



# Scotts Bluff National Monument

## *Paleontological Resource Inventory (Public Version)*



An Oligocene riparian woodland, depicting fossil mammals recorded from Scotts Bluff National Monument and the nearby Wildcat Hills. The oreodont *Sespia* is hunted by the canid *Sunkahetanka* before the latter is attacked by the “false sabertooth cat” *Nimravus*; all while the small primate *Ekgmowechashala* watches from above.

NPS / BENJI PAYSNOE

# **Scotts Bluff National Monument: Paleontological Resource Inventory (Public Version)**

Science Report NPS/SR—2026/504

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## Abstract

Scotts Bluff National Monument (SCBL) was established in 1919 in order to preserve the scenic, scientific, geologic, and historic resources of the area surrounding Scotts Bluff in western Nebraska, with paleontological resources representing an important constituent component. Similar to other National Park System units in the western Great Plains (e.g., Agate Fossil Beds National Monument, Badlands National Park), the fossils preserved at SCBL provide important insight into the mid-Cenozoic fauna of the region. The fauna recorded from SCBL includes a diverse array of mammals alongside invertebrates, reptiles, and birds, with many examples of these being well-preserved. Fossils are represented in all exposed geologic strata within SCBL, with the greatest diversity and abundance present in the Oligocene Brule Formation.

In order to comprehensively assess the paleontological resources present at SCBL, an inventory of the monument was undertaken in 2025. The field-based component of this inventory took place at SCBL in June 2025 and resulted in documentation of 30 new paleontological localities within the monument. In addition, a review of published and gray literature was conducted to gain a thorough understanding of the current state of paleontological knowledge related to the monument. From the field and literature components of this inventory, the significance of the paleontological resources preserved at SCBL is demonstrated, with future research likely to produce important scientific information, possibly including new taxa.

This report provides foundational data on the scope, significance, and distribution of paleontological resources at SCBL and provides recommendations to support the management, interpretation, and research of these resources.

## List of Terms or Acronyms

**Acetabulum:** A socket in the pelvis for the articulation of a leg.

**Alluvial** (adjective), **alluvium** (noun): Unconsolidated terrestrial sediment moved by running water (e.g., rivers), deposited in settings such as floodplains and alluvial fans.

**AMNH:** American Museum of Natural History.

**Amphicyonid:** A member of the family Amphicyonidae, an extinct group of carnivoran mammals also known as a “bear dog”, known from the Eocene to the end of the Miocene.

**Amynodont:** A member of the family Amynodontidae, an extinct group resembling modern rhinocerotids, known from the Eocene and Oligocene.

**Anterior** (anatomical term of direction): Toward the front of the body.

**Aplodontid:** A member of the rodent family Aplodontidae, including the modern mountain beaver.

**Ar:** (chemistry) Abbreviation for argon; (biostratigraphy) abbreviation for Arikareean.

**Arikareean:** A North American Land Mammal “Age” of the Oligocene and Early Miocene, approximately 30.0 to 18.8 Ma.

**Arkosic** (adjective), **arkose** (noun): Sandstone rich in grains of feldspar minerals.

**Artifact** (archeology): Objects made or modified by humans.

**Artiodactyl:** A member of the order Artiodactyla, the even-toed ungulate mammals (e.g., bison, camels, deer, pigs, sheep). Artiodactyls are known from the Eocene to the present.

**Astragalus** (anatomy): A major ankle bone, also known as the **talus**.

**Atlas** (anatomy): The first vertebra of the neck, which with the axis supports the skull and its movements.

**Axis** (anatomy): The second vertebra of the neck.

**Azimuth:** The angle between something and a cardinal direction (usually north).

**BADL:** Badlands National Park.

**Badland:** Dry, heavily weathered terrain of steep ridges and valleys cut into easily eroded bedrock.

**Barstovian:** A North American Land Mammal “Age” of the Middle Miocene, approximately 16.0 to 12.6 Ma.

**Basal** (geology): Located near or at the bottom of a specific geologic unit.

**Basal** (phylogeny): A taxon closer to the base/root of a phylogenetic tree or cladogram.

**Bathornithid**: A member of the family Bathornithidae, an extinct group of ground-dwelling predatory birds, known from the Eocene into the Miocene.

