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FEIN: 06-0906643

July 9, 2017

Subject: Comments from the Society of Vertebrate Paleontology about the scientific importance of paleontological resources at the 21 U.S. National Monuments established since 1996 (**Docket ID:** DOI-2017-0002).

Executive Summary

In this document, the Society of Vertebrate Paleontology reviews the paleontological resources currently known from the U.S. National Monuments established since 1996 and explains why altering or revoking their boundaries would be disastrous for the science of paleontology.

In these comments, we present:

i. our views on the role of public lands in the science of paleontology (p. 2);
ii. information on the benefit of paleontological science and education at these monuments to the general public (p. 4);
iii. comments on why mining operations are incompatible with discovery and scientific study of paleontological resources (p. 4);
iv. specific details about the paleontological resources at each of the continental monuments under review (p 6);
v. a copy of the comments we submitted on May 25, 2017, about Bears Ears and Grand Staircase-Escalante National Monuments (tracking number 1k1-8wld-cxoj) (Appendix 1, p. 17);
vi. representative scientific publications on paleontological resources at each of the moments (Appendix 2, p. 25)

We find that all 21 non-marine monuments protect scientifically important vertebrate fossils or rocks with a high potential for yielding them, and are therefore are appropriately designated under the Antiquities Act of 1906 (note: 'fossils' must not to be confused with 'fossil fuels'). We recommend that (1) the present boundaries of all of the monuments be maintained; (2) that the boundaries of Bears Ears National Monument be expanded to include fossiliferous areas on its western borders; (3) that paleontological inventories be conducted at all 21 monuments before any changes in monument boundary can even be considered; and (4) that regulations for the Paleontological Resources Protection Act be issued as soon as possible.

Our role.—The Society of Vertebrate Paleontology (**SVP**, http://vertpaleo.org) is an important stakeholder in U.S. National Monuments because of the scientifically important paleontological resources, specifically the prehistoric remains of backboned animals. SVP is a non-profit professional international organization with more than 2,500 members, including researchers, educators, students, and amateurs. Our mission is to advance the science and education of vertebrate paleontology and to encourage the protection of vertebrate fossils and fossil sites.

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I. On the role of public lands in the science of vertebrate paleontology

Scientific progress in paleontology and geology requires revisiting field areas, specimens, and data with new techniques and new questions. Consequently, paleontological science depends on paleontological resources being protected. The only uniform protection afforded to fossils in the United States is provided by the laws and regulations governing collection on U.S. public lands, including national monuments. Our science requires wide reconnaissance to find appropriate fossil localities and to establish their geologic and stratigraphic contexts, often involving prospecting and mapping of hundreds of square kilometers. This task is facilitated on public lands because of the ease with which permission can be obtained for researchers. Furthermore, the regulations that protect vertebrate fossils on public lands, especially the Paleontological Resources Preservation Act (**PRPA**) of 2009, prevent serious damage to and poaching of fossils that are still in the ground. As described below, important localities in the area that is now Bears Ears were destroyed prior to the area being designated as a national monument.

National monument status allows protection of many sensitive paleontological sites and makes it easier for vertebrate paleontologists to conduct scientific research. Obtaining research permits is easier than in landscapes that are a mosaic of public and private lands, or even ones that are subdivided among different federal agencies. The pace of research at Grand Staircase-Escalante National Monument (**GSENM**) since it was established in 1996 illustrates the value of monument designation to research, with more than 2,000 new vertebrate fossil localities and 20 vertebrate species new to science documented since that time.

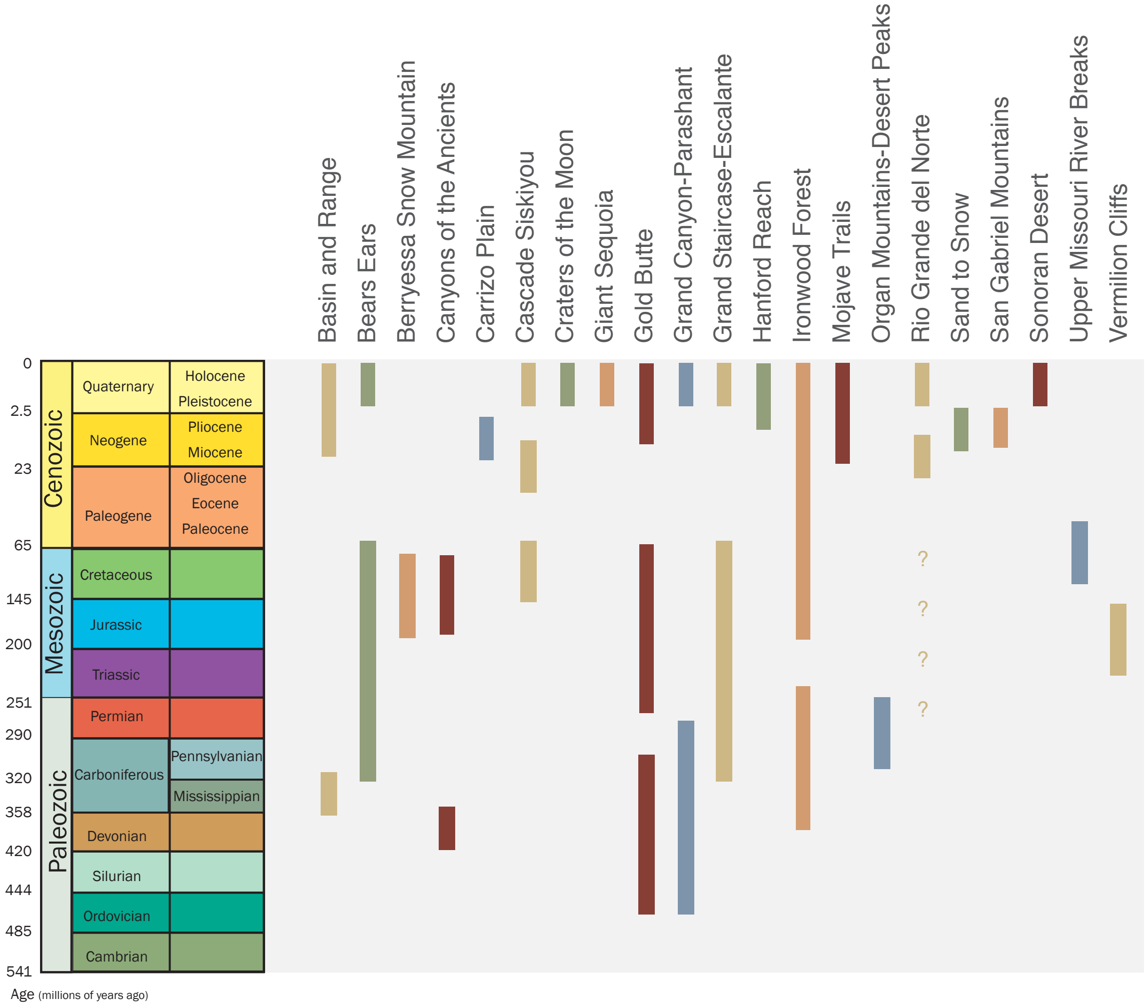


Figure 1. *Geological ages of rocks bearing vertebrate fossils or with the strong potential for bearing thems at each of the 21 national monuments.*

It is essential that monuments and other public lands be varied in location and topography in order to preserve a representative sample of the history of life. **Figure 1** shows the geological periods where vertebrate fossils and/or paleontologically sensitive rocks are preserved for each of the 21 currently under review. Whereas each is important on its own, only collectively do they begin to provide the broad overview of vertebrate history that is essential for understanding the history of life on Earth.

It is also essential that the geological context of sites be protected even after vertebrate fossils have been collected. The scientific process requires repeated testing of ideas, and scientific progress requires applying new hypotheses and innovative techniques to old data. Sites must therefore be protected even after initial studies have been completed so that they can be revisited and studied afresh. Paleontologists often preferentially choose to conduct research on national monument properties and other U.S. public lands because of the long term protection they afford, not to mention that many of the nation’s most important fossiliferous units are situated there. National monuments provide an almost ideal level of protection because they are more accessible for research than the more heavily protected national parks and are better protected than undesignated public lands.

