is consistent with a late Artinskian–early Kungurian age. The most important unit of the Paleozoic for the study of vertebrate tracks in desert paleoenvironments (Coconino Formation) yields an ichnoassociation similar to contemporary non-desertic units, suggesting a revision of the tetrapod ichnofacies. The finding of very long trackways on ancient dune slopes, including the longest trackway of the Paleozoic by number of tracks, permitted a re-interpretation of the locomotion and ichnotaxonomy of tetrapod tracks in eolian paleoenvironments. The Hermit Shale and Coconino Formations were compared, evidencing a different paleoecology of the ichnoassociation. Nevertheless, both units belong to the same tetrapod footprint biochron and are consistent with a possible global radiation of reptiles registered in the track record starting by the middle Artinskian. Quite significant is the occurrence of reptiliomorph anamniote tracks in desert paleoenvironments, as it is the occurrence of temnospondyl anamniote tracks in eolian settings. In addition, the Paleozoic Vertebrate Ichnology team published a journal article featuring the *Ichniotherium* trackway block from Grand Canyon National Park (Francischini et al. 2019).

Paleozoic Paleobotany

A review of known Paleozoic plant macrofossil resources in Grand Canyon National Park was completed by Cassi Knight, detailing previously published plant fossil occurrences from the Surprise Canyon Formation, the Grand Canyon Supergroup, and the Hermit Formation. No new paleobotanical sites were added to the fossil record in this report, but an effort was made to update the taxonomy for plant fossils included in this chapter. Many of the taxonomic names used by David White in his 1929 monograph on the plant fossils of the Hermit Shale needed to be reviewed in light of more recent publications. However, no formal analysis of these fossils was undertaken, due to lack of preserved epidermal information and reproductive structures. Below is a list of the taxonomic changes (► indicates “changed to”).

- *Callipteris conferta* ► *Atunia conferta*
- *Callipteris raymondii* ► *Gracilopteris raymondii*

- *Callipteris arizonae* ► *Rhachyphyllum* sp.
- *Callipteris* sp. ► *Rhachyphyllum* sp.
- *Walchia dawsonii* ► *Hermitia dawsonii*
- *Walchia gracillima* ► *Hermitia* sp.
- *Walchia hypnoides* ► *Otovicia hypnoides*
- *Ullmannia frumentaria* ► *Feysia* sp.

Museum Collections

Museum curators also benefited from the compilation of this report. A number of specimens housed at GRCA, Smithsonian, WACC, and other museum collections were photographed for inclusion in various chapters. These images were provided to the museums and added to the photo records associated with each specimen. Groups of specimens that were photographed include Paleozoic paleobotanical, invertebrate ichnological, vertebrate ichnological, and Precambrian specimens.

Additionally, a selection of specimens were photographed extensively to create 3D models using photogrammetry methods. These models are invaluable research, education, and outreach tools. Models can be viewed online (<https://www.nps.gov/articles/series.htm?id=A9E62040-AC6F-A6D7-BE564A036F1D6146>). All photogrammetry models, associated photos, and files are archived on the IRMA Portal. GRCA fossil specimens digitized this year include:

- Coiled Nautiloid (*Tainoceras schellbachi*)
- Brachiopod (*Peniculauris bassi*)
- Trilobite (*Dolichometopus productus*)
- Shasta Ground Sloth Skull (*Nothrotheriops shastensis*)
- Crinoid (unknown)
- Seed Fern (unknown)
- California Condor Beak (*Gymnogyps californianus*)
- Harrington's Mountain Goat (*Oreamnos harringtoni*)
- Stock's Vampire Bat (*Desmodus stocki*)
- Dragonfly Wing (*Tupus whitei*, also known as *Typus whitei*)
- Phyllodont Fish Tooth Plate (*Platysomus*)

In addition, during the National Fossil Day Celebration at Grand Canyon National Park, 11 paleontologists viewed the collections for research and personal interest purposes (Figure 1). Members of the Cave Paleontology team were also able to convene in Flagstaff, AZ around the National Fossil Day event (Figure 2).



Figure 1. Several paleontologists (11), some of which are pictured here, visited the GRCA museum collection during the National Fossil Day Celebration. Left to right (back): Tom Olson, Spencer Lucas, John-Paul Hodnett, Justin Tweet. Left to right (front): Adrian Hunt, Vincent Santucci, Ronnie Colvin, and Diana Boudreau. (NPS/COLLEEN HYDE).



Figure 2. Members of the GRCA Cave Paleontology team convened in Flagstaff, AZ during the National Fossil Day weekend. Left to right (back): Robyn Henderek, Benjamin Tobin, Carol Chambers, Faith Walker, and Shawn Thomas. Left to right (front): Jim Mead, Mary Carpenter, and Vincent Santucci (NPS).

Grand Canyon PaleoBlitz

Containing almost 2,000 square miles of rugged terrain and over a mile of vertical exposures, Grand Canyon National Park protects some of the most challenging landscapes in the country. Only a small portion of the park has been surveyed for paleontological resources due to the difficult terrain and limited staffing. Therefore, backed by funding and a capable staff, 2019 was the ideal year to hold the second ever NPS PaleoBlitz event (the first being in 2016 at Chickasaw National Recreation Area in Oklahoma).

GRCA's PaleoBlitz involved a partnership between NPS paleontology staff and outside experts to conduct focused paleontology surveys of the canyon. Slope models, a paleontology GIS database, and information gathered from the paleontology inventory report aided in determining accessible and potentially fossiliferous units to focus these PaleoBlitz efforts. This year, systematic surveys of the Chinle Formation, Moenkopi Formation, Kaibab Limestone, Coconino Sandstone, and Bright Angel Shale were conducted. From this effort, 25 new paleontological localities and 55 new paleontological sites have been added to the park paleontology GIS database.

Aside from documenting new paleontology localities, park staff have also been redeveloping and refining methods for collecting data in the field. Since 2017, the paleontology geodatabase has been undergoing updates to better maintain data on paleontological resources. In conjunction with this update, new field data collection forms were created and a GIS data collector system was deployed to expedite collecting information in the field. With more field surveys in the future, the number of fossil localities is expected to grow.

Mesozoic PaleoBlitz Summary

The 2019 GRCA PaleoBlitz of the Mesozoic strata was conducted July 15–16, 2019. Team members included Adam Marsh (PEFO), William Parker (PEFO), Anne Miller (GRCA/NAU), Diana Boudreau (GRCA/GIP), and Klara Widrig (GRCA/GIP). The primary goal was to assess the small exposure of Mesozoic age rocks at Cedar Mountain for paleontological resources. This team successfully surveyed accessible outcrops of Chinle and Moenkopi Formations and documented new occurrences of vertebrate traces, invertebrate traces, and petrified wood (Figure 3). Prior to the 2019 survey, another survey had been conducted in 2012 by GeoScientists-in-the-Parks interns, James Super and Jeff Dobbins. During this 2012 survey, petrified wood was the only documented paleontological resource at Cedar Mountain.

One specimen was collected from the Moenkopi Formation during this PaleoBlitz Survey. The collected block contains ripple marks, *Rotodactylus* vertebrate swim tracks, and possible horseshoe crab tracks (Figure 3A). Adam Marsh (PEFO) confirmed these identifications with specialist Tracy Thompson (UC Davis). Previous to the collection of this sample, there were no Mesozoic specimens in the paleontology collections at the GRCA museum. Therefore, this specimen helps fill a gap in the GRCA museum paleontology collection (Catalog # GRCA 33186). All documented petrified wood was likely sourced from the Shinarump Member of the Chinle Formation which caps Cedar Mountain. No petrified wood was collected during the 2019 Mesozoic PaleoBlitz.

The most accessible unit was the Wupatki Member of the Moenkopi Formation, as most exposures of the Holbrook Member were inaccessible due to steep terrain or vegetation cover. In areas where the Holbrook Member was accessible, no fossils were present. Sections of the Wupatki Member that contained many sedimentary structures, such as ripple marks, also contained fossils, such as invertebrate or vertebrate tracks.

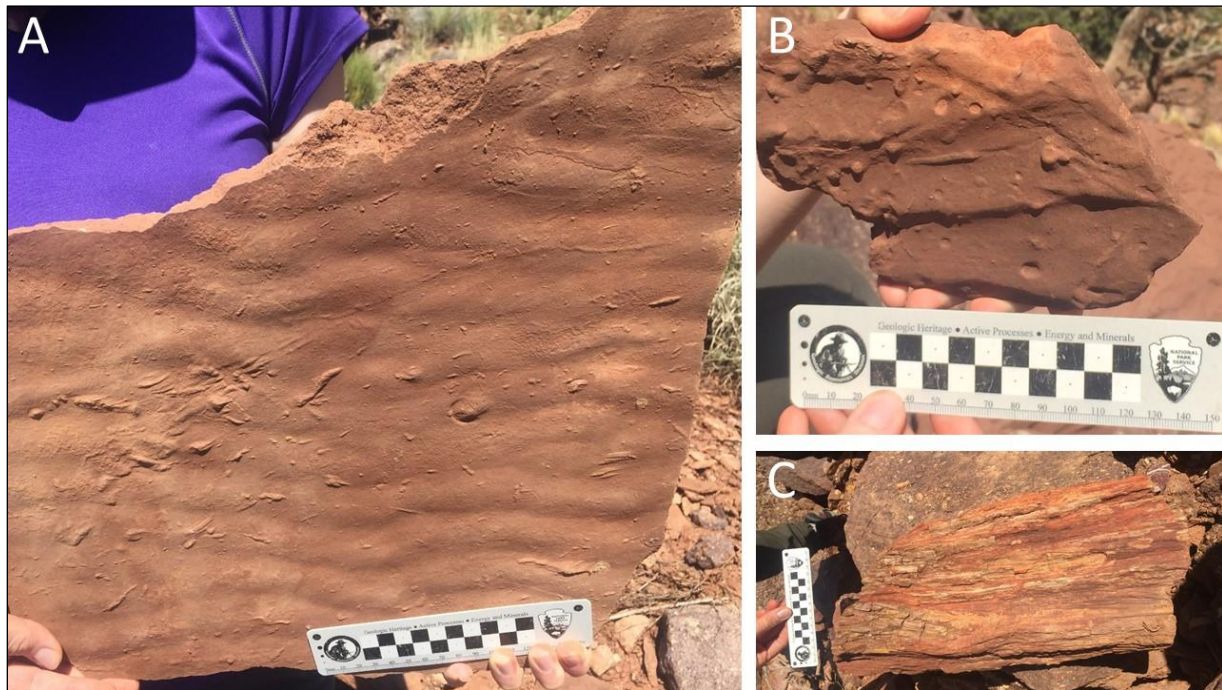


Figure 3. Notable specimen from the Mesozoic PaleoBlitz. A) Collected *Rotodactylus* specimen with horseshoe crab traces and ripple marks from the Moenkopi Formation (GRCA 33186; NPS/ADAM MARSH). B) Invertebrate trace fossils documented on Cedar Mountain are likely *Scoyenia* aff. *S. gracilis* due to their horizontal and vertical burrows (NPS/ANNE MILLER). C) Petrified wood was common in all surveyed areas of Cedar Mountain (NPS/ANNE MILLER).

In addition, this Mesozoic PaleoBlitz activity provided an opportunity for the initial deployment of the new ArcGIS Online (AGOL) and Collector applications. Data were collected in field notebooks, on paper field locality forms, as well as on the AGOL and Collector applications. Insight from this initial deployment allowed GRCA GIS staff to update the AGOL and Collector applications to further streamline field data collection.

Internal GRCA Team PaleoBlitz Summary

As part of the 2019 GRCA Centennial Paleontology Inventory Project, GRCA staff undertook paleontology PaleoBlitz inventories at multiple previously under- and unexplored areas of the park. These field inventory activities were focused initially on identifying in situ ichnofossils, particularly trackways, in the Permian Coconino Sandstone, and were expanded to also examine exposures of other Paleozoic strata, including the Kaibab and Toroweap Formations.

In spite of some well-known occurrences of ichnofossil trackways in the Coconino Sandstone of Grand Canyon, remarkably few of these were verified as *in situ* occurrences and were of limited areal extent, notably in the Hermit Basin. The Coconino Sandstone typically forms massive cliffs that are rarely accessible and, even then, offer very limited exposures of bedding plane surfaces that could preserve trace fossils. The goal was to identify and explore accessible, *in situ* exposures of Coconino Sandstone that could potentially broaden the known extent and taxonomic assemblage of Permian fossil trackways in Grand Canyon. This was the first concerted attempt to focus on new *in situ* Coconino Sandstone ichnofossils in nearly a century.

Our initial goal was to attempt to identify the outcrop source of a well-known and recently published (Francischini et al. 2019) float block occurrence of *Ichniotherium* tetrapod trackways from the Hermit Basin, but we quickly recognized that the source was undoubtedly steep and inaccessible cliffs above the Dripping Springs Trail. This led us to develop a simple GIS model (i.e., mapped areas of Coconino Sandstone, accessibility, slope and, to a lesser extent, known downslope float occurrences of Coconino Sandstone ichnofossils) to predict accessible areas of potentially *in situ* Coconino Sandstone trackway fossils throughout the park, and to begin targeting and prioritizing these areas for field exploration.

Between April and October 2019, various internal GRCA teams (various 2–5 person combinations of Anne Miller, Mark Nebel, Diana Boudreau, Klara Widrig, Jered Hansen, and Justin Tweet; Figure 4) spent at least nine field days exploring prioritized Coconino Sandstone ichnofossil targets. This effort led to the discovery of multiple new localities and documentation of the source areas for previously identified ichnofossils in float blocks. At least several of these localities are considered significant new resources due to the extent, number, diversity, and preservation of their tracks. Multiple apparent tetrapod and arthropod ichnospecies are represented in these localities, including some that may be new to, at least, Grand Canyon National Park. In addition, new Coconino Sandstone ichnofossil burrow localities were also located. Numerous other priority target areas of Coconino Sandstone remain to be explored. GRCA PaleoBlitz surveys also located new and expanded known fossil localities in the Kaibab and Toroweap formations.