**Bedrock** (geology): A general term for the rock that underlies soil or other unconsolidated, surficial material.

**Bilobate**: Having two lobes.

**Biochronology**: Using fossils to determine relative ages of fossil assemblages and events.

**Biostratigraphy**: Using fossils to determine the relative positions and relative ages of rock strata.

**Biotite**: A dark silicate mineral that forms thin flexible sheets.

**Bioturbation**: Disturbance of sediment by organisms to the extent that sedimentary structures such as bedding and stratification are destroyed.

**Biozone**: A stratigraphic interval defined by the types of fossils found in it.

**Bivalve**: A member of the class Bivalvia, a group of mollusks with two shells joined by a hinge; bivalves are also sometimes known as pelecypods, to reduce confusion (the term “bivalve” in a general sense also applies to other groups). Modern examples include clams, oysters, mussels, and scallops.

**Body fossil**: Fossilized remains of the bodies of past organisms, including bones, teeth, skin, shells, wood, and leaves.

**Borophagine**: A member of the canid subfamily Borophaginae, an extinct group of “bone-crushing” dogs, known from the Oligocene into the Pleistocene.

**Braincase**: The fused bones of the skull protecting the brain.

**Brontothere** (**titanothere** in old references): A member of the family Brontotheriidae, an extinct group of horned perissodactyls that resembled rhinoceroses and lived only during the Eocene.

**Calcaneum, calcaneus**: A major ankle bone; the heel bone in humans.

**Calcareous**: Describes rock or sediment that contains the mineral calcium carbonate ( $\text{CaCO}_3$ ), often as a cement; “lime-rich”.

**Calcite**: A mineral made of calcium carbonate ( $\text{CaCO}_3$ ), the primary component of limestone and some fossils.



**Calcium carbonate:** A compound with the chemical formula  $\text{CaCO}_3$ . Calcite is a common form.

**Camelid:** A member of the family Camelidae, a group of mammals including camels and relatives, known from the Eocene to the present.

**Canidae:** A member of the family Canidae, a group of mammals including dogs and relatives, known from the Eocene to the present.

**Caniform (taxonomy):** A member of the suborder Caniformia, a group of mammals including dogs, bears, raccoons, mustelids, and pinnipeds, known from the Eocene to the present.

**Canine (taxonomy):** A member of the subfamily Caninae, a group of mammals including all living dogs.

**Carbonate (geology):** A general term for minerals containing carbonate ions ( $\text{CO}_3^{2-}$ ), such as calcite, and rocks containing these minerals, such as limestone.

**Carnivoran:** A member of the order Carnivora, a group of mammals including most of the living flesh-eating forms (e.g., felines, canines, bears, raccoons, weasels, seals, etc.), known from the Eocene to the present.

**Case-hardening:** The production of a resistant zone or crust on outcrop surfaces due to weathering.

**CCC:** Civilian Conservation Corps.

**Cementation:** Chemical precipitation of material into pores between grains that bind the grains into rock.

**Cenozoic:** A geologic era, dated approximately 66 Ma to the present, noted for the diversification of mammals; the term means “new life”.

**Cervical vertebra:** A vertebra of the neck.

**Cf.:** When placed before a taxonomic name, this means the fossil is comparable to that taxon, but the identification is tentative; from the Latin *confer*.

**Chadronian:** A North American Land Mammal “Age” of the Late Eocene, approximately 37.0 to 33.7 Ma.

**Cladistics:** A biological classification method grouping organisms in groups (**clades**) based on the proportion of shared measurable derived characteristics (**synapomorphies**). Cladistics is the most commonly utilized method for classifying organisms.