Finally, it is essential that the protected status of National Monuments not be rescinded after it has already been in place. Scientists make strategic choices about where field studies will be conducted based in part on the level of protection afforded them. Removing protection from places where published scientific research has been conducted opens the possibility that 'type localities' (i.e., where new species were first ever described) will be ransacked, that the geological context of sites will be destroyed, and that fossils left in the ground for future research will disappear from the scientific record.

We are anxiously awaiting the final publication of the Department of the Interior's regulations under PRPA, which have still not been published even though eight years have elapsed since the Act was signed. This act serves as the pillar for protecting irreplaceable paleontologically important and sensitive U.S. public lands, including existing and future national monuments.

II. Educational benefits to the general public of paleontological resources at national monuments

Paleontological resources at national monuments benefit not only the science of paleontology, but also the general public because of the knowledge they impart about the natural heritage of our nation and the history of life on Earth. Research at national monuments impacts millions of American citizens. For example, consider outreach efforts from collaborative research at GSENM. Dozens to hundreds of peer-reviewed scientific articles, dozens of conference presentations, a 634-page multi-authored scientific volume (Titus and Loewen, eds., 2013: see Appendix 1), a richly illustrated popular science book titled *Where Dinosaurs Roamed*' by Christa Sadler (2016, Indiana University Press), four professional society field trips have focused on paleontological advances from these monuments. Many of the scientists working on monument material have committed to publishing in open-access venues so that all U.S. citizens can read the results. For example, at least six open-access papers on material from GSENM have been read by at least 140,000 people, and shared via social media by over 900 people (Sampson et al., 2010, 2013; Zanno et al., 2011; Boyd et al., 2013; Loewen et al., 2013; Lund et al., 2016: see Appendix 1). Monument fossils have garnered considerable media attention. A joint project between Utah Natural History Museum and GSENM was featured in a 2014 issue of National Geographic. More than 600 media outlets covered the discovery of a "pig-nosed" extinct turtle, *Arvinachelys*, from GSENM, more than 100 covered the discovery of the new horned dinosaur *Machairoceratops*, and nearly 1,100 covered the new tyrannosaur, *Lythronax*, as one might expect given the public fascination with these carnivorous dinosaurs.

III. Why modern mining techniques are incompatible with paleontological science

It is sometimes said in the media that mining is a benefit to paleontology because fossils are discovered by digging. With modern mining techniques, this view could not be further from the truth. We are aware that calls have been made to reduce the size of GSENM to make way for strip mining of coal on the Kaiparowits Plateau (e.g., Utah HCR12). Such a move would be devastating to the paleontological resources there, which, as we describe below, are producing the richest record of Late Cretaceous life anywhere in the world. The rock units that contain abundant vertebrate fossils are stratigraphically interleaved between the units that bear coal because of the pattern of rise and fall of sea level during Cretaceous deposition. Modern mechanized strip mining techniques remove the overburden from coal seams with heavy equipment, which in the Kaiparowits Plateau would consist of the rock units that are the most fossiliferous. The mining process would not only pulverize spectacular fossilized skeletons like *Kosmoceratops*, *Utahceratops*, and *Lythronax*, but it also destroys the stratigraphic context leaving the rubble mixed together. The scientific value of the deposits would be destroyed in the process. It is therefore critically important to protect these paleontological resources from destructive processes like strip mining. Indeed, this protection was a prime reason why GSENM was proclaimed.

IV. The role of consultation in establishing National Monuments

Executive Order 13792 was issued to determine whether designation or expansion of monuments "was made without adequate public outreach and coordination with relevant stakeholders". As a major scientific stakeholder, we can attest that there was considerable coordination with us when Bears Ears and GSENM were designated. The Department of the Interior and other stakeholders sought SVP's input on paleontological resources in the lead-up to the proclamations of both monuments. Because these areas contain one of the world's richest records of vertebrate life in the Mesozoic and late Paleozoic eras, our organization and the scientists we represent are very important stakeholders indeed. Overall, we were satisfied that our input was considered carefully and that the description of the paleontological resources in the two proclamations was appropriate.

That said, we recognize that the consultation process on national monuments is less formalized than is consultation on regulations. In our opinion, regularizing consultation when new national monuments are designated would be a great benefit from a scientific standpoint. We were seriously concerned in the lead up to the Bears Ears proclamation that the important paleontological resources there would not be mentioned, an omission that could have made it difficult to obtain permits for paleontological research. A formal consultation process would ensure that scientific resources are properly identified and included in proclamation documents, as well as would create a venue for discussion whether those resources are best protected using monument status or some other designation.

We are truly dissatisfied with this current consultation process on existing U.S. national monuments established since 1996. The short notice for Bears Ears and GSENM especially has made it a challenge for us to compile comprehensive comments. As a major stakeholder, it would be inappropriate for SVP not to be able to comment and the deadline of only four weeks has left us less time than we had when the monuments were originally proclaimed.

V. Paleontological resources at the 21 non-marine monuments established since 1996

The following sections briefly describe the paleontological resources found at each monument. Many of the properties have not yet been properly surveyed, so these resources represent only a fraction of their scientific potential. All of the monuments contain scientifically important vertebrate fossils and/or paleontologically sensitive rocks, indicating that they are properly classified with regard to the criteria for establishing monuments in the Antiquities Act of 1906. A representative bibliography of scientific papers about the paleontological resources at each monument is presented in Appendix 2.

BASIN AND RANGE NATIONAL MONUMENT, NEVADA

Paleontological importance: Rich marine fossils of the Mississippian Joana Limestone.

Justification for preservation: Marine fossils are abundant in the Joana Limestone that is about 350 million years old. Photographs of fossils taken within the Basin and Range National Monument can be seen at: http://desertsurvivor.blogspot.com/2016/05/exploring-new-basin-and-range-national.html. The Joana Limestone contains remains from conodont animals that share a common ancestry with the vertebrate linage. The Joana Limestone is often characterized as 'crinoidal limestone' reflecting its high invertebrate fossil content. Besides crinoids (starfish-relatives), the rock unit also contains corals, bryozoans (moss animals), brachiopods (lamp shells), and gastropods (snails). Extinct groups of corals, called horn corals, up to 9 inches in length, also occur in the formation. The Joana Limestone represents a time when vertebrates had reached considerable diversity in early oceans and the first tetrapods were evolving, which speaks to the urgent need to survey these deposits carefully for vertebrate material (for selected references, see Appendix 2). The scientific potential of this monument is yet to be realized. The Neogene basin fills and the underlying bedrock have the right age and characteristics to provide important paleontological data about Earth-life transitions in the Paleozoic and Neogene. These units in the Basin and Range National Monuments have not yet been investigated adequately, and we strongly suggest careful paleontological surveys before other uses are considered.

BEARS EARS NATIONAL MONUMENT, UTAH

Paleontological importance: Exceptionally rich Pennsylvanian, Triassic, Jurassic, and Cretaceous fossiliferous deposits.

Justification for preservation: The paleontological resources at Bears Ears National Monument are described in great detail in Appendix 1. Each section of the monument contains unique deposits that have already yielded material that suggests their scientific potential is equivalent to Grand Staircase-Escalante National Monument. Important fossiliferous units were excluded from western part of the monument when it was designated (see Appendix 1). We strongly recommend that the boundaries be extended to include them.

BERRYESSA SNOW MOUNTAIN NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: Rich Jurassic–Cretaceous marine fossils, including localities for multiple new species.

Justification for preservation: The Berryessa Snow Mountain National Monument contains the Late Jurassic Naknek Formation and Early Cretaceous Paskenta Formation that are rich in marine invertebrate fossils. The fossil collection database of the University of California Museum of Paleontology (UCMP) at Berkeley has nearly 80 registered fossil localities in the Berryessa Snow Mountain National Monument, and the collection includes diverse 'dinosaur-era' (Jurassic–Cretaceous) bivalves (clams), gastropods (snails), and echinoids (sea urchins) (note: many of these registered localities come from former U.S. Geological Survey Menlo Park Invertebrate Collection). The monument contains the type localities for multiple new species of extinct snails where their site preservation is imperative due to their uniqueness. Although we are not aware of reports of fossil vertebrates from those rocks, those rock formations have a very high yielding potential for Late Jurassic and Early Cretaceous dinosaurs as well as extinct sharks and other fishes. In fact, what makes the Berryessa Snow Mountain National Monument particularly significant is the exposed Late Jurassic and Early Cretaceous marine rocks that are exceptionally rare for the entire United States. Because of the presence of unique type localities of newly described fossil species, the monument land must be preserved in its perpetuity (for selected references, see Appendix 2).