Important Coconino Sandstone localities were documented from below both the South and North canyon rims, along or near the New Hance, Tanner, North Kaibab, and Saddle Mountain Trails. Several New Hance Trail localities contain hundreds of fossil tracks of multiple tetrapod and arthropod species that are particularly well-preserved (Figure 5).

A major new discovery off the North Rim Saddle Mountain Trail also contains tracks in Coconino Sandstone of multiple tetrapod and arthropod species (Figure 6). This locality preserves up to ten semi-parallel trackway sets of the largest clawed vertebrates yet identified at GRCA.



Figure 4. Members of the GRCA PaleoBlitz team. A) Mark Nebel (left) and Jered Hansen (right) hold up a trackway slab in the Coconino Sandstone. (NPS/DIANA BOUDREAU). B) Left to Right: Diana Boudreau, Klara Widrig, and Anne Miller rest on the New Hance Trail after collecting paleontological locality data in the Coconino Sandstone. (NPS/MARK NEBEL). C) Left to Right: Anne Miller, Mark Nebel, and Justin Tweet at the Grandview Trailhead (NPS).



Figure 5. A productive new locality in the Coconino Sandstone documented during the 2019 PaleoBlitz survey (NPS/MARK NEBEL). A) Multiple, freshly-exposed, clawed footprints on a Coconino sandstone slab with lichen. B) A paired arthropod trackway, possibly made by a scorpion. C) Small, very thin slab with approximately 28 vertebrate prints with 2-3 claws per print.



Figure 6. A new Coconino Sandstone trackway locality was documented near the Saddle Mountain Trail on the North Rim (NPS/DIANA BOUDREAU). A) Casts of 15 prints composing a tetrapod trackway. B) The longest documented trackway at this locality was composed of approximately 34 individual prints. C) This overturned block (right) revealed that trackways at this locality were often preserved as mirror image casts and molds.

Several new Kaibab Formation invertebrate localities were located along the North Bass Trail and include horizons rich in well-preserved bryozoans, brachiopods, crinoids, corals, sponges, and invertebrate burrows (Figure 7A–C). A known Kaibab invertebrate locality along the Hermit Trail was also greatly expanded. This locality contains impressive sponge-rich strata, as well as multiple other invertebrates (Figure 7D). A new locality comprised of several extensive horizons rich in ichnofossil (worm and ghost shrimp) burrows was discovered along the Grandview Trail (Figure 7E).

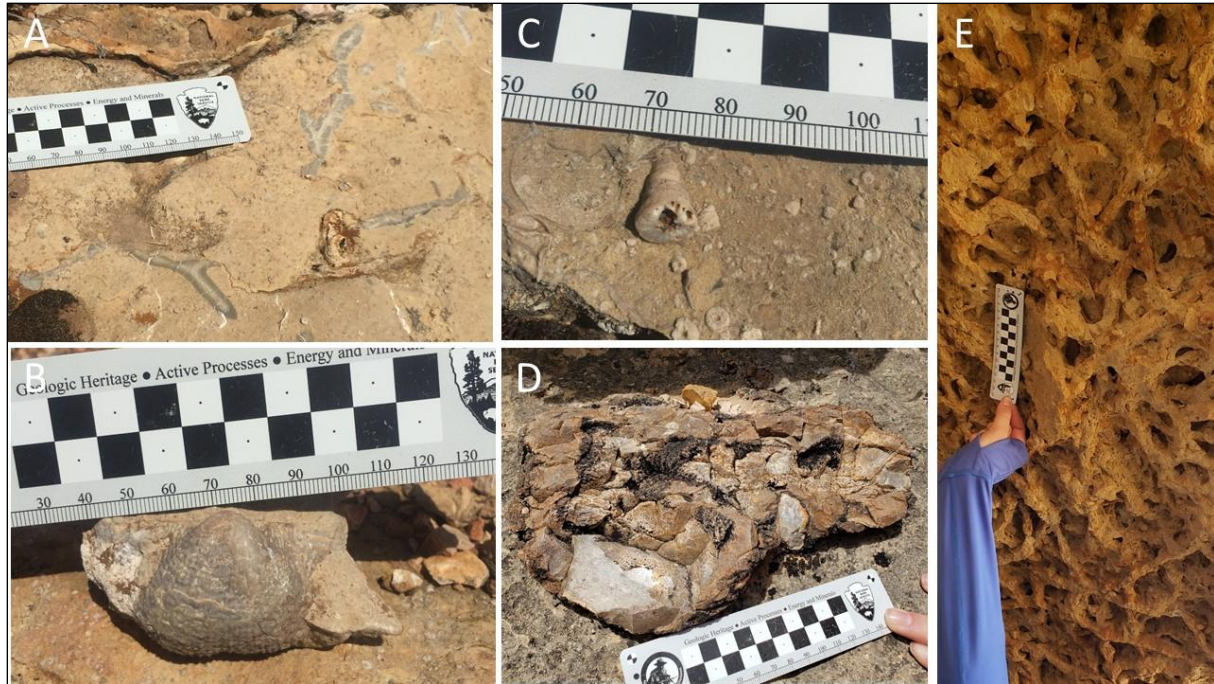


Figure 7. A collection of invertebrate body fossils and ichnofossils found during the 2019 GRCA PaleoBlitz surveys (NPS/MARK NEBEL). A) Bryozoans in cross-section in the Kaibab Formation on the North Rim. B) Well preserved brachiopod in the Kaibab Formation. C) Single rugose horn coral and many crinoid stem pieces in the Kaibab Formation. D) Large silicified sponge fossil with well-preserved internal structure found within larger silicified sponge-rich horizons in the Kaibab Formation. E) Dense network of *Thalassinoides*, burrows likely made by a ghost shrimp, on the underside of a fine-grained sandy horizon of the Kaibab Formation.

The GRCA PaleoBlitz was leveraged as an opportunity to develop, test, and refine the new paleontology geodatabase and field forms, and as a pilot project to transition to new ArcGIS Online (AGOL) and Collector applications. Over the course of the 2019 field season, the GRCA Paleontology Program successfully migrated completely away from previous Trimble-based field data collection protocols and workflows to the new AGOL and Collector technologies and their related workflows. For more information on these updates contact GIS Program Manager, Mark Nebel (mark_nebel@nps.gov).

Paleozoic Invertebrate Ichnology Summary – Bright Angel Shale

Another PaleoBlitz survey occurred May 27–29, 2019 in order to find new invertebrate trace fossils along the North Kaibab Trail and to conduct a more detailed survey of previously known localities in the Bright Angel Shale. The survey team consisted of Anne Miller (GRCA/NAU), Benjamin Wheeler (NAU), Susan Pratt, and Dustin Pratt (Figure 8). The team discovered a new locality in the Redwall Limestone that consisted of in situ, horizontal burrows on the upper surface of limestone beds (Figure 9). At a previously known locality in the Bright Angel Shale, near the Manzanita area, new horizontal and vertical burrows were identified including several specimens of the horizontal burrow network, *Palaeophycus* (Figure 10A). Three specimens were collected from this locality and identified as, *Cruziana isp.*, *Skolithos isp.*, and *Didymaulichnus isp.* *Cruziana* is a biolobed,

horizontal burrow made by arthropods (most likely trilobites) that were potentially deposit feeding (Figure 10B). The similar trace, *Didymaulichnus*, differs in that the bilobed burrow is smoother, devoid of arthropod scratch marks and could have also been made by other organisms like gastropods (Figure 10C). *Skolithos* is a vertical burrow most likely made by vermiform organisms as a dwelling structure for suspension feeding or predation (Figure 10D).



Figure 8. Invertebrate Ichnology PaleoBlitz team on the North Kaibab Trail en route to survey the Bright Angel Shale. Left to Right: Benjamin Wheeler, Anne Miller (team lead), Susan Pratt, and Dustin Pratt (NPS).



Figure 9. Burrows, likely *Palaeophycus* (?), found in the Redwall Limestone along the North Kaibab Trail (NPS/ANNE MILLER).

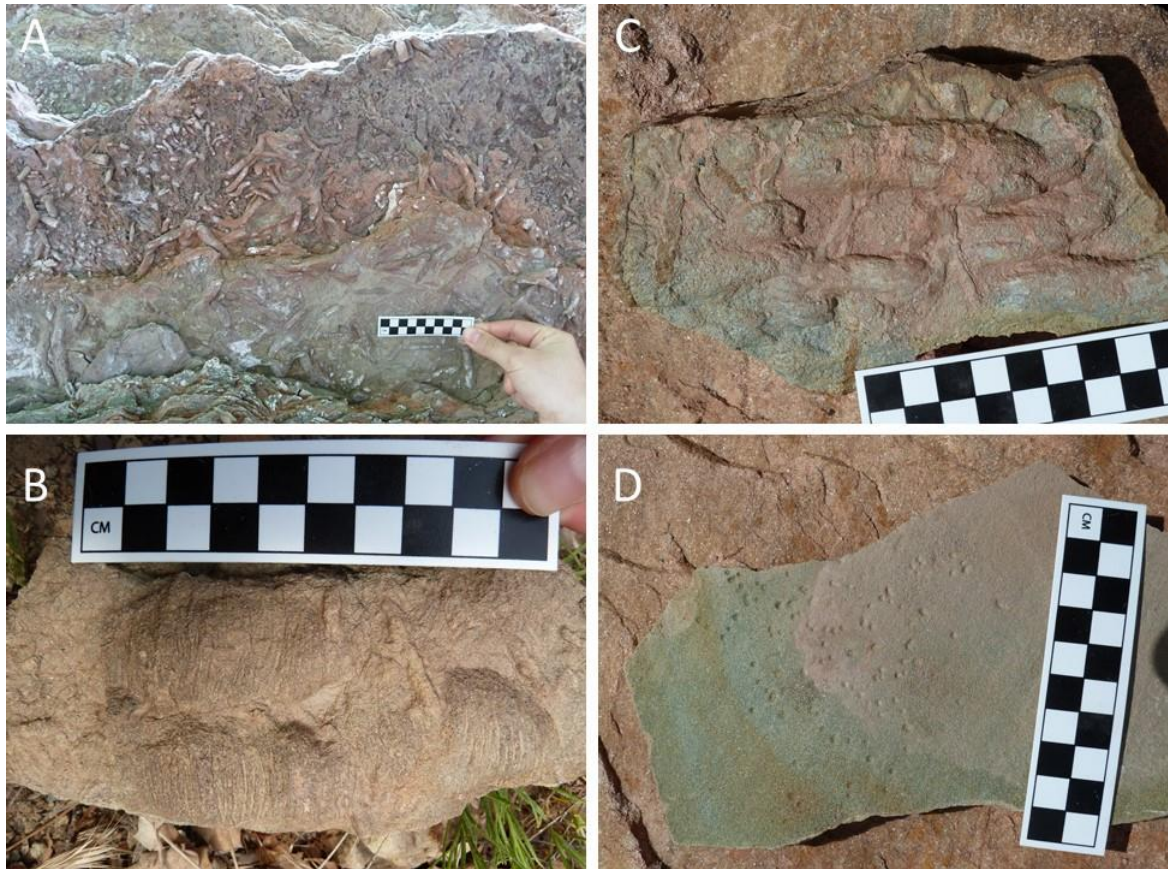


Figure 10. The Bright Angel Shale exposed along the North Kaibab Trail revealed numerous invertebrate trace fossils including A) *Palaeophycus* burrows, B) *Cruziana*, C) *Didymaulichnus*, and D) *Skolithos* (?). (NPS/ANNE MILLER).

Paleozoic Vertebrate Body Fossils PaleoBlitz Summary – Kaibab Formation

The 2019 GRCA PaleoBlitz for the Kaibab vertebrates was accomplished from September 22 to 26, 2019. During this time, the survey team consisted of John-Paul Hodnett (M-NCPPC), Diana Boudreau (GRCA/ACE), Anne Miller (GRCA/NAU), James (Max) Bovis (M-NCPPC), and Tom Olson (Figure 11). The primary goal was to explore both the North and South Rims of Grand Canyon National Park to locate and assess historic localities known for Kaibab Formation vertebrate body fossils and identify new potential vertebrate body fossils from the Kaibab Formation. As such, this team was successful in identifying two new significant fossil sites with well-preserved vertebrate remains from the North Rim of GRCA. The team also located the vertebrate-bearing beds at Fossil Mountain and the type section of the Fossil Mountain Member of the Kaibab Formation on the South Rim.

Preliminary results of the most significant vertebrate fossils recovered include the second tooth of *Megactenopetalus kaibabanus* collected from the North Rim (Figure 12B) and the first record of *Megactenopetalus* on the South Rim (Figure 12A). *Megactenopetalus* is a large petalodont shark, first discovered at the Grand Canyon in the 1940s. The park's first specimen of *Crassidonta stuckenbergi*, a holocephalan chondrichthyan, was also collected from the Kaibab Formation. It was

known previously only from Permian sites in Wyoming, Russia, and Australia (Figure 12C). The first records of the ctenacanth shark *Glikmanius* from both the North and South Rims was documented and specimens were collected (Figure 12D). As a historic first, this was also the first team of paleontologist in the 100-year-history of GRCA to set out to specifically to search for Paleozoic vertebrate body fossils. The end results of the surveys include collecting approximately 200 lb (90 kg) of vertebrate bearing rocks from the Kaibab Formation that will be prepared and processed for micro-vertebrate and conodont fossils. These fossils will be studied to better understand the diversity of marine vertebrates during the Early Permian in the American Southwest and will be included in a comprehensive report of the vertebrate record of the Kaibab Formation.



Figure 11. A) North Rim Kaibab Vertebrates PaleoBlitz team members at the North Rim Lodge (Left to right: Anne Miller, JP Hodnett, and Max Bovis). B) South Rim Kaibab Vertebrates PaleoBlitz team members striking a pose (Left to right: Tom Olson, Diana Boudreau, JP Hodnett, and Max Bovis). (NPS Photos).