**Cladogram:** In cladistics, a diagram used to show the relationships of organisms.

**Clarendonian:** A North American Land Mammal “Age” of the Middle and Late Miocene, approximately 12.6 to 9.0 Ma.

**Clastic:** Describes rock or sediment made of fragments of pre-existing rocks (clasts).

**Clay:** Can be used to refer to clay minerals or as a sedimentary fragment size classification (less than 1/256 mm [0.00015 in]).

**Cobble:** Clastic sedimentary material intermediate in size between pebbles and boulders (64 to 256 mm [2.5 to 10.1 in]).

**Coeval:** Occurring or existing at the same time; contemporary.

**Colluvial** (adjective), **colluvium** (noun): Unconsolidated sediment deposits formed by gravity-driven movement, commonly found at the bases of topographic highs such as hills.

**Concretion:** A mass that forms in sedimentary deposits from the precipitation of natural cement.

**Conformable** (geology): A successive, continuous sequence of strata deposited without interruption or disturbance.

**Conglomeratic** (adjective), **conglomerate** (noun): A clastic sedimentary rock comprised of a significant proportion of gravel-sized clasts (>2 mm [0.08 in]) and a finer grained matrix.

**Consolidant** (paleontology): A dilute adhesive used to penetrate a fossil specimen and adhere internally in order to prevent damage.

**Contact** (geology): The horizon or plane where two formations or other units meet.

**Convergence** (biology): The evolution of similar features in separate lineages of organisms.

**Coprolite:** Fossil feces.

**Cotype:** An outdated term for one of a group of specimens designated a type series for an organism. The modern term is syntype.

**Cranial:** Of the skull.

**Cretaceous:** The third and last geologic period of the Mesozoic Era, noted for the rise of flowering plants and the extinction of many groups at the end of the period; approximately 145 to 66 Ma.

**Cricetid:** A member of the rodent family Cricetidae, including among others New World mice and rats, muskrats, and voles, known from the Oligocene to the present.

**Cross-bedding or cross-stratification:** Uniform to highly varied sets of inclined sedimentary beds deposited by wind or water that indicate flow conditions such as deposition direction and depth/height.

**CWA:** Civil Works Administration.

**Distal** (anatomical term of direction): Farther from the core of the body.

**Dorsal vertebra:** A vertebra of the back.

**Early diverging:** A lineage that diverges from another lineage early in their collective evolutionary history.

**Entelodont:** A member of the family Entelodontidae, an extinct group of pig-like artiodactyls known from the Eocene into the Miocene.

**Eocene:** The second epoch of the Paleogene Period; approximately 56 to 34 Ma.

**Eolian:** A sedimentary process involving the erosion, transport, and deposition of sediments by wind; also used to describe rocks or environments formed or influenced by wind. Loess and sand dunes are features created by eolian processes.

**EOU:** Eastern Oregon University.

**Equid:** A member of the family Equidae, a group of mammals including horses and relatives, known from the Eocene to the present.

**Eulipotyphlan:** A member of the order Eulipotyphla, a group of mammals including hedgehogs, moles, and shrews, known from the Paleocene to the present.

**Eutherian:** A member of the clade Eutheria, a group of mammals including placental mammals and other mammals more closely related to them than to marsupials.

**Extant:** Still in existence, not extinct.

**Extinct:** A group of organisms that no longer exist.

**Felid:** A member of the family Felidae, a group of mammals including cats and relatives, known from the Oligocene to the present.

**Feliform** (taxonomy): A member of the suborder Feliformia, a group of mammals including cats and other cat-like carnivorans, known from the Eocene to the present.

**Femur:** The upper bone of the hind limb; the thigh bone.

**Ferae:** The clade including carnivorans, hyaenodonts, pangolins, and their relatives, known from the Cretaceous to the present.