CANYONS OF THE ANCIENTS NATIONAL MONUMENT, COLORADO

Paleontological importance: Many Devonian invertebrate fossils and poorly-surveyed Jurassic- and Cretaceous-aged rocks with a very high dinosaur-yielding potential.

Justification for preservation: The Canyons of the Ancients National Monument contains a number of paleontologically important sedimentary rock formations. The oldest known fossil fauna is that of the Devonian Ouray Limestone with many extinct invertebrate taxa. However, the larger concern to paleontologists is its widely distributed Middle Jurassic Entrada Sandstone and Upper Jurassic Morrison Formation within the monument. These rocks are well known for Jurassic dinosaur remains and tracks. The 155-million-year-old Morrison Formation in particular is a world-renowned fossiliferous rock unit with abundant exquisitely preserved remains of dinosaurs as well as other extinct animals such as clams, amphibians, turtles, crocodiles, lizards, and mammals exemplified at the Dinosaur National Monument in Utah. In addition, the Canyons of the Ancients National Monument also contains the Cretaceous Dakota Sandstone that has yielded fossil fishes and reptiles, including dinosaurs, elsewhere in the Western Interior. The fact is that these dinosaur-aged rocks have never been professionally prospected for paleontological resources at the Canyons of the Ancients National Monument to the best of our knowledge. Therefore, careful paleontological survey work must be done before any other uses of the land can be considered.

CARRIZO PLAIN NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: Numerous vertebrate and invertebrate fossil localities, including some 'type localities' of new species of extinct mammals.

Justification for preservation: The fossil collection database of the University of California Museum of Paleontology (UCMP) at Berkeley has nearly 280 registered invertebrate fossil localities in the Carrizo Plain National Monument, including preserved remains of foraminiferans (planktonic organisms), brachiopods (lamp shells), gastropods (snails), and echinoids (sea urchins) (note: many of these registered localities come from former U.S. Geological Survey Menlo Park Invertebrate Collection). The UCMP database also has over 20 registered fossil localities in the Carrizo Plain National Monument, and the collection includes approximately 50 fossil specimens of Cenozoic (primarily Miocene–Pliocene) vertebrates, including a turtle, an iguana, and an array of mammals, such as sloths, rodents, rabbits, cats, horses, camels as well as groups with no direct living descendants (Merycoidodontidae and Chalicotheriidae). Likewise, the Natural History Museum of Los Angeles County, California, also houses a number of important mammal fossils from the Carrizo Plain National Monument. Some of those specimens constitute the original materials ever described for the species making those sites on the monument land particularly important as their 'type locality' that must be preserved and protected (for selected references, see Appendix 2).

CASCADE SISKIYOU NATIONAL MONUMENT, OREGON

Paleontological importance: Rich marine fossils of the Cretaceous Hornbrook Formation and fossil-yielding Cenozoic volcanic rocks.

Justification for preservation: According to the Burke Museum of Natural History and Culture in Seattle, Washington, the museum houses five invertebrate fossil specimens from the Cascade-Siskiyou National Monument: three ammonites (extinct octopus-relative) and two inoceramid bivalves (clams) from the Cretaceous Hornbrook Formation. Although vertebrates have never been reported from the Hornbrook Formation to our knowledge, published data indicate abundant marine fossil invertebrates in the formation, including foraminiferans (planktonic organisms) and gastropods (snails) as well as other types of bivalves and ammonites. These occurrences strongly suggest a very high yielding potential for marine vertebrates, such as fishes (including sharks) and aquatic reptiles. Also, the potential for the discovery of dinosaur fossils cannot be ruled out given that plant fossils are also abundant in the marine formation. In addition, the Cascade Siskiyou National Monument also includes abundant volcanic or volcaniclastic rocks, some of which, such as the Roxy Formation of the Oligocene–Miocene Little Butte Volcanics, contain leaf (plant) fossils, as well as Quaternary alluvial (stream-based) deposits. All these Cenozoic rocks in the monument have the potential to yield vertebrate fossils, such as extinct mammals. Therefore, careful paleontological survey work must be done before any other uses of the land can be considered (for selected references, see Appendix 2).

CRATERS OF THE MOON NATIONAL MONUMENT, IDAHO

Paleontological importance: Important zooarchaeological sites from cave deposits offering data relevant to faunal range shifts through geologic time to be preserved and protected.

Justification for preservation: The Craters of the Moon National Monument predominantly consists of Holocene lava fields and surrounding Pleistocene basaltic lava fields. These rocks are quite young on the paleontological standpoint, but the discovery of some historical cave deposits with animal remains (e.g., bison bones) associated with human artifacts in the monument (e.g., http://tig.iri.isu.edu/ViewPage.aspx?id=647) are significant on the zooarchaeological and archaeological standpoints, and they are still very much relevant to paleontology in terms of understanding faunal range shifts through geologic time. As described at https://irma.nps.gov/DataStore/Reference/Profile/10840, "The caves contained an important Late Archaic archaeological component in shallow eolian [wind-produced] deposits. ... The most intensive utilization of the caves manifests a unique and selective Bison butchering/processing assemblage. Additionally, a wide array of recovered artifacts greatly expands the comparative base of Late Archaic assemblages on the Snake River Plain." Because of the relevance to the understanding of paleofaunal shifts over time, we strongly support the preservation of this monument (for selected references, see Appendix 2).

GIANT SEQUOIA NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: The home of mammoth fossils with a high yielding potential for other Ice Age mammals to be surveyed and preserved.

Justification for preservation: The fossil collection of the University of California Museum of Paleontology (UCMP) at Berkeley contains three mammoth molars from an area that is now represented by the Giant Sequoia National Monument. The locality is cataloged under UCMP locality number V69174 and specimen numbers 1582, 1586, and 1591. The fact that mammoth remains have been recovered suggests it is likely that the monument has a very high yielding potential for other paleontological resources from the Pleistocene (Ice Age) period. Therefore, comprehensive paleontological survey work must be done before any other uses of the land can be considered.

GOLD BUTTE NATIONAL MONUMENT, NEVADA

Paleontological importance: Rich animal footprint fossils and marine invertebrate fossils as well as rocks with a high yielding potential for dinosaur and synapsid remains to be preserved and protected.

Justification for preservation: The Gold Butte National Monument contains rich sedimentary deposits. As featured at http://www.birdandhike.com/Areas/GoldButte_Area/_gb_area.htm, they include Paleozoic rocks containing abundant marine invertebrate fossils as well as Paleozoic–Mesozoic vertebrate tracks (see also http://www.birdandhike.com/Hike/GoldButte/POI-gb/Fossils/_Fossils.htm).

These paleontological resources have remained largely unpublished, and in fact, animal footprint fossils at the monument and adjacent areas are currently the subject of active research as exemplified by the recent press: https://www.reviewjournal.com/news/science-and-technology/unlv-researchers-puzzle-over-tracks-left-near-gold-butte-that-predate-dinosaurs/. In fact, the original proclamation for the monument includes a passage that reads "the area shows great potential for continued paleontological research, with resources such as recently discovered dinosaur tracks dating back to the Jurassic Period. These fossil trackways were found in Gold Butte's distinctive Aztec Sandstone and also include prints from squirrel-sized reptilian ancestors of mammals [synapsids]." In addition, rocks equivalent to dinosaur-producing Jurassic deposits in the St. George area in Utah are also distributed in the Gold Butte National Monument, suggesting a high yielding potential for dinosaur remains. This monument was only recently declared and paleontological surveys are incomplete. For these reasons, the Gold Butte National Monument must receive continued preservation and protection.

GRAND CANYON-PARASHANT NATIONAL MONUMENT, ARIZONA

Paleontological importance: Fossil-rich Paleozoic rocks and Ice Age fossil vertebrates in caves important to understand environmental changes over time.