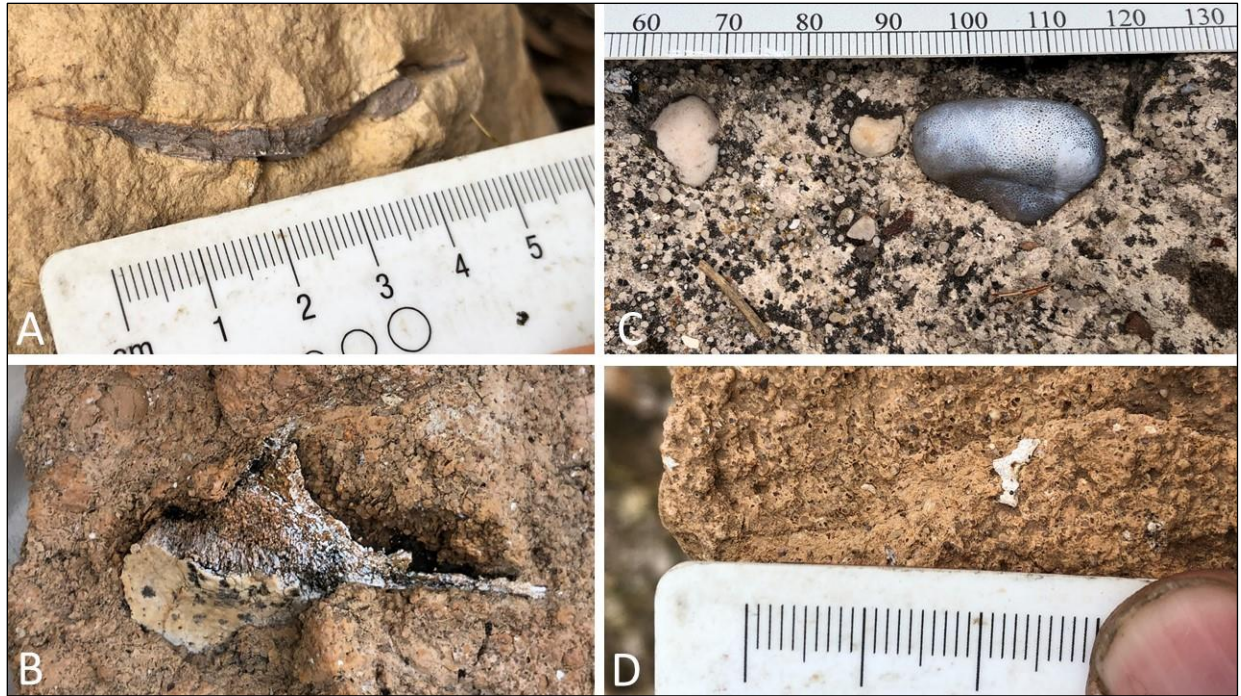


Figure 12. Notable specimens documented during the 2019 Vertebrate Body Fossil PaleoBlitz September 22–26, 2019 (NPS/JP HODNETT). A, B) *Megactenopetalus kaibabanus* C) *Crassidonta stuckenbergi* D) *Glikmanius* sp.

Significant Paleontological Specimens

As a result of the 2019 PaleoBlitz efforts, 10 paleontological specimens have been accessioned into the GRCA museum collection (see below for catalog numbers). These items include a phyllodont fish tooth plate from the Kaibab Formation (Figure 13A), vertebrate swim tracks from the Moenkopi Formation (Figure 3A), vertebrate and invertebrate tracks and trackways from the Coconino Sandstone (Figure 5), and invertebrate trace fossils from the Bright Angel Shale (Figure 10). Rock samples collected during the Kaibab Formation PaleoBlitz (Figure 12) are being processed for microvertebrates and will be accessioned in the museum collections following taxonomic assignment.

- GRCA #33184 – Phyllodont Fish Tooth Plate
- GRCA #120545 – Arthropod Trackway
- GRCA #120546 – Tetrapod Trackway
- GRCA #120547 – Tetrapod Trackway
- GRCA #120548 – Tetrapod Trackway
- GRCA #120549 – Tetrapod Trackway
- GRCA #33186 – *Rotodactylus* Swim Traces

- GRCA #122001 – *Didymaulichnus* Traces
- GRCA #122002 – *Cruziana* Traces
- GRCA #122003 – *Skolithos* Traces

A number of notable specimens were documented in the field and recorded in the Paleontology Geodatabase, but were not collected. These specimens include the occurrence of *Megactenopetalus* shark teeth on the South Rim (Figure 12A), tetrapod trackway block along the Bright Angel Trail (photogrammetry model) (Figure 13B), an assemblage of large, clawed trackways in the Coconino Sandstone on the North Rim (Figure 6), vertebrate trackways in the Coconino Sandstone on the South Rim (Figure 5A), and invertebrate body fossils from the Kaibab Formation (Figure 7A–D).

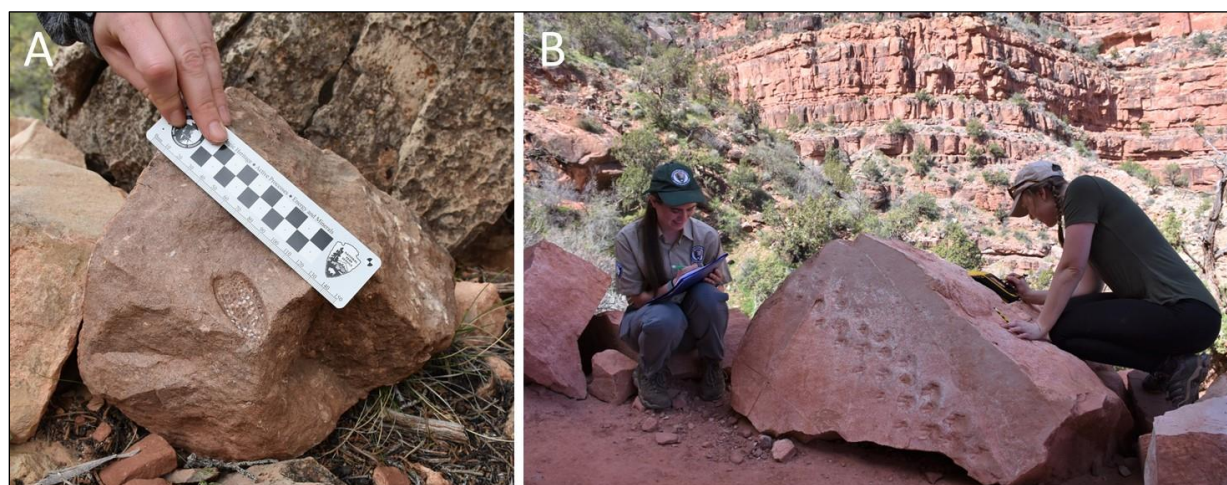


Figure 13. A) A phylloodont fish tooth plate from the Kaibab Formation collected along the Hermit Trail. (NPS/KLARA WIDRIG) B) GIP Intern Klara Widrig and NAU graduate student Anne Miller document a tetrapod trackway block along the Bright Angel Trail prior to imaging the block to create a 3D model. (NPS/DIANA BOUDREAU).

Paleontology Geodatabase & Collector System

In 2019, Mark Nebel (GIS Program Manager), Anne Miller (Science and Resource Management), and Jered Hansen (GIS Specialist) began developing an updated locality data collection form and online collector system. Surveys conducted in 2019 provided an opportunity to test these new data collection methods. Online collector systems allow the paleontology surveys to collect data in a more efficient and systematic way than with field notebooks and paper locality forms alone. The data collection system established over the past few years at Grand Canyon National Park has set the standard for paleontological resources data collection for other fossiliferous park units. A total of 25 new localities and 55 new sites were added to the GRCA paleontology geodatabase as a result of the 2019 PaleoBlitz surveys. For more information on these updates contact Mark Nebel (mark_nebel@nps.gov).

Research Permit

All PaleoBlitz activities undertaken in 2019 were permitted under scientific research and collecting permit #GRCA-2019-SCI-0002 (Appendix B). This permit allowed NPS staff and outside researchers to assess paleontological specimens in the field, document using GPS and photography, and collect in cases where rare, well-preserved, or scientifically significant fossils were encountered.

2019 National Fossil Day Celebration

National Fossil Day (NFD) is an annual celebration to highlight the scientific and educational value of paleontology and the importance of preserving fossils for future generations. NFD celebrated its 10th anniversary in 2019 providing an opportunity to partner with Grand Canyon National Park during their centennial anniversary. The resulting National Fossil Day Celebration was hosted on the South Rim of the Grand Canyon on September 27 and 28, 2019. Prior to this special event, the main National Fossil Day event had only been hosted at the National Mall in Washington, DC. The planning and logistics involved in hosting the event at Grand Canyon National Park in 2019 has paved the way for other National Park Service units to host National Fossil Day events in future years.

The 2019 National Fossil Day logo recreates a prehistoric scene from one of Grand Canyon National Park's most iconic fossil localities, Rampart Cave (Figure 14). The logo depicts a Shasta ground sloth, *Nothrotheriops shastensis*, walking across the sloth dung covered floor of Rampart Cave 11,000 years ago. A vampire bat, *Desmodus stocki*, hangs from the ceiling, waiting until dusk to forage for food. This logo was used to promote National Fossil Day activities hosted by 380 partner organizations across the country throughout the month of October. The official National Fossil Day was on October 16, 2019 in conjunction with National Earth Science Week.

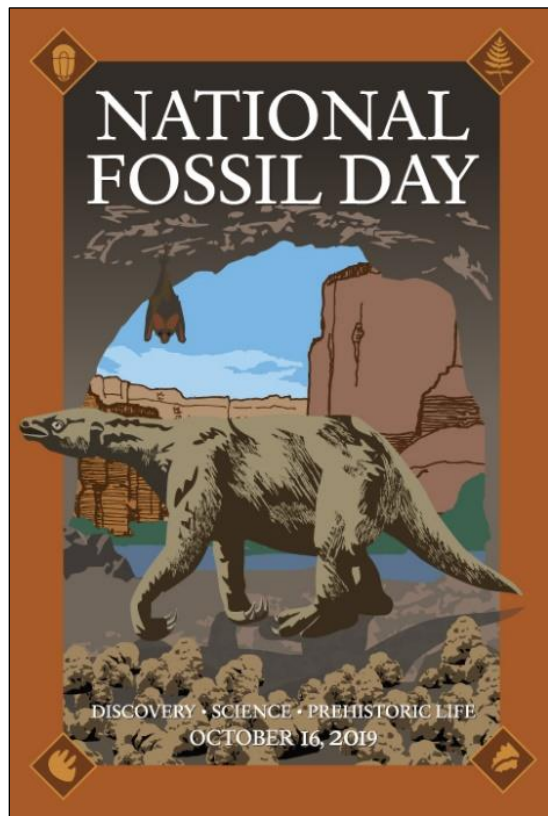


Figure 14. 2019 National Fossil Day logo featuring a scene recreating fossils from Rampart Cave in Grand Canyon National Park (NPS).

Pre-Event Planning

Many components went into preparing for the 2019 National Fossil Day Celebration at Grand Canyon National Park. From designing non-traditional outreach materials to developing a “run of show” to procuring lodging for visiting scientists, the 2019 NFD celebration required many steps to ensure a successful event. The first step was to establish a date for the National Fossil Day Celebration. Once the date was selected, the core paleo team developed a schedule of events based on previous NFD activities. Ronnie Colvin, Interpretive Park Ranger at GRCA, had been coordinating NFD events at the park for the past five years, so the 2019 schedule used her previous NFD event schedules for an outline. Events repeated from previous years include a featured ranger-led Fossil Walk program, children’s activity table at the Yavapai Geology Museum, Ask-a-Scientist event, Facebook Live broadcast at the fossil beds with Park Rangers, and paleontology themed evening programs. New additions to the schedule for 2019 included a paleontology symposium, 10 partner organization booths stationed at the Grand Canyon Visitor Center, and a welcome ceremony with speeches from the President of the Paleontological Society (Bruce MacFadden), GRCA Chief of Resources (Jeanne Calhoun), and NPS Paleontology Program Manager (Vincent Santucci), and a reading of the Arizona state greeting by Interpretive Ranger, Ronnie Colvin.

Planning such a large event required a great deal of pre-event planning. National Fossil Day activities were located at the Grand Canyon Visitors Center Plaza, Yavapai Geology Museum, Fossil Walk area along the Rim Trail, Shrine of the Ages, and Mather Amphitheater. Each location required its own set of supplies, staffing, and resources which were staged prior to the NFD event. Below is an event timeline for pre-event planning which can be adapted for future NFD events at GRCA or other NPS park units. Each pre-event planning item includes a suggested timeline and contact person.