**Float (geology):** Eroded material resting on the surface, not attached to an outcrop.

**Fluvial (geology):** A sedimentary process involving the erosion, transport, and deposition of sediments by confined flowing water; rivers and streams are depositional environments where fluvial processes dominate.

**Formation (geology):** A rock unit that is mappable, lithologically distinct from adjoining strata, and has definable upper and lower contacts; the basic unit of stratigraphy.

**Fossiliferous:** A rock or deposit that contains fossils.

**Ga:** An abbreviation for “gigaannum” or “giga-annum” meaning “billion years”, often informally used to mean “billion years ago”.

**Galliform:** A member of a group of ground-feeding birds including chickens, grouse, quail, and turkeys, also known as landfowl.

**Gastropod:** A member of the class Gastropoda, a group of mollusks including snails and slugs (snails without shells) with a single, usually coiled shell, known from the Cambrian to the present.

**Geochronology:** A branch of geology dedicated to determining the age of rocks, sediments, fossils, and geologic events using characteristics of rocks and strata such as isotopes.

**Glires:** The clade including lagomorphs and rodents, known from the Paleocene to the present.

**Gravel:** Rock fragment; depending on the classification scheme, gravel may include granule and pebble grain sizes (2 to 64 mm [0.08 to 2.5 in]) or anything larger than sand (2 mm [0.08 in and up]).

**GRD:** Geologic Resources Division of the National Park Service.

**GRI:** Geologic Resources Inventory.

**Group (geology):** A lithostratigraphic unit comprising several related formations classified together.

**GSRI:** Geologic & Soil Resources Inventories.

**Gully:** A small channel produced by running water in earth or unconsolidated material (e.g., soil or a bare slope).

**Gypsum:** A mineral made of calcium sulfate dihydrate,  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . Often deposited through evaporation of lake/sea water, as well as in veins.

**Hemingfordian:** A North American Land Mammal “Age” of the Early Miocene, approximately 18.8 to 16.0 Ma.

**Hemphillian:** A North American Land Mammal “Age” of the Late Miocene and Early Pliocene, approximately 9.0 to 4.9 Ma.

**Herpetotheriid:** A member of the family Herpetotheriidae, an extinct group of mammals related to the marsupials known from the Cretaceous into the Miocene.

**Hesperocyonine:** A member of the subfamily Hesperocyoninae, an extinct group of early dogs known from the Eocene into the Miocene.

**Holocene:** The second and most recent epoch of the Quaternary Period, following the Pleistocene and the last glacial maximum; approximately 11,700 years ago to the present.

**Holotype:** A specimen that serves as the basis for an organism’s scientific name and is ideally representative of the given taxon, although this is not necessarily the case. Other “types” exist for specific situations, such as a paratype or a neotype. Some species are based on multiple specimens, which are called cotypes (outdated; sometimes “co-types”) or syntypes.

**Humerus:** The upper bone of the forelimb or arm.

**Hyaenodont:** A member of the order Hyaenodonta, an extinct group of carnivorous mammals known from the Paleocene into the Miocene.

**Hypertragulid:** A member of the family Hypertragulidae, an extinct group of small deer-like artiodactyl ungulates known from the Eocene and Oligocene.

**Hyracodontid:** A member of the family Hyracodontidae, an extinct group of mammals closely related to modern rhinos known from the Eocene and Oligocene.

**Ichnofossil (also trace fossil):** Fossilized evidence of biological activity, including root traces, footprints, tracks, burrows, trails, feeding marks, fossilized dung, and other biogenically produced features.

**Ichnogenus, ichnospecies, ichnofamily, ichnotaxon:** A scientific name used for a trace fossil, existing in parallel to the names used for body fossils.

**Ichnology:** The study of traces of biological activity beyond an organism’s remains. Sometimes divided into **paleoichnology** (the study of trace fossils or ichnofossils) and **neoichnology** (the study of modern traces).