Justification for preservation: The Grand Canyon-Parashant National Monument contains numerous Paleozoic (Cambrian–Permian) rocks, including the Coconino Sandstone, Hermit Shale, Kaibab Limestone, Redwall Limestone, Tapeats Sandstone, and Bright Angel Shale, many of which are fossiliferous with diverse marine fossil invertebrates, such as sponges (e.g., see https://www.nps.gov/para/learn/nature/index.htm). However, what makes the Grand Canyon-Parashant National Monument particularly important is the discovery of many Quaternary alluvial (stream-based) and cave deposits that contain fossil vertebrates. In fact, the Museum of Northern Arizona in Flagstaff has been conducting collection and documentation of Pleistocene (Ice Age) vertebrate fossils from caves in the Redwall Limestone in the monument for the past four years. These fossil are scientifically very important for the understanding of the past climate and biogeography of animals in the American Southwest. As documented (https://gsa.confex.com/gsa/2016AM/webprogram/Paper283270.html), “fossils of remote Grand Canyon-Parashant National Monument are little known at present” suggesting that thorough paleontological survey work must be conducted before any other uses of the land can be considered.

GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT

Paleontological importance: Late Paleozoic–Cretaceous units, including one of the most important Late Cretaceous vertebrate faunas in the world in the rocks of Kaiparowits Plateau.

Justification for preservation: The paleontological resources of Grand Staircase-Escalante National Monument are described in detail in Appendix 1. This monument contains what is arguably the most important Mesozoic sequence in the world. Literally thousands of Late Cretaceous fossils have been recovered from the Kaiparowits Plateau that are still revolutionizing our understanding of the organisms and ecosystems that existed in the lead-up to the Cretaceous-

Paleogene extinction. Important resources from the Pennsylvanian, Permian, Triassic, and Jurassic periods are also being studied within the monument's boundaries.

HANFORD REACH NATIONAL MONUMENT, WASHINGTON

Paleontological importance: Exceptionally diverse vertebrate fauna of the Pliocene Ringold Formation to be preserved and protected.

Justification for preservation: The Hanford Reach National Monument contains exceptionally rich Pliocene fauna from the Ringold Formation. The fossil collection of the Burke Museum of Natural History and Culture in Seattle, Washington, alone includes over 2,600 catalogued Ringold Formation vertebrae fossils, the vast majority of which were collected inside the monument boundary. Those fossils consist of diverse freshwater fishes (e.g., sturgeon, catfish, perch, pike, and many more), amphibians (e.g., frogs), reptiles (e.g., turtles, lizards, and snakes), and birds (e.g., duck-relative) as well as a wide variety of extinct mammals including relatives of sloths, shrews, rodents (including beavers), rabbits, weasels, cats (including a 'saber-toothed' form), dogs, bears, elephants (mastodonts), horses, camels, deer, and peccaries. In addition, the Hanford Reach National Monument also yields some gigantic Pleistocene (Ice Age) mammals, such as bison, mammoths, and mastodonts. The extent of taxonomic diversity, especially the Pliocene fauna, seen in the monument is exceptional, not only with the mammal fauna, but also the freshwater fish fauna. Therefore, the paleontological resources in the Hanford Reach National Monument must be preserved and protected (for selected references, see Appendix 2).

IRONWOOD FOREST NATIONAL MONUMENT, ARIZONA

Paleontological importance: Paleozoic marine invertebrate fossils and Jurassic–Pleistocene rocks and sediments expected to contain vertebrate fossils.

Justification for preservation: The Ironwood Forest National Monument contains many rock units with paleontological resources. The oldest of which are various Paleozoic (Devonian–Permian) formations with marine invertebrate fossils (e.g., in the Concha and Escabrosa limestones). Although fossil vertebrates have not been recorded from these Paleozoic rocks to our knowledge, the possibility of fossils fishes cannot be entirely discounted. The monument also contains multiple Mesozoic (Jurassic–Cretaceous) rocks, and a number of vertebrate fossils have been noted, including theropod dinosaur and 'lizard' tracks in the Recreation Red Beds as well as biofilms, fishes, and hadrosaur dinosaurs from the Amole Arkose. There are also rock units that are considered paleontologically 'virgin territory' with the possibility for vertebrate fossils, including dinosaur remains, in the Cocoraque Formation and Caflin Ranch Formation. Additionally, the monument also has many Quaternary 'valley fills' with potential for vertebrate fossils, especially given that Pleistocene (Ice Age) camel and mammoth remains have been recovered from the adjacent areas. Also, fossil woodrat middens (packrat-gathered debris) are known and an additional survey for middens in all of the mountain ranges in the monument may be paleontologically productive. The fact is that much of the Ironwood Forest National Monument land remains largely unexplored for paleontological resources. Therefore, adequate paleontological survey work is needed to make informed decisions about the use of the land (for selected references, see Appendix 2).

MOJAVE TRAILS NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: Numerous late Cenozoic mammalian faunas critical for the understanding of temporal and geographic distributions of extinct species to be preserved.

Justification for preservation: Practically every regions of the Mojave Trials National Monument produce scientifically significant late Cenozoic vertebrate fossils. The Cady Mountains area contains three earliest Miocene faunas about 22.6–16 million years old that are paleontologically very important because they contain extinct mammal species that are identical to those in Nebraska, such as extinct horses and camels (*Merychyus*, *Michenia,* and *Stenomylus*), thereby assisting with and strengthening cross-continental temporal and biotic correlations. The southern Bristol Mountains contain the oldest Tertiary record of fossils (late Oligocene about 23.8 million years old) in the Mojave Desert, including camel tracks, invertebrate fossils, and a complex fossil flora. Pleistocene (Ice Age) spring deposits are found in the eastern region of the monument that produce extinct vertebrates representing the most complex vertebrate assemblage in the southeastern Mojave Desert. The five geographic areas in Cadiz Valley that produce fossil faunas have been tentatively dated at middle Pleistocene, a time period that is poorly known from the Mojave Desert and the only localities from this time period not currently on private or military land to our knowledge. These localities include small and large vertebrates, including a giant tortoise and diverse mammals. The Ship Mountain area in the monument yields early Miocene fossils that are some of the oldest in the southeastern Mojave Desert. The mammal fossils provide a faunal link to other mammalian assemblages to the west in the Cady Mountains and to the east in the Little Piute and Sacramento Mountains within the monument. The Sacramento Mountains area also contains Pleistocene fossil faunas, including the most eastern California record of giant ground sloth. All these fossil-bearing deposits deserve careful monitoring, strategic preservation management, and permitted access by professional paleontologists and volunteers to salvage fossils that are weathering out of the sediments and otherwise will be permanently lost to science and humanity (for selected references, see Appendix 2).

ORGAN MOUNTAINS-DESERT PEAKS NATIONAL MONUMENT, NEW MEXICO

Paleontological importance: The world-renowned Permian (280 million years old) animal trackway sites and other significant fossil localities to be preserved and protected.

Justification for preservation: The Organ Mountains-Desert Peaks National Monument has a number of paleontologically significant fossil sites. The most paleontologically productive deposit is the late Paleozoic (Pennsylvanian–Permian) rock sequence containing both marine and non-marine units. The marine unit is rich in fossil invertebrates, consisting of about 80 reported species comprising taxa such as sponges, corals, bryozoans (moss animals), brachiopods (lamp shells), bivalves (clams), gastropods (snails), nautiloids and ammonoids (octopus-relative), echinoids (sea urchins), crinoids (sea lilies), and trilobites (extinct joint-footed animals). In addition, an extinct shark (*Aggasizodus*) is known from the marine deposit. The non-marine unit is world famous for its 'ichnofossils,' including traces fossils of insects and scorpions, swimming traces of fishes and amphibians, and many types of tracks and trackways of tetrapod (four-legged) vertebrates. If fact, ichnofossils from the Organ Mountains-Desert Peaks National Monument, that includes the former Prehistoric Trackways National Monument, have re-written the Permian tetrapod footprint ichnotaxonomy. The rock sequence also includes abundant microfossils, including conodonts (animals that share a common ancestry with the vertebrate linage), as well as various fossil plants. The Organ Mountains-Desert Peaks National Monument also produces important Pleistocene (Ice Age) vertebrate fossils. The fossil record includes an extinct turkey, but even more noteworthy are the type specimens of *Tetrameryx conklingi* (extinct pronghorn) and *Pyelorhamphus molothroides* (extinct cowbird), making their fossil site the 'type locality.' It is the responsibility of this country to preserve and protect these world-renowned fossil sites in the monument that requires careful monitoring, strategic preservation management, and permitted access for researchers (for selected references, see Appendix 2).