NFD Pre-Event Planning Timeline

Friday, September 27, 2019, Paleontology Mini-Symposium

Saturday, September 28, 2019, National Fossil Day

NFD 2019 Theme: Grand Canyon National Park’s Rampart Cave’s Ice Age Fossils

<https://www.nps.gov/articles/fossils-of-the-2019-national-fossil-day-artwork.htm>

June/July (2–3 months out)

- Register as an event with NPS NFD website & advertise (PIO, Social Media Coordinator)
- Meet with Interpretation schedulers & supervisors for Evening Program and Fossil Walk Ranger Program to be added to their calendars and plan for extra staffing (Interpretation Staff)
- Reserve area outside Yavapai Geology Museum for activity & touch table (Building Lead)
- Reserve Shrine of the Ages as inclement weather location for 9/27 evening & 9/28 all day (Building Lead)
- Contact Science and Resource Management (SRM) regarding current paleo research (SRM Staff)
- Recruit volunteers to assist with activities and setup (Volunteer Coordinator, Interpretation Staff, & SRM Staff)

- Draft signs and set meetings with Creative Media Staff (Indesign and PDF) (Creative Media staff)
- Connect with NFD Partners and Vendors to gauge participation and needs (NFD Coordinator, Partner Organizations)

August (1 month out)

- Produce flyers and information to distribute (Creative Media and Social Media Coordinator)
- Sandwich boards with Velcro for locations with laminated posters (Creative Media, Interpretation Staff)
- Flyers for locations with laminated posters (Creative Media)
- Confirm partners and vendors participation and needs (NFD Coordinator, Partner Organizations)
- Social media teasers for NFD (Social Media Coordinator, PIO)
- Complete table layout, activities, and materials for children's activity tables (Interpretation Staff)
- Gather all activity supplies and load into NFD bins (Interpretation Staff)

September (Month of)

- Send press release for NFD two weeks prior to event (Creative Media, PIO, Social Media Coord.)
- Promote event using flyers, social media link to subject webpage, teasers, etc. (Social Media)
- Distribute digital and paper flyers through normal program advertising media (Creative media & Social Media staff)
- Provide Visitor Center with presentation slides for Evening Program & Symposium announcement (Interpretation)
- Two weeks before event contact Facilities to reserve delivery of tables and chairs (Facilities)
- Compose and stage Countdown to National Fossil Day social media posts (Social Media)
- Distribute handouts to North Rim, Desert View, and Inner Canyon Districts (Interpretation)

September 23–28 (Week of)

- Bring tables and supplies to Yavapai Geology Museum storage for children's table (Building lead)
- Bring supplies to the Grand Canyon Visitor Center storage for partner activities (Interpretation)
- Gather specimens from Museum Collections to exhibit during Evening Programs (Museum Staff)

- Gather speaker presentations and upload on the Shrine of the Ages computer for Paleontology Symposium and Evening Program (Guest Speakers, Interpretation)
- Day before event deliver NPS tablecloths, activity supplies, and NFD bins to various locations around the park (Interpretation)
- Day of event, See Run of Show (Appendix D)

Grand Canyon National Park is a large park composed of four main districts (South Rim, North Rim, Desert View, and Inner Canyon). In an attempt to reach a wider audience, NFD postcards, stickers, fossil trading cards, and Junior Paleontologist supplies were delivered to each of these districts with information about the National Fossil Day Celebration. No formal data was gathered about NFD participation, but Interpretation staff indicated that visitors were enthusiastic about the paleontology event, cards, and stickers. In future events at Grand Canyon, or in other park units with multiple districts, attempts should be made when possible to include each district in the NFD event.

Multiple non-traditional interpretive products were produced in preparation for the National Fossil Day Celebration. The first product, a NFD promotional postcard, was developed for inclusion in the Earth Science Week toolkits mailed out by the American Geosciences Institute. The postcards took approximately two months from initial design to delivery. These postcards were useful in promoting NFD at Grand Canyon, Geological Society of America Meeting, and Flagstaff Science Festival. The second product was an unstaffed pop-up exhibit featuring the fossils of Grand Canyon National Park (Figure 15). This exhibit was unveiled during the NFD celebration on Friday, September 27 and remained on display in the Grand Canyon Visitors Center. The pop-up exhibit went through multiple iterations and was reviewed by paleontologists and interpretive staff for correct content and engaging design. It took approximately three months from initial design to delivery. The third and final product produced for the NFD event was a set of nine GRCA fossil-themed trading cards. Each card contains an image of a Grand Canyon fossil with information, graphics, preservation message, and QR code link to photogrammetry models on the back (Figure 16). From design to delivery, the process took approximately three months. When developing interpretive products such as those listed above, the lengthiest part of the process was the printing and delivering steps. It is recommended that parks start this process early to ensure the timely delivery of the products.



Figure 15. Diana Boudreau (GIP/ACE) and Ronnie Colvin (GRCA) display the GRCA Paleontology Pop-Up Exhibit designed as an unstaffed interpretive tool for National Fossil Day (NPS/KLARA WIDRIG).

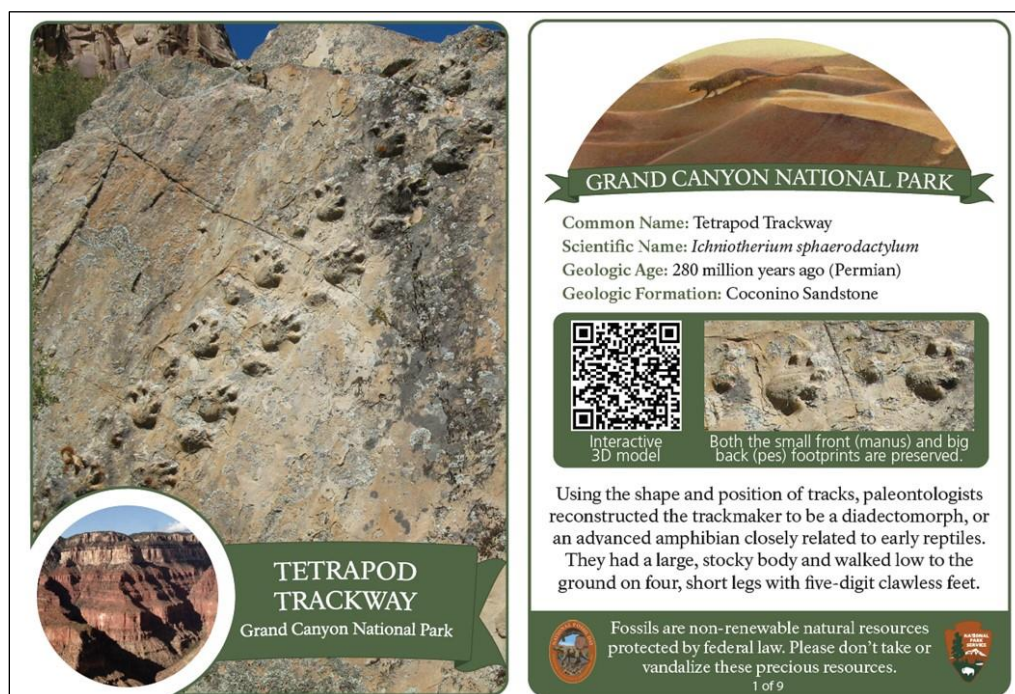


Figure 16. Front and back side of a Grand Canyon National Park Fossil Trading Card, "Tetrapod Trackway," that features photos of a footprint trackway in stone made by an amphibian that had a large, stocky body, and walked on four short legs with five-digit clawless feet (NPS Photo).

National Fossil Day was also promoted at the Flagstaff Science Festival on Saturday, September 21, 2019, one week prior to the National Fossil Day Celebration. Grand Canyon National Park Science and Resource Management staff participated in the science festival by promoting the National Fossil

Day Celebration, educating visitors about paleontological resources, and encouraging visitors to paint a fossil cast or build their own crinoid.

National Fossil Day Celebration

The 2019 National Fossil Day Celebration at Grand Canyon National Park included an evening paleontology symposium and museum collections table on September 27 (Figure 18) and a full day of events and activities on September 28 (Figure 19). September 28 was also a fee free day providing an opportunity for a larger group of individuals to visit Grand Canyon National Park for the National Fossil Day Celebration. A full schedule of NFD events can be accessed online at <https://www.nps.gov/grca/planyourvisit/2019-national-fossil-day-celebration.htm>.

The paleontology symposium on September 27, 2019 provided park staff and visitors an opportunity to attend scientific presentations by guest paleontologists Jim Mead, Spencer Lucas, Linda Lassiter, and JP Hodnett (Figure 18). Attendees of this symposium were able to interact with park staff and paleontologists at the museum collections table. A number of notable fossil specimens and replicas with identification cards were on display prior to and during the symposium talks. The GRCA fossil-themed trading cards were also debuted and distributed for the first time during this symposium event. Following the presentations, Vincent Santucci awarded NPS Paleontology Arrowhead Awards to members of the GRCA Paleontology Team for their outstanding work during the 2019 Paleontology Project at Grand Canyon National Park (Figure 17). Approximately 110 visitors attended the Paleontology Symposium on Friday September 27.



Figure 17. A few members of the GRCA Paleontology Team received NPS Paleontology Arrowhead Awards from NPS Senior Paleontologist, Vincent Santucci, during the Paleontology Symposium on Friday September 27, 2019. Left to Right: Diana Boudreau, Mark Nebel, Ronnie Colvin, JP Hodnett, Colleen Hyde, and Anne Miller. (Not pictured: Jeanne Calhoun, Sarah Haas, Kim Besom, Ronda Newton, and Klara Widrig) (NPS/MICHAEL QUINN).



Paleontology Symposium

Friday, September 27, 2019

7:30 pm

Shrine of the Ages Auditorium



Jaws of the Grand Canyon Fossil Sharks of Grand Canyon

John-Paul Hodnett is the National Fossil Day Coordinator, and the paleontologist and coordinator for the M-NCPPC Dinosaur Park in Maryland. His research focuses on the evolution and ecology of sharks and mammalian carnivores.



No Bones About It... Grand Canyon's Invertebrate Fossils

Linda Sue Lassiter is a researcher of evolutionary biology studying Early Paleozoic fossil groups including vertebrates, eurypterid arthropods, and interactions of ancient species. She teaches Paleontology at Northern Arizona University.



An Ice Age *in Grand Canyon* Cave Paleontology of Grand Canyon

Dr. Jim Mead is the Research Director at South Dakota's Mammoth Site, specializing in Pleistocene mammal, reptile, and amphibian fossils in the Black Hills, Grand Canyon, Sonora (Mexico), Abaco (Bahamas), and Guangxi (China).



Paleozoic Tracks and Traces *of the Grand Canyon* Grand Canyon's Vertebrate Trace Fossils

Dr. Spencer G. Lucas' research focuses on biostratigraphic problems of the late Paleozoic, Mesozoic and early Cenozoic. He is the Curator of Geology and Paleontology at the New Mexico Museum of Natural History and Science.

Join us for an evening of fossil discovery and learning with paleontologists!



Programs are subject to cancellation. See bulletin boards, visitor centers, or nps.gov/grca for a complete list of park ranger programs. Take a picture for reference.

Figure 18. Sandwich board sign showcasing guest speakers for the 2019 National Fossil Day Paleontology Symposium at Grand Canyon National Park on September 27 (NPS).

Grand Canyon

National Park Service
U.S. Department of the Interior

Grand Canyon National Park



2019 National Fossil Day Celebration



Friday, September 27

- 7:30 - 9:00 pm Paleontology Symposium**
Shrine of the Ages Auditorium
 Join us for an evening of fossil discovery and learning with visiting paleontologists. Four guest speakers will highlight some of Grand Canyon National Park's most notable fossils.

Saturday, September 28

- 9:00 am - 10:00 am Fossil Walk**
Meet at Bright Angel Trailhead
 Learn about Grand Canyon's ancient life through its fossil history. This easy walk along the Rim Trail explores the marine fossils of an ancient Permian Sea.
- 10:00 am - 3:00 pm All Day Events**
Grand Canyon Visitor Center and Yavapai Geology Museum
 Meet with partner organizations such as American Geosciences Institute, Museum of Northern Arizona, Southwestern Paleontological Society, and others!
- 10:00 am - 12:00 pm Fun with Fossils!**
Yavapai Geology Museum
 Discover why fossils are important. Fun fossil games and activities for kids of all ages! Meet some of Grand Canyon's scientists and ask your questions!
- 10:00 am - 11:00 am Ask a Scientist!**
Yavapai Geology Museum
 How do fossils form? What is a trace fossil? Meet some of Grand Canyon's scientists and ask your questions! (Live event)
- 1:00 pm - 2:00 pm Welcome Ceremony**
Mather Point Amphitheater
 Join Park Rangers for a welcome ceremony, event proclamation, and remarks by Grand Canyon Superintendent and visiting paleontologists.
- 4:30-5:30 pm Facebook Live!**
 Unable to be at Grand Canyon today? No worries! You can join us live for your personal tour of the Fossil Beds via Facebook Live!
- 7:30-8:30 pm Special Centennial Evening Program**
Shrine of the Ages
 Join NPS Senior Paleontologist, Vincent Santucci, for a special centennial celebration of the rich Paleontological Heritage at Grand Canyon National Park.

Figure 19. Schedule of events for the 2019 National Fossil Day Celebration at Grand Canyon National Park on September 27 and 28 (NPS).

The following day, September 28, 2019, was full of fossil festivities around the park (Figure 19). A regularly scheduled Ranger-led Fossil Walk kicked off the day at 9 AM. During that time partner organizations were arriving at the Grand Canyon Visitor Center Plaza and setting up their outreach booths. At 10 AM all of the partner booths were set up and participants were already interacting with park visitors (Figure 20). A photobooth run by the American Geoscience Institute (AGI) allowed the public to take photos in front of a green screen and superimpose their image onto a variety of GRCA themed photos such as fossil track blocks, Rampart Cave, on river rafts, etc. (Figure 20A). The GRCA paleontology pop-up exhibit was set up inside the Visitors Center and fossil trading card sets were distributed. Over at the Yavapai Geology Museum, another table was set up from 10 AM–12 PM to provide kids the opportunity to build their own crinoid, paint a fossil cast, weave a complex trilobite knot, or start earning their Junior Paleontologist badges. Paleontologists stationed at this booth also livestreamed an Ask-a-Scientist social media event reaching 7,617 individuals. Over 100 viewers submitted comments or questions during the livestream event. A welcome ceremony at the Mather Amphitheater was conducted from 1:00–1:30 PM to formally welcome participants to the National Fossil Day Celebration (Figure 21). Jeanne Calhoun, GRCA Chief of Resources, introduced the ceremony and welcomed guest speaker, Bruce MacFadden, President of the Paleontological Society. After a warm welcome from Bruce MacFadden, Ronnie Colvin (GRCA) read a greeting from the Arizona governor’s office. Vincent Santucci, NPS Senior Paleontologist, ended the ceremony with an inspirational speech about the impact National Fossil Day activities have on youth and public perception of paleontological resources. A few hours following the welcome ceremony, partner booths were packed up. Another social media livestream event, held at 4:30 PM at the Fossil Beds with Park Rangers, was very popular, reaching 23,788 viewers. In the evening, a special program was hosted at the Shrine of the Ages with guest speaker NPS Senior Paleontologist Vincent Santucci. The table of museum specimens was set up again, so visitors could interact with paleontologists and Grand Canyon fossils. Vincent Santucci’s presentation was titled “Celebrating the Paleontological Heritage of Grand Canyon National Park during the Park’s Centennial”. Approximately 85 visitors attended the special evening program.