**IMPF:** Independence Multi-Park Facility.

**In situ (geology):** When describing fossils, this means found in place at an outcrop.

**Incisor:** One of the narrow teeth at the very front of a mammal's jaws.

**Indet.:** An abbreviation of "indeterminate" used with taxonomic names to indicate a specimen cannot be assigned to a lower taxonomic level.

**Insectivore:** An organism that feeds on insects. Several groups of mammals were once classified as the order Insectivora, but this has now been disbanded. Most of them are now under Eulipotyphla.

**Index fossil:** A widespread, distinctive fossil organism that corresponds to a specific geologic age and is used to date and correlate rock strata.

**Irvingtonian:** A North American Land Mammal "Age" of the Early and Middle Pleistocene, approximately 1.72 Ma to 150,000 years ago.

**Ischyromyid:** A member of the extinct rodent family Ischyromyidae, known from the Paleocene into the Oligocene.

**Isotope:** Varieties of a chemical element that differ in the number of neutrons in the nucleus. Some are radioactive and decay at predictable rates, permitting radiometric dating. Others are stable; the slight differences in mass allow them to be used to study processes that prefer lighter or heavier isotopes, such as evaporation preferring lighter oxygen isotopes.

**K:** Chemical abbreviation for potassium.

**Lagomorph:** A member of the order Lagomorpha, a group of mammals including pikas, rabbits, and relatives, known from the Paleocene to the present.

**Lenticular (geology):** A feature with a lens-shaped cross-section.

**Leptaucheniine:** A member of the oreodont subfamily Leptaucheniinae, an extinct group of artiodactyl ungulates known from the Oligocene.

**Leptictid:** A member of the order Leptictida, an extinct group of small mammals with long hind legs and tails, traditionally classified as insectivores, known from the Cretaceous into the Oligocene.

**Leptomerycid:** A member of the family Leptomerycidae, an extinct group of small deer-like artiodactyl ungulates, known from the Eocene into the Miocene.

**Limestone:** A sedimentary rock consisting mainly of calcium carbonate, primarily in the form of the mineral calcite.

**Lithified:** A sedimentary deposit that has become rock.

**Lithology:** Physical characteristics of a rock such as texture, grain size, etc., that are used for description and classification by rock type and lithostratigraphic unit (e.g., formation, member, etc.).

**Lithostratigraphy:** The definition, classification, correlation, and relative dating of rock units by characteristics of their physical composition.

**Locality:** A distinct location, especially one known for field fossils or other unique features.

**Loess:** A deposit of generally silt-sized wind-blown dust.

**Loessite:** A lithified loess deposit.

**Ma:** An abbreviation for “megaannum” or “mega-annum” meaning “million years”, often informally used to mean “million years ago”.

**Mandible:** The lower jaw.

**Manus (anatomy):** A fore foot (“hand”) of a tetrapod.

**Marker bed:** A stratum that is distinctive and found in a wide area, properties allowing it to correlate outcrops over distances.

**Mass wasting:** A general term for the downslope movement of soil and rock material under the direct influence of gravity.

**Massive (geology):** Rocks without visible stratification or other bedding features.

**Matrix (geology):** A fine-grained mass of rock in which larger grains, clasts, crystals, and/or fossils are embedded.

**Maxilla (singular), maxillae (plural):** The primary tooth-bearing bone of the upper jaw; in mammals, the paired maxillae fuse, but in other vertebrates they are separate.

**MCMS:** Museum Collection Management System.

**MCZ:** Museum of Comparative Zoology.

**Member (geology):** A subdivision of a formation.

**Merycoidodontid:** A member of the oreodont family Merycoidodontidae, an extinct group of artiodactyl ungulates known from the Eocene into the Miocene.

**Merycoidodontine:** A member of the oreodont subfamily Merycoidodontinae, an extinct group of artiodactyl ungulates known from the Eocene into the Miocene.