RIO GRANDE DEL NORTE NATIONAL MONUMENT, NEW MEXICO

Paleontological importance: Known fossil mammal sites and sedimentary deposits with a high fossil-bearing potential to be preserved and protected.

Justification for preservation: The Rio Grande del Norte National Monument contains abundant Cenozoic volcanic rocks, but fossil-bearing deposits are also known. Reported vertebrate remains include Miocene (15 million years old) fossils such as horse (*Protohippus*), possible 'bone-crushing dog' (*Aelurodon*), oreodont (extinct plant-eating mammal; *Merychyus*), and camel (*Protolabis*) skeletal and dental materials. The monument area may also include locally distributed Permian, Triassic, Jurassic, and possibly Cretaceous deposits that are all potentially vertebrate-bearing. In addition, the Rio Grande del Norte National Monument likely also contains Quaternary deposits with potential for Ice Age vertebrates. The limited amount of information about fossil vertebrates from the Rio Grande del Norte National Monument is most certainly not due to the lack of them but rather implies that the region has not been adequately surveyed. We strongly suggest that the Rio Grande del Norte National Monument to be preserved as is until at least a comprehensive paleontological survey is conducted (for selected references, see Appendix 2).

SAND TO SNOW NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: Mid-Miocene (11-million-year-old) rocks containing mammal fossils as well as paleontologically uninvestigated areas to be surveyed, preserved, and protected.

Justification for preservation: The Sand to Snow National Monument contains the Pioneertown sedimentary sequence that produces Clarendonian (mid-Miocene about 11 million years old) vertebrate fossils. These sediments constitute one of only three Mojave Desert sequences that contain Clarendonian-aged mammals. The fossil fauna is diverse and includes extinct rabbits, rodents, horses, pronghorns, camels, and gomphotheres (elephant-relative). This fauna is important because the taxonomic composition contrasts markedly to fossil faunas at other Miocene localities in the area, and provides critical information about the faunal and environmental changes in the southern California through the Miocene time. Therefore, the Pioneertown sedimentary sequence in the Sand to Snow National Monument must be preserved and protected. In addition, it is entirely possible that the national monument may also contain Pleistocene mammals in deposits such as stream-laid sediments or valley- and fissure-filled sediments. The lack of any reports on such fossils from the Sand to Snow National Monument is likely due to the fact that no organized paleontological survey has been conducted in the monument. We therefore strongly recommend the need for a comprehensive paleontological survey in the Sand to Snow National Monument before any changes in its boundary can even be considered.

SAN GABRIEL MOUNTAINS NATIONAL MONUMENT, CALIFORNIA

Paleontological importance: Known invertebrate and mammal fossil sites as well as largely uninvestigated paleontology of the monument land to be surveyed, preserved, and protected.

Justification for preservation: The San Gabriel Mountains National Monument contains the fossil-bearing Punchbowl Formation that is upper Miocene to lower Pliocene in age (5–10 million years ago). The Natural History Museum of Los Angeles County contains fossil mammal specimens from the Devil's Punchbowl area that belong to an extinct weasel-relative (Mustelidae) and horses (*Merychippus* and *Cormohipparion*). The Paleocene San Francisquito Formation, that contains marine mollusk fossils, is also exposed in the area. Whereas these fossil beds remain to be insufficiently surveyed, our concern also extends to the rest of the San Gabriel Mountains National Monument. There are several unpublished accounts of earlier Pleistocene land mammal sites in the vicinity of the monument, strongly suggesting the possibility that similar Ice Age mammalian fossil sites are present in the monument. Such Pleistocene deposits are typically represented by stream deposits or valley-, fissure-, or cave-filled deposits, and the existence of such deposits in the San Gabriel Mountains National Monument is entirely possible. The lack of any reports on such fossils from the San Gabriel Mountains National Monument is primarily due to the fact that no organized paleontological survey has been conducted in the monument. We therefore strongly recommend a comprehensive paleontological survey in the San Gabriel Mountains National Monument.

SONORAN DESERT NATIONAL MONUMENT, ARIZONA

Paleontological importance: Poorly surveyed paleontological resources and sites to be preserved and protected.

Justification for preservation: A preliminary assessment of paleontological resources in the Lower Sonoran and Sonoran Desert National Monument can be found in the "Draft Resource Management Plan and Environmental Impact Statement" published by the Bureau of Land Management (BLM) in 2011 (for link, see Appendix 2). The report indicates that "vertebrate fossils are typically found in unconsolidated Quaternary silt, sand, and gravel deposits and Tertiary sedimentary rocks" (p. 266). It describes the presence of fish, bird, and mammal fossils in those sedimentary deposits. The monument also contains Paleozoic limestones with marine invertebrate fossils, and the listed invertebrate taxa in the document include corals, bryozoans (moss animals), brachiopods (lamp shells), cephalopods (octopus-relatives), and trilobites (extinct joint-footed animals) presumably from such Paleozoic rocks. The report also notes that those vertebrate and invertebrate fossils are not common or abundant, but for this reason, it states that "the BLM considers any discovery of vertebrate fossils and noteworthy occurrences of invertebrate and plant fossils as important" and further notes that "Increased ground-disturbing activities in these deposits may increase the threat to noteworthy fossils." Likewise, the report states that "No significant paleontological resources are known to occur in either the Lower Sonoran or SDNM [Sonoran Desert National Monument]", but it adds "It is the scarcity of fossils in these Decision Areas [i.e., now the monument area] that makes subsequent finds that much more significant" (p. 266). In should also be noted that the Sonoran Desert area includes many ravines and rock shelters with zooarchaeological and archaeological significance (for reference, see Appendix 2). Because mammoth kill sites are known both to the north and southeast of the monument, the potential exists for finding exceptionally significant Paleoindian kill sites within the monument. For these reasons, we fully support the BLM's "Goals, Objectives, and Management Actions" in regards to paleontological resources in the Sonoran Desert National Monument stated in its 2012 final document entitled "Sonoran Desert National Monument Record of Decision and Approved Resource Management Plan" (for link, see Appendix 2). It reads, "Protect and manage any paleontological resources, including all vertebrate fossils, traces, and invertebrate or plant fossils of paleontological interest, found on public lands for scientific, educational, or recreational values", and adds "Manage paleontological resources to maintain or enhance their physical integrity, educational values, and scientific interest while avoiding all surface-disturbing activities to the extent possible that will damage paleontological resources" (p. 27).

UPPER MISSOURI RIVER BREAKS NATIONAL MONUMENT, MONTANA

Paleontological importance: Paleontologically exceptionally diverse and abundant Late Cretaceous beds, including dinosaur bones and nests, to be preserved and protected.

Justification for preservation: The Upper Missouri River Breaks National Monument has extensive exposures of Late Cretaceous rocks with numerous vertebrate fossils—the most fossiliferous of which are the Judith River and Bearpaw formations. The Judith River Formation preserves faunas with rich terrestrial and near-shore taxonomic diversity, and vertebrate fossils can be found throughout the formation, including skeletal and dental remains of fishes (including sharks), amphibians, birds, and mammals as well as those of dinosaurs and other reptiles. The fossil record of the Judith River Formation even includes dinosaur nests. The Bearpaw Formation is known for its marine invertebrates including ammonites (octopus-relatives) as well as marine vertebrates such as fishes, mosasaurs (extinct aquatic true lizards), and plesiosaurs (extinct aquatic reptiles). The Upper Missouri River Breaks National Monument is not only important scientifically, but also historically as the place where the very first dinosaur bones in North America were discovered by a renowned geologist Ferdinand Vandeveer Hayden back in 1853, followed by a renowned paleontologist Edward Drinker Cope whose expeditions now in the monument area are featured in a classic 1973 book *The Bone Hunters* by Url Lanham. Paleontological work in the Upper Missouri River Breaks National Monument still continues today that has yielded important insights about the biodiversity of the Late Cretaceous fauna and the formation of microfossil bonebeds as well as important baseline data for vertebrate diversity 10 million years before the end-Cretaceous mass extinction (i.e., so-called ‘dinosaur extinction event'). From a paleontological perspective, the entire monument land is important and must be preserved and protected because the Judith River and Bearpaw formations are exposed throughout the area (for selected references, see Appendix 2).