Figure 20. Paleontology activities were everywhere at the Grand Canyon Visitor Center Plaza on National Fossil Day. A) Mary Carpenter (BADL) takes a photo at the American Geosciences Institute photo booth (NPS/VINCENT SANTUCCI). B) Jason Kenworthy (GRD) swears in a new Junior Paleontologist at the NPS outreach booth (NPS/HAZEL WOLFE). C) Maria Rodriguez (GLCA) admires the *Suskityrannus* puppet Doug Wolfe (ZDig) exhibited at his Zuni Dinosaur Institute outreach booth (NPS/MICHAEL QUINN). D) Park Ranger Mary Ontiveros (TUSK) tells visitors about the fossil resources at TUSK (NPS/HAZEL WOLFE).



Figure 21. Vincent Santucci, NPS Senior Paleontologist, addresses visitors at the Welcome Ceremony during the National Fossil Day Celebration at Grand Canyon National Park (NPS/MICHAEL QUINN).

A Run of Show was developed by Interpretive Park Ranger Ronnie Colvin (Appendix D). This Run of Show ensured each participant, volunteer, and staff member knew where they needed to be, when they needed to be there, what items needed to be present in a particular location, and any other pertinent information. The Run of Show provided in depth detail of the pre-event planning and staging of items as well as the schedule for the event itself. Staff at GRCA and other NPS units are strongly encouraged to utilize a Run of Show document for future NFD events.

This event would not have been possible without the help and support from our partner organizations, GRCA Interpretation Staff, GRCA Science and Resource Management staff, and other supporting individuals. We would like to thank these individuals for their participation in the 10th annual National Fossil Day Celebration (Appendix E). This special kickoff event was so successful, because of their enthusiastic contributions highlighting the scientific and educational value of paleontology and the importance of preserving fossils for future generations. Following the National Fossil Day Celebration, Vincent Santucci, Ronnie Colvin, and Diana Boudreau sent an official letter of thanks to participants of the National Fossil Day Celebration and attached a copy of the group photo taken on the GCVC plaza (Figure 22).

The success of the 2019 National Fossil Day Celebration at Grand Canyon National Park sets the stage for future National Fossil Day events to be held at National Park units across the country. The work completed by GRCA and WASO staff (Figure 23) to host this event will be utilized for years by other NPS staff planning large National Fossil Day Celebrations in the future.



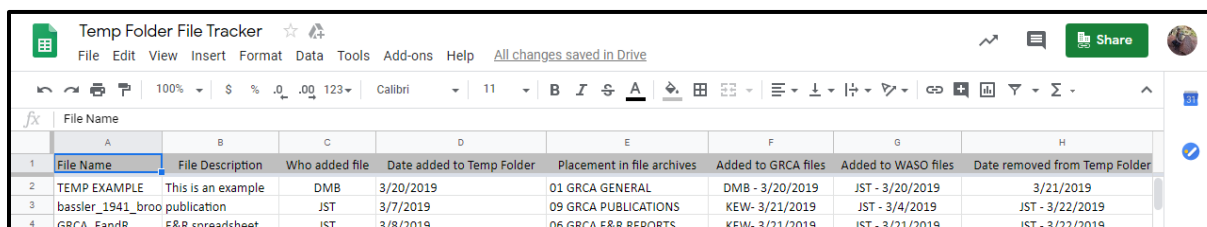
Figure 22. Partner organizations and NPS staff gathered at the Visitors Center to celebrate National Fossil Day at Grand Canyon National Park on September 28, 2019. Left to right (front): Jeremy Childs, Jennifer Glennon, Anne Miller, Hazel Wolfe, Celia Dubin, Kevin Garcia, John-Paul Hodnett, Vincent Santucci, Mary Carpenter, Jim Mead, Joel Despain, Adam Blankenbicker, Chris Symons, Jason Kenworthy, and Justin Tweet. Left to right (back): Grace Lilly, Janet Gillette, David Gillette, Tom Olson, Richard McMichael, Don Weeks, Anne Scott, Eleanor Snow, Andy Grass, Sequoyah McGee, Robyn Henderek, Sandy Croteau, Erin Eichenberg, Diana Boudreau, Sherman Mohler, Mary Ontiveros, Doug Wolfe, Maria Rodriguez, Veronica Colvin, Joel Kane, and Bryan Maul (NPS/MICHAEL QUINN).



Figure 23. Members of the GRCA Paleontology Team at the Mather Amphitheater following the Welcome Ceremony. Left to Right: Jeanne Calhoun, Anne Miller, Mark Nebel, Ronnie Colvin, Diana Boudreau, Sarah Haas, JP Hodnett, and Vincent Santucci. (Not pictured: Justin Tweet, Ronda Newton, Kim Besom, Colleen Hyde, and Klara Widrig) (NPS/MICHAEL QUINN).

Data Management and Archives

During the 2019 Paleontology Project, many new documents, publications, photos, and files needed to be digitally archived in both the GRCA and WASO paleontology archives. To ensure each document was filed in the same location in both archives, a temporary Google Drive folder and file tracker spreadsheet were created (Figure 24). Diana Boudreau maintained the GRCA archives and Justin Tweet maintained the WASO archives. Archives have been fully updated as part of the 2019 Paleontology Inventory. In addition, photogrammetry models, files, and associated photos have been archived on IRMA.



	A	B	C	D	E	F	G	H
	File Name	File Description	Who added file	Date added to Temp Folder	Placement in file archives	Added to GRCA files	Added to WASO files	Date removed from Temp Folder
1	TEMP EXAMPLE	This is an example	DMB	3/20/2019	01 GRCA GENERAL	DMB - 3/20/2019	JST - 3/20/2019	3/21/2019
2	bassler_1941_broo publication		JST	3/7/2019	09 GRCA PUBLICATIONS	KEW- 3/21/2019	JST - 3/4/2019	JST - 3/22/2019
3	GRCA E&R E&R spreadsheet		IST	3/8/2019	06 GRCA E&R REPORTS	KEW- 3/21/2019	JST - 3/21/2019	JST - 3/22/2019

Figure 24. Temporary folder file tracker spreadsheet developed to keep a record of files shared and added to WASO and GRCA digital archives. Files were shared using Google Drive (NPS).

GRCA Paleontology Archives

GRCA maintains a paleontology archive and library to organize all documents related to paleontology resources at the park. Items such as field notes, publications, historic photos, maps, research permits, and museum collection documents can be found within the archives. Due to the sensitive nature of paleontological resources, paleontology archives are restricted access only. To request access to information within the archives, contact Mark Nebel (mark_nebel@nps.gov) or Anne Miller (anne_miller@nps.gov).

NPS Paleontology Program Archives (WASO)

The National Park Service Paleontology Program (WASO) maintains a copy of all field notes, sketches, photographs, maps, reports, publications, and fossil specimens archived at GRCA (Santucci et al. 2018). This ensures the safety of paleontological resource data in the event either GRCA or WASO archives are lost. To request access to materials in the NPS Paleontology Program archives contact Vincent Santucci (vincent_santucci@nps.gov) or Justin Tweet (justin_tweet@nps.gov).

GRCA Museum Archives

In addition to the digital GRCA archives, a number of physical materials related to the Inventory Report, PaleoBlitz, and National Fossil Day (NFD) activities were added to the GRCA archives. National Fossil Day Celebration items include NFD logo pins, patches, stickers; NFD postcards; GRCA fossil-themed trading card set; and a framed Arizona State greeting read during the welcome ceremony. PaleoBlitz items include physical or scanned copies of field notebooks from Klara Widrig (GIP), Diana Boudreau (GIP/ACE), John-Paul Hodnett (NFD, M-NCPPC), Anne Miller (GRCA), Adam Marsh (PEFO), and Bill Parker (PEFO), and ten specimens collected during PaleoBlitz

activities. Inventory report items will include a physical copy of the GRCA Paleontological Resources Inventory Report once it has been published.

Literature Cited

- Francischini, H., S. G. Lucas, S. Voigt, L. Marchetti, V. L. Santucci, C.L. Knight, J.R. Wood, P. Dentzien-Dias, and C.L. Schultz. 2019. On the presence of *Ichniotherium* in the Coconino Sandstone (Cisuralian) of the Grand Canyon and remarks on the occupation of deserts by non-amniote tetrapods. PalZ: 1-19. <https://doi.org/10.1007/s12542-019-00450-5>.
- Santucci, V. L., J. S. Tweet, and T. Connors. 2018. The paleontology synthesis project and establishing a framework for managing National Park Service paleontological resource archives and data. New Mexico Museum of Natural History and Science Bulletin 79:589–601.

Appendix A: 2019 Paleontology Project Accomplishments

GRCA Paleontology Project—General

- Updated the GRCA Cave/Archeology Non-Disclosure form to include Paleontological Resources.
- Obtained funding from GCC to support the GRCA Paleontological Resource Inventory (approximately \$50,000).
- Obtained funding to support two paleo interns to support the GRCA Paleontological Resource Inventory.
- Wrote an After Action Report to summarize accomplishments and processes of the project (this report).
- Finalized the Paleontology Programmatic Categorical Exclusion (PEPC 90271).

GRCA Paleontology Inventory Report

- Recruited a variety of paleontologists to participate in writing the inventory report chapters.
- Development, internal team review, peer review, and program review of original manuscripts which will be published in the GRCA Paleontological Resource Inventory Report including:
 - History of GRCA Paleontology (Spamer)
 - Geology and Stratigraphy (Connors, Tweet, & Santucci)
 - Precambrian Paleontology (Tweet)
 - Paleozoic Invertebrate Paleontology (Lassiter, Tweet, Foster, Sundberg, & Bergman)
 - Paleozoic Vertebrate Paleontology (Hodnett & Elliot)
 - Paleozoic Paleobotany (Knight)
 - Paleozoic Invertebrate Ichnology (Miller, Marchetti, Francischini, & Lucas)
 - Paleozoic Vertebrate Ichnology (Marchetti, Francischini, Lucas, Voigt, Santucci, & Hunt)
 - Mesozoic Paleontology (Marsh, Parker, & Miller)
 - Pleistocene/Holocene Cave Paleontology (Mead, Tweet, Santucci, Tobin, Chambers, Thomas, & Carpenter)
 - Paleontological Resources Management (Boudreau, Santucci, Widrig, Miller, Nebel, Colvin, Hyde, & Besom)

GRCA PaleoBlitz & Field Collection of Fossil Specimens

- Obtained funding from BRD to support the PaleoBlitz (\$5,000).
- Completed PaleoBlitz activities in the Mesozoic Strata (Chinle & Moenkopi), Kaibab Limestone, Coconino Sandstone, and Bright Angel Shale.
- Added 25 new localities and 55 new sites to the paleontology geodatabase.
- Collected three specimens from the Bright Angel Shale along North Kaibab Trail
 - Catalog #GRCA122002, GRCA122001, GRCA122003; Accession #GRCA5930
- Collected multiple track blocks from Coconino Sandstone along New Hance Trail including one 40 lb block. Trackways include both invertebrate and vertebrate traces.
 - Catalog #GRCA120545, GRCA120546, GRCA120547, GRCA120548, GRCA120549; Accession #GRCA5930
- Collected one vertebrate swim trace track block from Mesozoic PaleoBlitz.
 - Catalog #GRCA33186; Accession #GRCA5930
- Collected Permian fish tooth plate from Hermit Trail.
 - Catalog #GRCA33184; Accession #GRCA5898
- Collected Permian bony fish and shark material during the Paleozoic Vertebrates PaleoBlitz.
 - Items will be cataloged following processing and identification by John-Paul Hodnett.

GRCA National Fossil Day Celebration, Interpretation, Education, & Outreach

- Created logo depicting Rampart Cave/Sloth/Bat as 2019 NFD logo and a companion Fossil Park logo for GRCA.
- Designed and printed a new GRCA Paleontology Pop-Up Exhibit.
- Designed and printed 12,000 postcards featuring the 2019 NFD logo and info on the 2019 NFD event at Grand Canyon. 10,000 will be distributed in the Earth Science Week toolkits.
- Designed and printed 14,000 sets of nine GRCA fossil-themed trading cards.
 - Used cards to generate excitement for NFD Celebration at GRCA with a “countdown to NFD” social media series ten days prior to the event.
- Obtained an Arizona State greeting from the governor’s office for the NFD welcome ceremony.
- Commissioned original artwork depicting Rampart Cave fossils.

- Hosted a National Fossil Day Celebration at Grand Canyon National Park September 27 & 28.
 - Hosted a Paleontology Symposium evening of September 27.
 - Hosted 12 partner organizations and many volunteers to assist with NFD September 28.

GRCA Paleontology Research

- *Ichniotherium* specimen from GRCA described and published. Information on this publication shared with media by GRCA and WASO public affairs.
- Obtained copies of Charles Walcott's field notes from the Smithsonian.

GRCA Paleontology Collections & Archives

- Obtained photogrammetric images of 16 specimens from GRCA and Smithsonian museum collections and specimens in the field, and made models available online with descriptions for interpretive purposes.
 - Vampire Bat Skull; Sloth Skull + Dung; Felid Skull; Harrington's Mountain Goat Skull; Crinoid; Trilobite; Seed Fern; Coiled Nautiloid; Brachiopod (*Peniculauris*); California Condor; *Ichniotherium* Trackway; Dragonfly Wing; Phylloodont Tooth Plate; *Chelichnus* Tracks; Bright Angel Trackway
 - Online link: <https://www.nps.gov/articles/series.htm?id=A9E62040-AC6F-A6D7-BE564A036F1D6146>
 - All photogrammetry files were archived on IRMA Portal.
- Many fossils in the GRCA museum collection were photographed including (fossil plants, invertebrate traces, and vertebrate ichnofossils).
- Digitized Daryl Martin's thesis "Depositional systems and ichnology of the Bright Angel Shale (Cambrian), Eastern Grand Canyon, AZ" and added it to GRCA museum collection.
- A missing specimen of GRCA fossil fish was relocated by John-Paul Hodnett during research for the GRCA Paleozoic Vertebrate Fossil chapter.
- Accessioned a number of NFD, PaleoBlitz, and Inventory Report items into the GRCA museum collection, including: NFD logo pins, patches, stickers; NFD postcards; GRCA fossil-themed trading card set; framed Arizona state greeting read at the welcome ceremony; copies of field notebooks from PaleoBlitz activities; and a physical copy of the published inventory report.