**Mesozoic:** A geologic era, dated approximately 252 to 66 Ma, noted for the dominance of dinosaurs on land and the appearance of birds, mammals, and flowering plants. The term means “middle life.”

**Metacarpal:** One of the long bones of the hand, making up the palm in humans.

**Metapodial:** One of the long bones of the hand or foot.

**Metatherian:** A member of the mammal clade Metatheria, including marsupials and their closest relatives, known from the Late Cretaceous to the present.

**Microfossil:** A complete or partial fossil, typically 1 mm (0.04 in) or less in size, that must be studied with a microscope; many kinds are important for relative dating of rocks.

**Microvertebrate:** A vertebrate microfossil, requiring a microscope for study.

**Microwear:** Microscopic scratches and other marks on tooth enamel, used to study the kinds of foods an animal ate and how it processed food with its teeth.

**Miniochoerine:** A member of the oreodont subfamily Miniochoerinae, an extinct group of artiodactyl ungulates known from the Eocene and Oligocene.

**Miocene:** The first epoch of the Neogene Period; approximately 23 to 5.33 Ma.

**Molar:** One of the grinding teeth at the back of the jaws in mammals.

**Mollusk:** A member of the phylum Mollusca, a diverse group of invertebrates that frequently combine a soft unsegmented body, a muscular foot, a shell, and a mantle that covers the innards and secretes the shell. Examples include bivalves and gastropods (snails).

**Mudstone:** A clastic sedimentary rock composed of silt- and clay-sized grains and lacking the thin beds of shale.

**MWAC:** Midwest Archeological Center.

**Mylagaulid:** A member of the extinct rodent family Mylagaulidae, known from the Oligocene into the Pliocene.

**NAGPRA:** Native American Graves Protection and Repatriation Act.

**NALMA:** North American Land Mammal “Age”; the quotation marks denote these are informal biostratigraphic/biochronologic units, not formally defined geochronologic ages.

**Neogene:** The second geologic period of the Cenozoic Era; approximately 23 to 2.58 Ma.

**Nimravid:** A member of the Nimravidae, an extinct group of saber-toothed carnivoran mammals also known as “false saber-toothed cats”, known from the Eocene into the Miocene.

**Nodule (geology):** A mineral lump or mass found in sedimentary rocks.

**NPS:** National Park Service, National Park System.



**Oligocene:** The third and final epoch of the Paleogene Period; approximately 34 to 23 Ma.

**Orellan:** A North American Land Mammal “Age” of the Early Oligocene, approximately 33.7 to 32.0 Ma.

**Oreodont:** A member of the superfamily Merycoidodontoidea, an extinct group of artiodactyl ungulates with low-slung pig-like bodies and short stocky skulls, known from the Eocene to the end of the Miocene.

**Organic:** Made of organic compounds (i.e., molecules of carbon, hydrogen, nitrogen, and oxygen); pollen, spores, and algal resting cysts, all of which can be fossilized, have organic walls.

**Orogeny:** A mountain-building event.

**Ostracod** or **ostracode:** A member of the class Ostracoda, a group of shelled and generally microscopic crustaceans known informally as “seed shrimp”.

**Outcrop:** An exposure of bedrock.

**Paleocene:** The first epoch of the Paleogene Period; approximately 66 to 56 Ma.

**Paleoecology:** The study of interactions among organisms and between organisms and their environments on a geologic timescale.

**Paleogene:** The first geologic period of the Cenozoic Era; approximately 66 to 23 Ma.

**Paleogeography:** The study, description, and reconstruction of the physical landscape from past geologic periods.

**Paleosol** (geology): A preserved ancient soil buried and sometimes lithified. Can be useful for interpretation of the depositional environment and/or climate. Divided into distinct classes similar to those used in modern soil science.