VERMILION CLIFFS NATIONAL MONUMENT, ARIZONA

Paleontological importance: Extensive Triassic and Jurassic rock exposures with a very high potential for vertebrate fossils, including dinosaurs, to be preserved and protected.

Justification for preservation: The area where the Vermilion Cliffs National Monument is located has extensive rock exposures of the Triassic Moenkoopi and Chinle formations as well as the Jurassic Moenave and Kayenta formations and Navajo Sandstone. These Mesozoic rocks that formed during the 'the age of reptiles' are fossiliferous elsewhere, including remains of dinosaurs. To simply put, a more adequate analysis is needed to fully grasp its actual fossil potential, and therefore the Vermilion Cliffs National Monument is considered to be scientifically an extremely sensitive area that requires preservation and protection for further paleontological surveys.

Appendix 1. Paleontological significance of the Bear Ears National Monument and Grand Staircase-Escalante National Monument (GSENM) in Utah

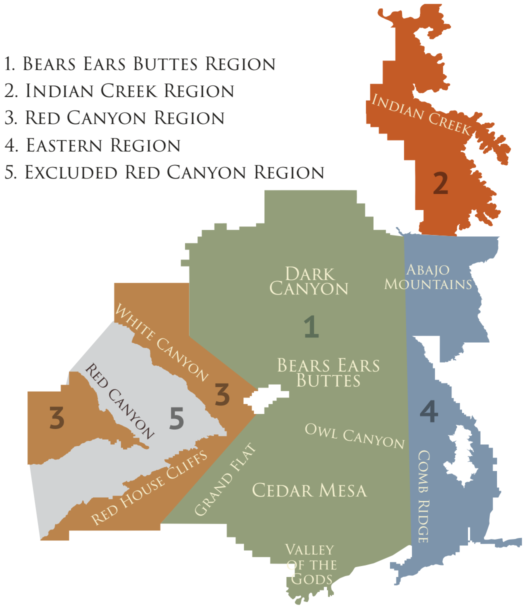
The following information was presented in the comments we submitted on 25 May, 2017 (tracking number 1k1-8wld-cxoj). This information is included again here for convenience.

Bears Ears National Monument

The Bears Ears proclamation of 2016 accurately describes its paleontological resources when it says that they "are among the richest and most significant in the United States, and protection of this area will provide important opportunities for further archaeological and paleontological study." Vertebrate paleontologists have only started seriously studying the fossil record preserved there in the last few years, but already it promises to be as important as GSENM for the data it yields about life in Earth's past, including the history before and after our planet's most massive extinction 252 million years ago (the Permian-Triassic extinction).

The Natural History Museum of Utah in Salt Lake City alone has discovered 149 paleontological localities at Bears Ears since 2013—work that strongly justified the Monument's proclamation. This material includes 339 fossil specimens collected from the Lower Permian Cutler Group and Upper Triassic Chinle Formation). These discoveries were made in field seasons that lasted 1-2 weeks a year here, so the surface is only just being scratched.

All of the areas of Bears Ears contain scientifically invaluable paleontological resources, and thus justify the existing boundaries. Furthermore, the area at the western end that is currently excluded also contains significant scientific resources and deserves to be added to the monument. To justify this point, we have divided the monument into five regions (**Map 1**), each with a broadly similar geology, and describe the resources in each area.



Map 1. Five regions with scientifically important paleontological resources in Bears Ears National Monument.

1. *Bears Ears Buttes Region*

The central Bears Ears Buttes, Dark Canyon, and Cedar Mesa region contain scientifically invaluable Pennsylvanian and Permian communities that document the history of terrestrial vertebrate life prior to the Permian-Triassic extinction. The area includes spectacular synapsid remains and strange burrows from these early mammal relatives that are still poorly understood. The Valley of the Gods area includes some of the earliest vertebrates to walk on land in America, as well as exquisitely preserved leaf fossils and petrified wood. Fossils exposed along the Honaker Trail provide evidence that this arid landscape was once part of a thriving coral reef during the Pennsylvanian Period.

Byers, B.A., Ash, S.R., Chaney, D. and DeSoto, L., 2014. First known fire scar on a fossil tree trunk provides evidence of Late Triassic wildfire. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *411:* 180-187.
Scott, K., 2013. Carboniferous–Permian boundary in the Halgaito Formation, Cutler Group, Valley of the Gods and surrounding area, southeastern Utah. *The Carboniferous–Permian Transition. New Mexico Museum of Natural History and Science Bulletin*, *60*: 398-409.
Morales, M., 1987. Terrestrial fauna and flora from the Triassic Moenkopi Formation of the southwestern United States. *Journal of the Arizona-Nevada Academy of Science*, 1987: 1-19.
Sumida, S.S., Lombard, R.E., Berman, D.S. and Henrici, A.C., 1999. Late Paleozoic Amniotes and Their Near Relatives from Utah and Northeastern Arizona, With Comments on the Permian-Pennsylvanian Boundary in Utah and Northern Arizona in Gilette. *Vertebrate Paleontology in Utah. Utah Geological Survey, Miscellaneous Publication*, *9*(1): 31-43.

2. *Indian Creek Region*

This region, along with Red Canyon, hosts one of the best records of the Late Triassic and Early Jurassic periods in the world, a time when the early phase of recovering from the massive Permian-Triassic extinction was ending and a new phase of Mesozoic life was beginning. Early Permian sites in this region have produced well-preserved fossils of the giant amphibian Eryops, and many individuals of the sail-backed early mammal relative *Sphenacodon*. The Indian Creek Region documents the ecology of large carnivorous temnospondyl amphibians in the Moenkopi Formation, and the geologically younger Chinle Formation has produced abundant fossil plants, crayfish and burrows, as well as extinct amphibians and reptiles, such as metoposaurs, phytosaurs, crocodylomorphs, and dinosaurs. Fossil sites in this area were looted before the Monument was established.

Sprinkel, D.A., Chidsey Jr, T.C. and Anderson, P.B., 1995. A Survey of the Paleontological Resources from the National Parks and Monuments in Utah.
Sumida, S.S., Albright, G.M. and Rega, E.A., 1999. Late Paleozoic fishes of Utah. *Vertebrate paleontology of Utah. Geological Survey of Utah Miscellaneous Publication*, *99*(1): 13-20.

3. *Red Canyon Region*

Along with Indian Creek regions, the Red Canyon Region preserves one of the best records of the Triassic-Jurassic transition anywhere in the world, providing crucial information for paleontologists seeking to understand how dinosaurs came to dominate terrestrial ecosystems during the Mesozoic Era. This area has only just begun to be prospected and it has already produced an incredible range of vertebrate diversity, including enigmatic animals like the armored *Doswellia*.

Chamberlain, C.K. and Baer, J.L., 1973. Ophiomorpha and a new thalassinid burrow from the Permian of Utah. *Brigham Young University Geology Studies*, *20*(1): 79-94.

Dubiel, R.F., 1987. Sedimentology and new fossil occurrences of the Upper Triassic Chinle Formation, southeastern Utah.

Parrish, J.M., 1999. Small fossil vertebrates from the Chinle Formation (Upper Triassic) of southern Utah. *Vertebrate Paleontology in Utah*, 99(1), p.45.

Tanner, L.H. and Lucas, S.G., 2016. Stratigraphic distribution and significance of a 15million-year record of fusain in the Upper Triassic Chinle Group, southwestern USA. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *461*, pp.261-271.

4. Eastern Region

The Eastern Region of the Monument has a unique record of Jurassic and Cretaceous vertebrate life. Examples include many new dinosaur taxa like the prosauropod *Seitaad*, whose remains are unique to this area. This region has also produced important vertebrate and plant fossils from the Quaternary that help us understand the climatic and environmental processes that have shaped the history of life in western North America over the last 2.5 million years of Earth's history.

Agenbroad, L.D. and Mead, J.I., 1989. Quaternary geochronology and distribution of *Mammuthus* on the Colorado Plateau. *Geology*, *17*(9), pp.861-864.