GRCA Paleontology Geodatabase, GIS, & File Structure

- Mark Nebel and Anne Miller completed their GRCA Paleontology geodatabase for managing fossil locality data, photos, collected specimens, etc.
- Updated field locality and site form for collecting data in the field.

- Incorporated legacy photos into new database organization.
- Created related table for collected specimens within the geodatabase.
- Implemented GIS Collector software during 2019 PaleoBlitz to easily collect locality and site data in the field.

Appendix B: GRCA Scientific Research and Collecting Permit

SCIENTIFIC RESEARCH AND COLLECTING PERMIT Grants permission in accordance with the attached general and special conditions United States Department of the Interior National Park Service Grand Canyon		Study#: GRCA-00745 Permit#: GRCA-2019-SCI-0002 Start Date: Jan 01, 2019 Expiration Date: Dec 31, 2019 Coop Agreement#: Optional Park Code:
Name of principal investigator: Name: Mr Vincent Santucci Phone: 202-513-7186 Email: VINCENT_SANTUCCI@nps.gov		
Name of institution represented: NPS		
Additional investigators or key field assistants: Name: Justin Tweet Phone: 612-860-9469 Email: justin_tweet@nps.gov Name: Mark Nebel Phone: 928-638-7451 Email: mark_nebel@nps.gov Name: Anne Miller Phone: 918-520-8346 Email: annemiller317@gmail.com		
Study Title: Grand Canyon National Park Paleontological Resource Inventory and PaleoBlitz		
Purpose of study: GRCA's Paleontological Resource Inventory is directed towards compiling the substantial paleontological resource information for GRCA into a single report. The report is intended as a reference and guidance document concerning GRCA's expansive paleontological resources, which will support and inform park planning, operations, outreach and other activities which may relate to the park fossils. This effort is supported by a Technical Assistance Request by GRCA to the NPS Paleontology Program within the WASO Geologic Resources Division, and does not require a great deal of field work. There has been 130+ years of previous field work documenting the extensive paleontological resources of GRCA, including the work of multiple paleontology interns and researchers over the past decade. NPS Senior Paleontologist, and PI, Vincent Santucci has been compiling GRCA paleontological information and archives beginning in 1991, during his tenure as the paleontologist at PEFO. During 1994, Santucci worked for GRCA developing the last Integrated Resource Management Plan for the park and obtained substantial paleontological resource info through this process. Over the course of 27 years Santucci has compiled a huge archive of scientific publications, resource management information, photographs, maps, etc. related to GRCA paleontology. The proposed work for GRCA will synthesize the large amount of paleontological resource information into a dedicated paleontological resource inventory document. The primary deliverables for this project included the GRCA Paleontological Resource Inventory Report and the associated data, maps, photographs and other archives. The report will contain sensitive paleontological resource locality information which will be valuable for current and future staff to have access to help inform park planning. Additionally, this information will represent the first effort to compile comprehensive baseline data for GRCA paleontological resources which will ultimately expand over time with new fossil discoveries. One of the questions that the research team will propose to park leadership is the option to develop a second version of the GRCA paleontological resource inventory report which would not include sensitive paleontological resource information and more appropriate for sharing with a wider audience and the public. Although the field collection of fossils is not a significant component in this proposed fossil inventory, the team will host a PaleoBlitz at GRCA during the spring of 2019. The PaleoBlitz would involve teams of paleontology specialists, familiar with the paleoflora and paleofauna of the park's strata, to visit targeted localities where field assessment and documentation of the paleontological resources can be accomplished using modern scientific principles, methodologies and expertise. Most of the documentation of fossils during the PaleoBlitz is intended for field assessments, taxonomic identifications, photography and GPS recording rather than actual field collection of fossils. However, in cases where rare, well preserved or scientifically significant fossils are encountered by members of the PaleoBlitz, there would be consideration of fossil collection if these specimens contribute to potential new scientific understandings.		
Subject/Discipline: Management (Administration) Paleontology		
Locations authorized: Although the paleontological resource inventory is a park-wide undertaking, the specific locations to be inventoried are yet to be determined. All localities surveyed will be documented in the final report.		
Transportation method to research site(s):		

Permit: GRCA-2019-SCI-0002 - Page 1 of 6

Figure B-1. First page of a collecting permit issued for the 2019 GRCA paleontology project.

Foot travel throughout the park.
Collection of the following specimens or materials, quantities, and any limitations on collecting: n/a
Name of repository for specimens or sample materials if applicable:
NPS General Conditions for Scientific Research and Collecting Permit (available at the RPRS HELP page) apply to this permit. The following specific conditions or restrictions, and any attached conditions, also apply to this permit: CONDITIONS SUBJECT TO ALL GRCA PERMITS: NON-RIVER USE 1. UTM Zone 12N NAD83 is to be used by all researchers to ensure compatibility with all GRCA GIS layers. 2. PI confirms knowledge of Leave No Trace techniques and agrees to utilize these techniques to minimize impacts to vegetation during collection and processing. 3. Reporting Requirements: a. Reports and datasets: Copies of all maps, data, reports, etc. will be archived at Grand Canyon upon completion of study; b. Submit a Final Report within six months of completion of study or expiration date of this permit. This report can be submitted electronically to Ronda_Newton@nps.gov or through the IRMA website (https://irma.nps.gov/Portal); c. All final reports and documentation resulting from this study are to be submitted to the park for review before distributing to the public/press; d. PI is required to submit datasets and reports from any previous permitted research before a new or renewal of a permit will be considered. The 90-day evaluation period will not start until datasets and reports are received by the GRCA Research Coordinator. 4. PI and associated researchers will camp in areas that minimize public interaction and that are less desirable to the visiting public; and will have professional contacts with the public, spending a reasonable amount of time explaining the purpose of their studies to the visiting public. 5. Breach of any of the terms of this permit or for violation of park regulations will be grounds for revocation of this permit and denial of future permits. Citations may be issued for adverse actions and violations of this permit. 6. PI will meet with GRCA staff as needed to discuss the conditions of their permit. 7. GRCA staff is authorized to accompany research trips and provisions will be made for park participants. 8. If archaeological materials and/or sites are encountered, all work must stop and the Research Office & GRCA Cultural Resources Program Manager must be consulted and provided with exact locations and/or UTM coordinates of the sites/plots. GRCA Cultural Resources Program Manager, Ellen Brennan, can be contacted at (928) 638-7742 and GRCA Research Coordinator, Ronda Newton, can be contacted at (928) 638-7447. Work cannot resume until the discovery is evaluated by a GRCA staff archaeologist and a mitigation plan, if necessary is developed and implemented. 9. The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) assigns ownership and control of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony to the lineal descendants, closest culturally affiliated tribe, or to the Indian tribe recognized as aboriginally occupying the area in which the objects were discovered. Consultation with potentially culturally affiliated tribes is required within a set time frame, with very specific processes that have been established through the NAGPRA regulations. Responsibility falls to the land manager regardless of the context of the discovery. All GRCA research projects and research personnel must be aware of the NAGPRA regulations. The PI is responsible for immediately notifying GRCA of any NAGPRA discoveries. Notifications and /or questions can be directed to GRCA Cultural Resources Program Manager, Ellen Brennan, at (928) 638-7742. 10. In accordance with the Paleontological Resources Protection Act of 2009 (PL 111-11), resources collected from federal land are federal property. All collected resources and copies of associated records will be preserved and made available for the public and researchers (Sec. 6304. C. 1-2). In addition, any resources and data and records collected will be stored and curated in an approved repository (Sec. 6305). 11. Accessing research areas and conducting research in GRCA entails various serious risks to human health or safety posed by the largely natural conditions of the park. The PI is aware of these risks, and voluntarily and knowingly assumes all risks associated with accessing research areas and conducting research in the park. Furthermore, the PI hereby agrees to indemnify and hold harmless the United States and its employees and officers against any and all liability to third parties arising out of or related to the PI access to research areas or the conduct of research in Grand Canyon National Park. As part of this agreement the PI agrees to reimburse the United States for its costs, including the costs of federal employees time, in investigating, defending, compromising, or otherwise resolving any claim, demand, or cause of action brought by any third party against the United States or its employees or officers arising out of or related to the PIs access to research areas of the conduct of research in the park. 12. By signing this document, I hereby affirm that I will abide by the DOI policy set forth in the DOI Departmental Manual, DOI Departmental Management Series, Part 305, Ch. 3, Sec. 3.7, and with Director's Order #79 (Integrity of Scientific and Scholarly Activities). 13. If you collect specimens that are to be permanently retained, regardless of where they are kept, they must be accessioned and cataloged into the NPS catalog system, and must bear NPS accession and catalog numbers. For assistance, contact the Curator's Office at (928) 638-7769, or GRCA_Museum_Collection@nps.gov. Copies of all catalogue records will be submitted to GRCA Museum Collection upon completion of cataloging. 14. I agree to keep confidential any protected information that I may develop or otherwise acquire as part of my work with the NPS. I understand that with regard to protected information, I am an agent of the NPS and must not release that information. I also understand that by law I may not share protected information with anyone through any means except as specifically authorized by the NPS. I understand that protected information concerns the nature and specific location of endangered, threatened, rare, commercially valuable, mineral, paleontological, or cultural patrimony resources such as threatened or endangered species, rare features,

Permit: GRCA-2019-SCI-0002 - Page 2 of 6

Figure B-2. Second page of a collecting permit issued for the 2019 GRCA paleontology project.

archaeological sites, museum collections, caves, fossil sites, gemstones, and sacred ceremonial sites. Lastly, I understand that protected information must not be inadvertently disclosed through any means including websites, maps, scientific articles, presentation and speeches.

15. Unless otherwise authorized on your permit, you must carry out all of your activities out of public view. If you have obtained special permission to work in public view, it will be noted on your permit-specific conditions. Please consult these conditions for further guidance. If sampling at some sites cannot be accomplished out of public view, please contact the Research Office at (928) 638-7447 to obtain a uniformed escort.

16. PI is responsible for the research-related activities of your staff. Please ensure that field staff adhere to all conditions of your permit. Field staff must possess a copy of your permit at all times while in the field.

17. This research permit does not authorize entrance into closed or restricted areas of the park. The following are restricted areas and entrance is prohibited: Anasazi Bridge; Furnace Flats archaeological site; caves and mine shafts or adits including but not limited to Bass Mine, Hance Mine, Hopi Salt Mine, Orphan Mine, Deer Creek Narrows, and Maricopa Point. If you have obtained special permission to work in one of these areas, it will be noted on your permit-specific conditions.

18. PI agrees to notify the superintendent of GRCA of every subject discovery or invention that relates in any respect to research results derived from use of any research specimens or other materials collected from GRCA, or that may be patentable or otherwise protected under the intellectual property (IP) laws of the United States or other jurisdiction. Notification must occur within sixty days of the time that an inventor or other agent of the PI reports such a subject discovery or invention to the persons responsible for patent or other proprietary rights matters in the PI's organization, and in no case not less than sixty days before a patent application is filed. Additionally, the PI agrees to notify the superintendent of GRCA within thirty days of filing any patent application or other IP claim in the United States or other country that relates in any respect to research results or other discoveries or inventions derived from use of any research specimens or other materials collected from GRCA. For purposes of this paragraph, the term "subject discovery or invention" means any discovery or invention related to or derived from research specimens or other materials collected from GRCA. All invention disclosures shall be marked as confidential under 35 U.S.C. Section 205.

19. This permit does not authorize the bearer or those that accompany them to conduct commercial filming activities. Commercial film permits must be obtained from the Commercial Services office (928-638-7707).

20. Each year, PIs are required to submit copies of journal articles, theses, and dissertations that resulted from park research activities to the Research Office. Documents should be submitted in .pdf format, with the exception of theses/dissertations, which should be sent as bound documents.

THIS PERMIT SERVES AS YOUR GATE PASS THROUGH 12/31/2019.

A copy of this permit should be displayed visibly in your parked vehicle when in the park.

Recommended by park staff(name and title):

R. P. H. Research Coordinator

Approved by park official:

James Calhoun

Title: James Calhoun
Chief, Science & Resource Management

Reviewed by Collections Manager:

Yes ☒ No ☐

Date Approved:

2/7/2019

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

Unit L. S. S.

(Principal investigator's signature)

Dec. 18, 2018

(Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

Figure B-3. Third page of a collecting permit issued for the 2019 GRCA paleontology project.



GENERAL CONDITIONS For SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.
2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.
3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.
4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.
5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.
6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.
- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog. Unless exempted by additional park - specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

Figure B-4. Fourth page of a collecting permit issued for the 2019 GRCA paleontology project.

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement (CRADA) or other approved benefit - sharing agreement with the NPS. The sale of collected research specimens or other unauthorized transfers to third parties is prohibited. Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent (20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

7. Reports -- The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff. Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested. The permittee is responsible for the content of reports and data provided to the National Park Service

8. Confidentiality -- The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

9. Methods of travel - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

10. Other permits - The permittee must obtain all other required permit(s) to conduct the specified project.

11. Insurance - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

12. Mechanized equipment - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

13. NPS participation - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

14. Permanent markers and field equipment - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

15. Access to park and restricted areas - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

16. Notification - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit. Ideally this contact should occur at least one week prior to the initial visit to the park.

17. Expiration date - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

18. Other stipulations - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this

Figure B-5. Fifth page of a collecting permit issued for the 2019 GRCA paleontology project.