Betancourt, J.L., 1984. Late Quaternary plant zonation and climate in southeastern Utah. *The Great Basin Naturalist*, pp.1-35.

Fraser, N.C., Irmis, R.B. and Elliott, D.K., 2005. A procolophonid (Parareptilia) from the Owl Rock Member, Chinle Formation of Utah, USA. *Palaeontologia Electronica*, *8*(1), p.13A.

Gay, R.J., Jenkins, X.A. and Lepore, T., 2017. *The oldest vertebrate trace fossils from Comb Ridge (Bears Ears Region, southeastern Utah)* (No. e2662v2). PeerJ Preprints.

Lockley, M.G. and Mickelson, D., 1997. Dinosaur and pterosaur tracks in the Summerville and Bluff (Jurassic) beds of eastern Utah and northeastern Arizona. *Mesozoic Geology and Paleontology of the Four Corners Region*, *48*: 133-138.

Sertich, J.J. and Loewen, M.A., 2010. A new basal sauropodomorph dinosaur from the Lower Jurassic Navajo Sandstone of southern Utah. *PLoS One*, *5*(3), p.e9789.

5. Excluded Red Canyon Region

Only parts of the Red Canyon Region are currently protected within the boundaries of Bears Ears National Monument. Area 5 is literally central to the important record of the Triassic-Jurassic transition described above. To protect this area, the boundaries of the Monument should be expanded to include the area between the western "island" and the rest.

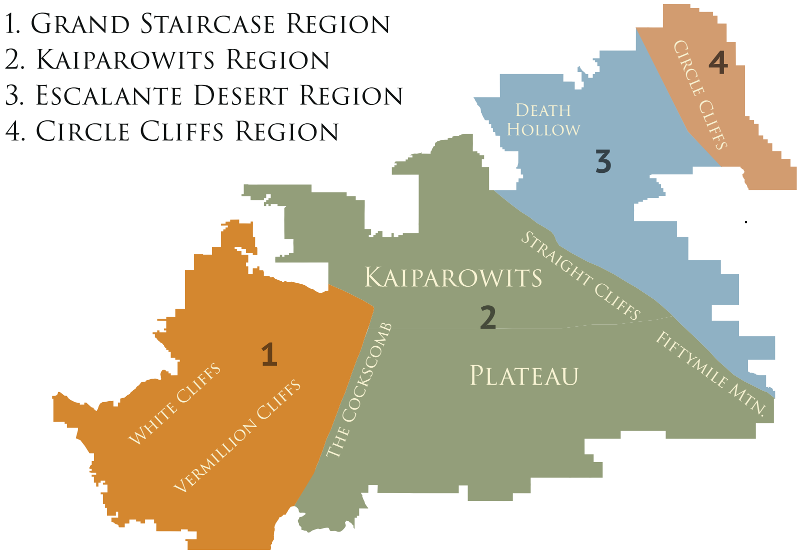
Grand Staircase-Escalante National Monument (GSENM)

The boundaries of GSENM enclose literally thousands of fossil vertebrate localities, making it one of the most densely fossiliferous Mesozoic ("Age of Dinosaurs") areas in the world that require full protection. The Kaiparowits Plateau in particular produces an incredible yield of scientifically important vertebrate fossils from the floodplain facies of the Cretaceous strata. As stated in the Monument proclamation, GSENM is "one of the best and most continuous records of Late Cretaceous terrestrial life in the world". Five new types of horned dinosaur (relatives of the famous *Triceratops*) have come from GSENM, as have new duck-billed dinosaurs, tyrannosaurs, ankylosaurs, caimans, plesiosaurs, crocodylians, lizards, snakes, turtles, and mammals.
GSENM is one of the great success stories for science. Its designation as a National Monument and the appointment of a monument paleontologist (Dr. Alan Titus) have greatly facilitated research there, making it one of the most scientifically prolific areas in the US in terms of vertebrate paleontology. One indication of the success is the 634 page volume on GSENM paleontology published by Indiana University Press, which contains 28 peer-reviewed papers by more than 40 authors from around the world:

Titus, A. L. and M. A. Loewen (eds.). 2013. *At the Top of the Grand Staircase: the Late Cretaceous of Southern Utah*. Indiana University Press: Bloomington, Indiana.

New finds from GSENM are so important that they were highlighted by displays at the Society of Vertebrate Paleontology annual meeting in Salt Lake City last years, as explained in this short video (https://www.youtube.com/watch?v=5Av0PNt3ZaI). Research at GSENM by the Natural History Museum of Utah alone has registered 964 paleontological localities and over 2,000 fossil specimens saved for scientific research, including about 100 associated skeletons of extinct vertebrates. These yields were based on about 950 days of fieldwork over a 16-year span. Other groups (e.g., BLM and Denver Museum of Nature & Science) have discovered numerous vertebrate sites not included in this count, and yet other researchers (e.g., from Denver Museum of Nature & Science and Idaho State University) have focused on the paleobotanical and invertebrate sites from the non-marine Late Cretaceous strata of the Colorado Plateau. This is nothing to say of the very rich invertebrate and vertebrate fossil assemblages from the marine Tropic Shale, which has been worked by the Museum of Northern Arizona and the BLM.

To justify our opinion that the GSENM boundaries are appropriate with respect to paleontological science, we have divided the monument into four regions (**Map 2**) and describe the paleontological resources of each. We understand that BLM paleontologists have provided detailed maps of paleontological sites within GSENM for purposes of this consultation, many of which have been studied by members of our Society.



Map 2. Paleontologically significant regions in Grand Staircase-Escalante National Monument.

1. Grand Staircase Region

The Grand Staircase Region on the western side of the monument has yielded spectacular trackways, including unusual forms like *Brasilichnium*, which is likely to have been produced by Mesozoic synapsids. Extensive collections of fossils have been recovered from the Chinle, Moenave, Kayenta, and Navajo formations, many of them still under study, including fish and petrified forest.

Difley, R. and Ekdale, A.A., 2006. Trace fossils and paleoenvironments of the Early Jurassic Kayenta Formation, Washington County, Utah. *Making Tracks Across the Southwest.*

Lockley, M.G., Gierlinski, G.D., Titus, A.L. and Albright, B., 2006. An introduction to thunderbird footprints at the Flag Point pictograph–track site–preliminary observations on Lower Jurassic theropod tracks from the Vermillion Cliffs area, southwestern Utah. *New Mexico Museum of Natural History and Science Bulletin*, *37*: 310-314.

2. Kaiparowits Plateau Region

The Kaiparowits Plateau Region is the most impressive part of the Monument from the perspective of vertebrate paleontology. It provides one of the most complete records of the Late Cretaceous time anywhere in the world. More than 2,000 new vertebrate localities have been documented in this area alone since the monument was established, and only about 20% of it has been inventoried. Many new species have been described from this area, including mammals, dinosaurs, lizards and snakes, turtles, crocodyliforms, elasmobranchs, bony fish, invertebrates, and plants. The spectacular dinosaur skulls that were on display at our Society's Salt Lake City meeting in 2016 were collected from the Kaiparowits Plateau Region, including *Kosmoceratops*, *Utahceratops*, *Diabloceratops*, *Nasutoceratops*, *Teratophoneus*, and *Lythronax*.

Paleontological research began in earnest on the Kaiparowits Plateau in 1983 when Jeffrey Eaton (then a Ph.D. candidate at the University of Colorado) and Dr. Richard Cifelli (then at the Museum of Northern Arizona) initiated research largely centered around the study of small, but extremely important, Cretaceous mammals. Interest in the Kaiparowits Plateau region was the result of its having a relatively continuous record of terrestrial evolution that was 20 million years long (about 95-75 million years ago) during the Cretaceous Period (see Eaton, 1991). It was quickly discovered that many of the units were fossiliferous, and in subsequent years has produced significant vertebrate fossils in every terrestrial unit in the sequence. This is the most continuous record of terrestrial evolution during this interval in the world.

From the Kaiparowits Plateau, the remains of mammals, frogs, salamanders, lizards, fish, turtles, crocodiles, and dinosaurs have all been recovered. Although the original work was focused on small vertebrates, other researchers (e.g., Dr. David Gillette, Museum of Northern Arizona; Dr. Scott Sampson with his students and other colleagues, Natural History Museum of Utah; Dr. Randall Irmis, Natural History Museum of Utah; Dr. Alan Titus, GSENM; Dr. Joseph Sertich, Denver Museum of Nature and Science; etc.) have subsequently focused on larger vertebrates such as dinosaurs. The results have been remarkable. The Kaiparowits region has produced an enormous number of taxa that are new to science and have significantly changed our understanding of terrestrial evolution during the Cretaceous. Even the only significant marine unit in the region, the Tropic Shale, has become well known for its remarkable plesiosaurs (large marine reptiles). There is no question that the Kaiparowits region contains a world-class assemblage of fossils, and that area will continue to produce new information about the geologic history of the Earth based on the rocks and fossils in the region.

The northern part of the Kaiparowits Plateau contains remarkable localities in all of the Cretaceous units (Naturita, Tropic Shale, Straight Cliffs, Wahweap, and Kaiparowits formations) whereas the southern portion of the plateau has excellent localities in the Naturita, Tropic Shale and Straight Cliffs formations (the stratigraphically higher formations, the Wahweap and Kaiparowits, have been largely removed by erosion). Over 45 new taxa and more than 300 taxa total have been reported from these areas (see Eaton and Cifelli, 2013; Titus et al., 2016). The collections are represented by tens of thousands of specimens housed in public repositories at the Natural History Museum of Utah, Oklahoma Museum of Natural History, Denver Museum of Nature and Science, Museum of Northern Arizona, and University of Colorado Museum to name a few.

Many of the larger fossils, such as turtles, crocodiles, and dinosaurs, are subject to poaching of fossils for non-scientific purposes and inadvertent destruction by all-terrain vehicle (ATV) activity. Important specimens were lost to unregulated collecting prior to designation of the monument (this is also true of archeological areas that were looted) and we are aware of many cases of destruction by off-road activities. The monument has greatly improved the protection of paleontological resources and has also helped to coordinate and regulate the large number of scientists working there, thus improving the quality of the science and education.

A few representative publications on geological and paleontological studies from Kaiparowits Plateau include:

Boyd, C.A., Drumheller, S.K. and Gates, T.A., 2013. Crocodyliform feeding traces on juvenile ornithischian dinosaurs from the Upper Cretaceous (Campanian) Kaiparowits Formation, Utah. *PloS one*, *8*(2), p.e57605.

Eaton, J. G., 1991, Biostratigraphic framework for Upper Cretaceous rocks of the Kaiparowits Plateau, southern Utah: *in* Nations, J.D., and Eaton, J.G. eds., Stratigraphy, depositional environments, and sedimentary tectonics of the western margin, Cretaceous Western Interior Seaway: *Geological Society of America Special Paper* 260: 47-63.

Eaton, J.G., 2006. Santonian (Late Cretaceous) mammals from the John Henry Member of the Straight Cliffs Formation, Grand Staircase-Escalante National Monument, Utah. *Journal of Vertebrate Paleontology*, *26*(2): 446-460.

Eaton, J.G., and Cifelli, R.L., 2013, Review of Late Cretaceous Mammalian Faunas of the Kaiparowits and Paunsaugunt Plateaus, Southwestern Utah, Chapter 14 *in* Titus, A. L., and Loewen, M. A. eds. *At the Top of the Grand Staircase – the Late Cretaceous of Southern Utah*. Indiana University Press, Bloomington, pp. 319-328.

Loewen, M.A., Irmis, R.B., Sertich, J.J., Currie, P.J. and Sampson, S.D., 2013. Tyrant dinosaur evolution tracks the rise and fall of Late Cretaceous oceans. *PLoS One*, *8*(11): e79420.

Lund, E.K., O'Connor, P.M., Loewen, M.A. and Jinnah, Z.A., 2016. A New Centrosaurine Ceratopsid, *Machairoceratops cronusi* gen. et sp. nov., from the Upper Sand Member of the Wahweap Formation (Middle Campanian), Southern Utah. *PloS one*, *11*(5), p.e0154403.

Sampson, S.D., Loewen, M.A., Farke, A.A., Roberts, E.M., Forster, C.A., Smith, J.A. and Titus, A.L., 2010. New horned dinosaurs from Utah provide evidence for intracontinental dinosaur endemism. *PLoS One*, *5*(9): e12292.

Sampson, S.D., Lund, E.K., Loewen, M.A., Farke, A.A. and Clayton, K.E. 2013. A remarkable short-snouted horned dinosaur from the Late Cretaceous (late Campanian) of southern Laramidia. *Proceedings of the Royal Society, B*, 280: 20131186.

Titus, A., Eaton, J. G., and Sertich, J., 2016, Late Cretaceous stratigraphy and faunas of the Markagunt, Paunsaugunt, and Kaiparowits plateaus, southern Utah. *Geology of the Intermountain West*, 3: 229-291.

Zanno, L.E., Varricchio, D.J., O'Connor, P.M., Titus, A.L. and Knell, M.J., 2011. A new troodontid theropod, *Talos sampsoni* gen. et sp. nov., from the Upper Cretaceous Western Interior Basin of North America. *PloS One*, *6*(9): e24487.

3. Escalante Desert Region

The Escalante Desert Region of the Monument contains mostly Jurassic rocks, including important fossil vertebrate trackways and Morrison Formation paleobotanical and dinosaurian sites.

Foster, J.R., Hamblin, A.H. and Lockley, M.G., 2000. The oldest evidence of a sauropod dinosaur in the western united states and other important vertebrate trackways from Grand Staircase-Escalante national monument, Utah. *Ichnos: An International Journal of Plant & Animal*, *7*(3): 169-181.

Stokes, W.L., 1978. Animal tracks in the Navajo-Nugget sandstone. *Rocky Mountain Geology*, *16*(2): 103-107.

4. Circle Cliffs Region

The Circle Cliffs Region at the northeastern end of the Monument contains Permian and Triassic rocks, which have yielded scientifically important fossils including the largest Triassic age petrified forest outside of Petrified Forest National Monument. This region has also produced the most complete skeleton of the bipedal stem-crocodilian *Poposaurus* ever found, an animal that is important for understanding the evolution of archosaurs and crocodilians.

Foster, J., Hamblin, A. and Lockley, M., 2003. *Apatopus* trackway and other footprints from the Chinle Group of southern Utah: an update. *Ichnos*, *10*(2-4), pp. 165-167.

Gauthier, J.A., Nesbitt, S.J., Schachner, E.R., Bever, G.S. and Joyce, W.G., 2011. The bipedal stem crocodilian *Poposaurus gracilis*: inferring function in fossils and innovation in archosaur locomotion. *Bulletin of the Peabody Museum of Natural History*, 52(1), pp. 107-126.

Appendix 2. Representative scientific bibliography about the paleontological resources at each of the 21 monuments.

This appendix contains a representative bibliography of scientific literature that is based on the paleontological resources of each national monument. Lack of papers about any given monument does not mean that paleontological resources are rare or unimportant there; for most of these monuments, it means that scientific investigation of their paleontological resources is incomplete. Similarly, a bountiful list does not imply that sites have been 'fully investigated,' but rather it reflects the ongoing scientific process of hypothesis testing that involves revisiting old data, collecting new data, and hashing out interpretations in the peer-reviewed scientific literature.

Basin and Range National Monument, Nevada

Bartel, D. J. 1968. Structure and stratigraphy of the Western Red Hills, Nevada. M.S. thesis, University of Nebraska, Lincoln, Nebraska.

Ekren, E. B., C. L. Rogers, and G. L. Dixon. 1973. Geologic and bouguer gravity map of the Reveille Quadrangle, Nye County, Nevada. United States Geological Survey Miscellaneous Geological Investigation Map I-806.

Tschanz, C. M., and E. H. Pampeyan. 1970. Geology and mineral deposits of Lincoln County, Nevada. Nevada Bureau of Mines Geological Bulletin 73, 188 pp.

Bears Ears National Monument, Utah

Agenbroad, L.D. and Mead, J.I., 1989. Quaternary geochronology and distribution of Mammuthus on the Colorado Plateau. Geology, 17(9), pp.861-864.

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