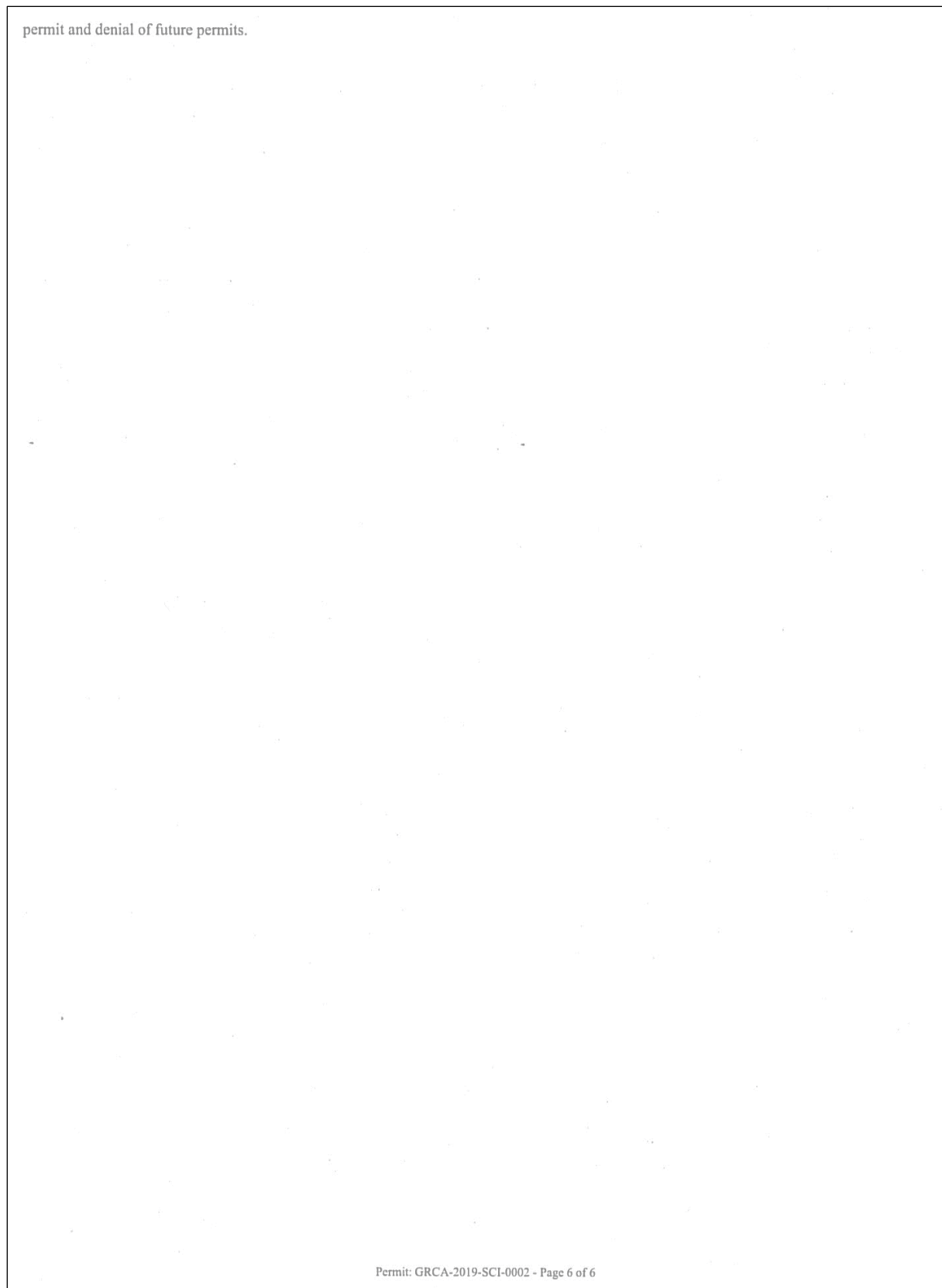


Figure B-6. Sixth page of a collecting permit issued for the 2019 GRCA paleontology project.

Appendix C: 2019 Paleontology Project Timeline

Table C-1. Project Timeline. Government shut-down caused a delay in all aspects of the 2019 Paleo Project.

Date(s)	Activities
July 2018	NPS Paleontology Program (Vincent Santucci) coordinated with GRCA SRM Leadership (Jeanne Calhoun) to propose 2019 Paleontology Project components
December 6, 2018	Budget proposal submitted to Grand Canyon Conservancy by NPS Paleontology Program (Vincent Santucci) and GRCA SRM staff (Mark Nebel). Budget was approved by GRCA leadership and ultimately Grand Canyon Conservancy. This provided funds to hire two paleontology interns through GeoScientists-in-the-Parks (GIP) program, supported PaleoBlitz events, and other project needs.
February 19, 2019	Onboard two GIP Paleontology Assistants; Establish GRCA Paleo Core Team
February 26, 2019	GRCA Centennial Celebration
February 27, 2019	Initial meeting with GRCA Paleo Core Team (weekly calls on Wednesday)
March 20, 2019	Begin designs for GRCA Pop-Up Exhibit (delivered June 26, 2019)
April 1-5, 2019	Photogrammetry Training Project with Jack Wood (GRD)
April 16, 2019	Began designs for Earth Science Week and National Fossil Day promotional postcard (delivered June 18)
April 30 – May 1	Internal Team PaleoBlitz – 2-day survey of Coconino, Toroweap, and Kaibab on New Hance Trail *Collected 2 specimens, will be accessioned into GRCA Museum
May 13, 2019	Internal Team PaleoBlitz – 1-day survey of Kaibab along Hermit Trail
June 24-25, 2019	Internal Team PaleoBlitz – 2-day survey of Coconino on New Hance Trail *Collected 5 specimens and accessioned into GRCA Museum
July 8, 2019	Began designs for GRCA Trading Cards (delivered September 17, 2019)
July 15-16, 2019	Mesozoic Team PaleoBlitz – 2-day survey of Cedar Mountain *First test of the ArcGIS Collector system for paleontology field data collection *Collected 1 specimen and accessioned into GRCA Museum
July 30, 2019	Internal Team PaleoBlitz – 1-day survey of Coconino Formation on Tanner Trail
August 5-8, 2019	Internal Team PaleoBlitz – 2-day survey of Kaibab and Coconino formations on North Bass Trail and Coconino on Saddle Mountain Trail
Sept 4, 2019	Paleontology Project Briefing for GRCA Leadership
Sept 21, 2019	Flagstaff Science Festival – GRCA Outreach Booth
Sept 22-23, 2019	Vertebrate Body Fossil PaleoBlitz – Point Sublime, The Basin
Sept 25-26, 2019	Vertebrate Body Fossil PaleoBlitz – Fossil Mountain, Hermit Drainage
Sept 25, 2019	Internal Team PaleoBlitz – 1-day survey of Coconino and Kaibab along Grandview Trail
Sept 26, 2019	Internal Team PaleoBlitz – 1-day survey of Kaibab along Hermit Trail
Sept 27, 2019	Paleontology Symposium (7:30 PM at Shrine of the Ages) Events included: fossil specimen table; Spencer Lucas – Tracks and Traces at GRCA; Linda Lassiter – Invertebrate Fossils of GRCA; Jim Mead – Cave Paleontology; JP Hodnett – Sharks of GRCA; Vincent Santucci presented awards to the GRCA Paleo Team

Table C-1 (continued). Project Timeline

Date(s)	Activities
Sept 28, 2019	National Fossil Day Celebration at Grand Canyon National Park Events included: Fossil Walk Ranger Program; Partner organization booths at Visitor Center, Children's activity table at Geology Museum; Facebook Live events with paleontologists; Welcome Ceremony; Special Evening program by NPS Senior Paleontologist, Vincent Santucci
November 14, 2019	After Action Report Completed
November 15, 2019	Final Paleontology Project Briefing for GRCA Leadership
January 2020	Anticipated publication of GRCA Paleontological Resources Inventory Report

Appendix D: National Fossil Day Celebration Run of Show

Table D-1. Thursday/Friday, September 27 Staging and Set-up Activities.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
12:00 PM– 5:00 PM	Stage items for Paleontology Symposium *Items for the fossil museum table will be staged in the Education Office (SOTA)	SOTA Auditorium and Education Office	Sandwich board signs (GCVC, SOTA sidewalk, lobby) Museum Display Tables (2) and labels 2 NPS Tablecloths (Interp, PIO) John, Ronnie, Diana, Anne, Mark
12:00 PM– 5:00 PM	Stage items for NPS Booth *Larger items: tables, chairs, pop up tents will be staged in the storage shed next to GCC store	GCVC Break Room To access storage shed contact Zane Johnson/Ken Andrews	NPS Table Cloth Park Brochures Museum Specimens & labels Giveaways -NFD Stickers & Postcards -Fossil Trading Cards -Junior Ranger Books and Badges -Centennial Books and stickers John, Ronnie, Joel, Jeremy, Diana
12:00 PM– 5:00 PM	Stage items for GCVC Plaza Partner Booths & Welcome Ceremony *Larger items: tables, chairs, pop up tents will be staged in the storage shed next to GCC store.	GCVC Break Room To access storage shed contact Zane Johnson/Ken Andrews	<u>Welcome Ceremony</u> Podium US, NPS, AZ Flag Sandwich board signs Sandwich boards Speakers and stands Green NPS Table Cloths 1 (6 ft) table 4 chairs AZ State Greeting in frame <u>GCVC Plaza</u> 8 (6ft) Tables 30 Chairs 2 (10x10) Pop Ups & Weights Sandwich board signs Sandwich boards Nature Valley Bars Extra Materials Bin Green NPS Table Cloths Tape Bungee Cords Hand Sanitizer Sunblock Extension Cords John, Ronnie, Joel, Jeremy, Diana

Table D-1 (continued). Thursday/Friday, September 27: Staging and Set-up Activities.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
12:00 PM– 5:00 PM	Stage items for Yavapai Geology Museum	Yavapai Geology Museum Storage Room	2 (6 ft) Tables 2 Table Cloths (NPS logo) Fun with Fossils Bin Touch Table Items & labels Jeremy (lead), John, Warren, Anne, Robyn

Table D-2. Friday, September 27: Paleontology Symposium, Shrine of Ages Auditorium.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
6:30 PM	Setup fossils & tables for Paleo Symposium Greet Visitors	SOTA Auditorium and Education Office *Items for the fossil museum table will be staged in the Education Office	Front row of chairs for speakers AV Check: John, Ronnie Junior Paleo Booklets and Badges GRCA Fossil Trading Cards Museum Display Tables (2) NPS Logo Tablecloths (2) Load Presentations onto Interp computer John, Ronnie, Diana, Anne, Mark, Vince
7:30 PM	Paleontology Symposium	SOTA Auditorium *Following Symposium return fossil specimens to Education Office, Lock up Building, Collect tablecloths for Saturday	Symposium Outline EP/NPS Welcome (Ronnie) Remarks, Trading Cards (Vince) Intro Speaker 1 (Ronnie) Intro Speaker 2 (Ronnie) Intro Speaker 3 (Ronnie) Intro Speaker 4 (Ronnie) Program Wrap-up, Junior Rangers (Ronnie, John) John, Ronnie, Diana, Anne, Mark, Vince
9:00 PM	Paleo Team Award Presentation	SOTA Auditorium	Vince Team Photo

Table D-3. Saturday, September 28: Welcome Ceremony 1:00-2:00 PM, Mather Amphitheater.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
12:00 PM	Welcome Ceremony Set up tables and chairs Two tables outside of the amphitheater Flags set up behind speakers-easiest to tie to railing 1 row of chairs set up next to podium for speakers Chairs set up on first two rows of amphitheater Media area blocked off	Mather Amphitheater Rain Location: GCVC Theater	3 (6 ft) tables US, NPS, AZ Flag Speakers and stands Podium Media-chairs Sandwich board signs Diana, Ronnie, John, Chris, Mark, Anne, Justin, Vince
12:00 PM	Set up sandwich boards (2 locations)	Tribal Medallion Amphitheater	2 sandwich boards, double sided *Rain Location sign will be in the back of GCVC
12:45 PM	Guests Arrive	Mather Amphitheater	Greeters at amphitheater Volunteers (4) Ronnie, Diana, Chris, John
1:00 PM	CEREMONY STARTS Introduction/Remarks	Mather Amphitheater	SRM Leadership- Jeanne Calhoun
1:05 PM	Remarks by NPS leadership	Mather Amphitheater	Jeanne Calhoun
1:10 PM	Intro of Bruce MacFadden	Mather Amphitheater	Jeanne Calhoun
1:12 PM	Remarks President, Paleontological Society	Mather Amphitheater	Bruce MacFadden
1:17 PM	Intro of Ronnie Colvin	Mather Amphitheater	Jeanne Calhoun
1:19 PM	Proclamation by Az Gov Office	Mather Amphitheater	Ronnie Colvin
1:22 PM	Intro of Vincent Santucci	Mather Amphitheater	Ronnie Colvin
1:23 PM	Remarks by NPS Paleontology Program Manager	Mather Amphitheater	Vincent Santucci
1:28 PM	Program wrap-up & Photo Op	Mather Amphitheater	Vincent Santucci
1:30 PM	Break down amphitheater	Load podium, speakers, stands, table, chairs, etc. into vehicles and store at GCVC	Ronnie, John, Diana, Justin, Chris, Mike

Table D-4. Saturday, September 28: All Day NFD Partner Activities 10:00 AM–3:00 PM, Grand Canyon Visitor Center Plaza.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
7:30 AM	Morning briefing with Interpretation Staff Set up tables, Pop-Up Tents, chairs, props, supplies, parking signs, and sandwich boards at Plaza locations *Larger items: tables, chairs, pop up tents will be staged in the storage shed next to GCC store.	GCVC Breakroom GCVC Plaza To access storage shed contact Zane Johnson/Ken Andrews	Red Truck (Interp) 8 (6 ft) Tables 20 chairs 2 NPS Pop-Up Tents 2 Pop-Up Tents Banners, Sand bags Supply Bin Cave Paleo Pop-Up display 3 boxes, Junior Paleo booklets and badges 3 boxes, Junior Cave Scientists booklets and badges 27 boxes, Trading Cards NPS Props Bin 4 double sandwich boards in Plaza Bus Island, Mather, BAB, VC All available staff and support team
9:00 AM	<u>Partners Arrive</u> National Park Service (NPS) American Geosciences Institute (AGI) Az Museum of Natural History (AzMNH) Southwest Paleontological Society (SPS) Zuni Dinosaur Institute for Geosciences (ZDIG) National Cave and Karst Research Institute (NCKRI) Museum of Northern Arizona (MNA) Protectors of Tule Springs Fossil Bed (TULE) United States Geological Survey (USGS)	GCVC Plaza & Parking Lots *Safety Vests required, stored in GCVC closet by breakroom	Parking Lot 4 will be reserved as Loading Zone, please make sure any spaces not used are released by 10 am Partner Parking available in Employee Parking behind GCVC Safety Vests Required Traffic cones from GCVC hall All available Support Staff
10 AM	NPS Table Floating Staff for NPS Tables (Justin, Maria, Jason staffed consistently)	GCVC Plaza	NPS Tablecloth & Pop-Up Tent 3 boxes Junior Paleo books, badges, pencils 27 boxes of Trading Cards NFD Stickers & postcards NPS Props Bin Park Brochures Centennial Books, etc. Fossil replicas & labels

Table D-4 (continued). Saturday, September 28: All Day NFD Partner Activities 10:00 AM–3:00 PM, Grand Canyon Visitor Center Plaza.

DATE	ACTIVITY	LOCATION	NOTES/STAFF
12:30 PM	Welcome Ceremony	Mather Amphitheater	Speakers-Vince, Leadership Jeanne, Bruce, Ronnie Support Staff: Ronnie, John, Diana, Mark, Anne, JP
2:45 PM	Reserve Parking Lot 4 as Loading Zone	Parking Lots Safety Vests stored in GCVC closet by breakroom	Diana Safety vest required
3:00 PM	Breakdown Plaza Tables	Tables and chairs to GCVC back entrance and kitchen Pop-Up Tents, sandbags, Sandwich boards, Props/Supply bins to HQ/OPAC Junior Paleo and Cave booklets and badges to GCVC Pop-Up Exhibit, Trading Cards, Fossil replicas to SRM	Red Truck (Interp) 8 (6 ft) Tables 20 chairs 2 NPS Pop-Up Tents 2 Pop-Up Tents Banners Sand bags Supply Bin Cave Paleo Pop-Up display 3 boxes, Junior Paleo booklets and badges 3 boxes, Junior Cave Scientists booklets and badges 27 boxes, Trading Cards NPS Props Bin 4 Double Sandwich boards in Plaza Bus Island, Mather, BAB, VC All available staff and support team Be sure to release reserved parking spots by 4
3:30 PM	Facebook Live prep	Fossil Beds Rim Trail west	Joel*, Bryan*, Ronnie* *Leave for FB Live at Fossil Bed

Table D-5. Saturday, September 28: 2019 NFD Celebration, Morning Briefing 7:30 AM–8:30 AM.

DATE	ACTIVITY	LOCATION	NOTES
7:30 AM	Briefing, Setup tables, tents on Plaza Block off parking LOT 4, near Bright Angel Bikes for Partner loading zone	GCVC	Red Truck, Safety Vests All available staff

Table D-6. Saturday, September 28: 2019 NFD Celebration, Fossil Walk 9:00 AM–10:00 AM (10:30 AM).

DATE	ACTIVITY	LOCATION	NOTES
9:00 AM	Fossil Walk Ranger-Led Program	Meet at Bright Angel Trailhead sign to Fossil Beds along Rim Trail west	Jeremy as Primary advertised Fossil Walk
9:30 AM	Fossil Walk Ranger-Led Program	Meet at Bright Angel Trailhead sign to Fossil Beds along Rim Trail west	(Optional staggered 2 nd Fossil Walk if a large group—John as backup)
9:00 AM	GRCA Fossil Trading Card Table	Bright Angel Trailhead	EDUC roll up table Chair Junior Paleo booklets, badges, pencils, NFD Stickers, Trading card sets in rolling cart. Jean Sullivan

Table D-7. Saturday, September 28: 2019 NFD Celebration, Fun With Fossils/Ask A Scientist 10:00 AM–12:00 PM.

DATE	ACTIVITY	LOCATION	NOTES
9:30 AM–10:00 AM	Setup 2 tables with NPS tablecloth Set up touch table props Set up kids' activities	Yavapai Geology Museum	Warren, Robyn (ZION), Anne (SRM), John (if not a second Fossil Walk), Jeremy (lead) after Fossil Walk
10:00 AM–11:00 AM	Ask a Scientist LIVE—Q&A on social media Break down tables Bin of props, tablecloths to SOTA - Education office Sandwich board	Yavapai Geology Museum	Robyn, Anne, Bryan, Ronnie Warren, Robyn (ZION), Anne (SRM), John (if not a second Fossil Walk), Jeremy (lead)

Table D-8. Saturday, September 28: 2019 NFD Celebration, All Day Partner Activities 10:00 AM–3:00 PM.

DATE	ACTIVITY	LOCATION	NOTES
9:00 AM–4:00 PM	See detailed Run of Show for details Groups will arrive to set up	GCVC Plaza & Parking lots Celia – Volunteer Traffic Control	8 tables +2 chairs each for booth Parking Lot 4 will be Loading Zone Partner Parking in Employee Lot behind GCVC Extension cord from outlet for AGI
10:00 AM	Partner Organization tables open	GCVC Plaza & Parking lots Celia – Volunteer Traffic Control	8 tables +2 chairs each for booth Parking Lot 4 will be Loading Zone Partner Parking in Employee Lot behind GCVC Extension cord from outlet for AGI

Table D-9. Saturday, September 28: 2019 NFD Celebration, Fossil Beds Facebook Live 4:30 PM–5:30 PM.

DATE	ACTIVITY	LOCATION	NOTES
4:00 PM	Prep at Fossil Beds	Fossil Beds, Rim Trail West	Bryan, Joel, Ronnie
4:30 PM–5:00 PM	Facebook LIVE Presentation	Fossil Beds, Rim Trail West	Bryan, Joel, Ronnie
5:00 PM–5:30 PM	Facebook LIVE Q & A	Fossil Beds, Rim Trail West	Bryan, Joel, Ronnie

Table D-10. Saturday, September 28: 2019 NFD Celebration, Special Centennial Evening Presentation 7:30 PM–9:00 PM.

DATE	ACTIVITY	LOCATION	NOTES
6:30 PM	Setup fossils for Special Centennial Evening Program Greet Visitors Staff Specimen Table	SOTA Auditorium & Education Office *Items for the fossil museum table will be staged in the Education Office	AV Check: Joel, Ronnie Junior Paleo Booklets and Badges GRCA Fossil Trading Cards Museum Display Tables (2) Joel, Ronnie, Diana, Anne, Robyn, Mary, Mark
7:30 PM	Special Centennial Evening Program “Celebrating the Paleontological Heritage of Grand Canyon National Park During the Park’s Centennial”	SOTA Auditorium	Vince Santucci Ronnie, Joel Return Fossil specimens to EDUC Office, Lock up Building

Appendix E: GRCA Paleontology Project Acknowledgements

2019 Paleontology Project Core Team

- Anne Miller (GRCA, Northern Arizona University)
- Colleen Hyde (GRCA)
- Diana Boudreau (GRCA, Geoscientists-in-the-Parks, American Conservation Experience)
- John-Paul Hodnett (Maryland-National Capital Park and Planning Commission)
- Justin Tweet (NPS Geologic Resources Division)
- Kim Besom (GRCA)
- Klara Widrig (GRCA, Geoscientists-in-the-Parks)
- Mark Nebel (GRCA)
- Ronda Newton (GRCA)
- Ronnie Colvin (GRCA)
- Vincent Santucci (NPS Geologic Resources Division)

Contributing Paleontological Resources Inventory Report Authors

- Adam Marsh (PEFO)
- Adrian Hunt (Flying Heritage and Combat Armor Museum)
- Anne Miller (GRCA, Northern Arizona University)
- Benjamin Tobin (University of Kentucky)
- Carol Chambers (Northern Arizona University)
- Cassi Knight (Paleoworks Consulting)
- Colleen Hyde (GRCA)
- Dave Elliott (Northern Arizona University)
- Diana Boudreau (GRCA, Geoscientists-in-the-Parks, American Conservation Experience)
- Earle Spamer (retired – American Philosophical Society)
- Fred Sundberg (retired – Show Low High School)
- Heitor Francischini (Federal University of Rio Grande do Sul)
- Jim Mead (The Mammoth Site)
- John Foster (Utah Field House of Natural History State Park Museum)
- John-Paul Hodnett (Maryland-National Capital Park and Planning Commission)
- Justin Tweet (NPS Geological Resources Division)
- Kim Besom (GRCA)
- Klara Widrig (GRCA, Geoscientists-in-the-Parks)
- Linda Lassiter (Northern Arizona University)
- Lorenzo Marchetti (Prehistoric Museum Geoskop)
- Mark Nebel (GRCA)
- Mary Carpenter (BADL)
- Ronnie Colvin (GRCA)
- Sebastian Voigt (Prehistoric Museum Geoskop)
- Shawn Thomas (Bat Conservation International)

- Spencer Lucas (New Mexico Museum of Natural History and Science)
- Tim Connors (NPS Geologic Resources Division)
- Vincent Santucci (NPS Geologic Resources Division)
- William Parker (PEFO)

Peer Reviewers

- Andrew Milner (St. George Dinosaur Discovery Site)
- Bill DiMichele (Smithsonian Institute)
- Carol Dehler (Utah State University)
- Cindy Looy (Smithsonian Institute)
- David Elliot (Northern Arizona University)
- Don Corrick (BIBE)
- Erin Eichenberg (TUSK)
- Gary Morgan (New Mexico Museum of Natural History)
- Harry Butowsky (retired – NPS)
- Hendrik Klein (Saurierwelt Paläontologisches Museum Neumarkt)
- Jeff Martz (University of Houston)
- Matt Friedman (Museum of Paleontology, University of Michigan)
- Nicholas Minter (University of Portsmouth)
- Rick Toomey (MACA)
- Spencer Lucas (New Mexico Museum of Natural History and Science)
- Sterling Nesbitt (Virginia Polytechnic Institute and State University)
- Susannah Porter (University of California: Santa Barbara)
- Wayne Ranney (GRCA river guide, writer, and educator)

Peer Review Coordinator

Don Weeks (NPS Intermountain Region)

Grand Canyon National Park (GRCA) Staff

- Bryan Maul (Interpretation, Creative Media)
- Celia Dubin (Fees)
- Chris Symons (Interpretation, Canyon Field School)
- Edward “Ted” McClure (Library)
- Eugenia Sullivan (Library)
- Grace Lilly (Interpretation)
- Jeanne Calhoun (Science and Resource Management)
- Jennifer Eberlein (Visual Information Specialist)
- Jered Hansen (Science and Resource Management, GIS Specialist)
- Jeremy Childs (Interpretation)
- Joel Kane (Interpretation)
- Joelle Baird (Law Enforcement Officer)

- John Wishart (Interpretation)
- Kevin Garcia (Interpretation)
- Laurel Brierly (Interpretation)
- Michael Quinn (Visual Media Specialist)
- Ronda Newton (Science and Resource Management)
- Santiago Garcia (Data Manager)
- Sarah Haas (Science and Resource Management)
- Sharon Cawley (Interpretation, Education)
- Todd Stoeberl (Interpretation)
- Vanessa Ceja-Cervantes (Outreach, Media)
- Warren Rudkin (Interpretation)

Previous GRCA Staff

- Ben Tobin (University of Kentucky)
- Deanna Greco (Chattahoochee River National Recreation Area)
- James Super (former Geoscientists-in-the-Parks)
- Jeff Dobbins (former Geoscientists-in-the-Parks)
- Taylor Hartman (former Geoscientists-in-the-Parks)

NPS Geologic Resources Division

- Harold Pranger
- Jack Wood
- Jason Kenworthy
- Jim Wood
- John Graham
- Tim Connors

National Fossil Day Celebration Partners

- Adam Blankenbicker (American Geosciences Institute)
- Andy Grass (Arizona Museum of Natural History, Southwest Paleontological Society)
- Anne Scott (US Geologic Survey)
- Bruce MacFadden (Paleontological Society, Florida Museum of Natural History)
- David Gillette (Museum of Northern Arizona)
- Doug Wolfe (Zuni Dinosaur Institute for Geosciences)
- Eleanor Snow (US Geological Survey)
- Erin Eichenberg (TUSK)
- Hazel Wolfe (Zuni Dinosaur Institute for Geosciences)
- Janet Gillette (Museum of Northern Arizona)
- Jason Kenworthy (NPS Geologic Resources Division)
- Jennifer Glennon (Museum of Northern Arizona)
- Jim Mead (The Mammoth Site)

- Joel Despain (National Cave and Karst Research Institute)
- John-Paul Hodnett (Maryland-National Capital Park and Planning Commission)
- Maria Rodriguez (GLCA)
- Mary Carpenter (BADL)
- Mary Ontiveros (TUSK)
- Richard McMichael (Museum of Northern Arizona)
- Robyn Henderek (ZION)
- Sandy Croteau (Protectors of Tule Springs)
- Sequoyah McGee (American Geosciences Institute)
- Sherman Mohler (Arizona Museum of Natural History, Southwest Paleontological Society)
- Tom Olson (Geology for Kids)

Paleontology Symposium Speakers

- Jim Mead (The Mammoth Site)
- John-Paul Hodnett (Maryland-National Capital Park and Planning Commission)
- Linda Sue Lassiter (Northern Arizona University)
- Spencer Lucas (New Mexico Museum of Natural History and Science)
- Vincent Santucci (NPS Geological Resources Division)

PaleoBlitz Support

- GRCA Vegetation Division (Vehicle use)
- James (Max) Bovis (Maryland-National Capital Park and Planning Commission)
- Tom Olson (Geology for Kids)

Examine & Report (E&R) reports

- David Soller (US Geological Survey)
- Nancy Stamm (US Geological Survey)

Additional Museum assistance (outside GRCA)

- Janet & David Gillette (Museum of Northern Arizona)
- Kim Beckwith (Western Archeological and Conservation Center)

Conservation Legacy, Geoscientists-in-the-Parks (GIP), & AmeriCorps Staff

- Emma Savely
- Katie Nemmer
- Krista Rogers
- Lima Soto

American Conservation Experience (ACE) Staff

- Joel Baker
- Peter Woodruff

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 113/166290, January 2020

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525