**Paleozoic:** A geologic era, dated approximately 539 to 252 Ma, noted for the diversification of invertebrates and the appearance of vertebrates and land plants; the term means “early life”.

**Palynomorph:** An organic-walled microfossil. Pollen and spores are common examples; other types include tests of some microorganisms and jaw elements of worms.

**Pantolestid:** A member of the family Pantolestidae, an extinct family of omnivorous mammals, some of which were diggers and others semi-aquatic, known from the Paleocene into the Oligocene.

**Paratype:** A specimen of an organism that helps define it, but which is not a name-bearing specimen.

**Patella:** A bone protecting the knee joint.

**Pebble:** Clastic sedimentary material intermediate in size between granules and cobbles (4 to 64 mm [0.16 to 2.5 in]).

**Pelvis:** The hip.

**Perissodactyl:** A member of the order Perissodactyla, the odd-toed ungulate mammals (e.g., horses, rhinos), known from the Paleocene to the present.

**Pes (anatomy):** A hind foot of a tetrapod.

**Phalanx (singular), phalanges (plural) (anatomy):** A digit bone, making up the fingers and toes.

**Phylogenetics:** The study of the evolutionary relationships and history of organisms, determined through a variety of methods (such as DNA sequences and morphology). A **phylogenetic tree** is utilized to show hypothesized relationships and the evolutionary history of a group of organisms.

**Phytolith:** A microscopic silica structure that forms within the cells of some plants.

**Placental:** Describes mammals that use a placenta in reproduction.

**Plastron:** The belly plate of a turtle.

**Plate (tectonic):** One of the fundamental pieces of the Earth's crust, e.g., the North American plate.

**Pleistocene:** The older of two epochs in the Quaternary Period, noted for ice ages; approximately 2.58 Ma to 11,700 years ago.

**Pliocene:** The second and final epoch of the Neogene Period; approximately 5.33 to 2.58 Ma.

**Podial:** A bone of the wrist or ankle.

**Postcrania:** In a skeleton, bones below or past the skull (cranium).

**Posterior (anatomical term of direction):** Toward the rear of the body.

**Premolar:** A tooth in front of the molars in mammals.

**Proximal (anatomical term of direction):** Closer to the core of the body.

**Protoceratid:** A member of the family Protoceratidae, an extinct group of artiodactyl ungulates resembling deer, known from the Eocene into the Pliocene; males had large bony horns behind the eyes and on the snout.

**PRPA:** Paleontological Resources Preservation Act.

**Pseudomorph:** A mineral crystal that has replaced a crystal of a different mineral and shape.

**Pumice:** A very porous volcanic rock made up of quickly cooled volcanic glass with many bubbles.

**Quartz:** A common mineral composed of silica, chemical formula  $\text{SiO}_2$ .

**Quaternary:** The most recent geologic period, third and last in the Cenozoic Era, noted for multiple glacial and interglacial episodes; approximately 2.58 Ma to the present.

**Radiometric dating:** A geochronologic method in which the age of a given material can be determined through measuring a radioactive isotope's amount of decay. Different dating schemes may be employed given the age range of a sample (e.g., **radiocarbon ( $^{14}\text{C}$ ) dating** is reliable for samples up to roughly 50,000 years old, whereas **uranium-lead (U-Pb) dating** is reliable for samples ranging from 1 Ma to upwards of 4.5 Ga).

**Radius:** One of two bones of the forearm.

**Ramus** (singular), **rami** (plural): In the context of a mandible, a ramus is the portion from the articulation surface to the tooth row.

**Rancholabrean:** A North American Land Mammal "Age" of the Middle and Late Pleistocene, approximately 150,000 to between 13,000 and 9,500 years ago.

**Regression** (noun), **regressive** (adjective): A marine retreat, exposing land.

**Repository:** A place, often an institution, where artifacts such as fossils are permanently held.

**Reworked** (geology): A fossil or other clast that has been eroded from an older rock unit and redeposited in a younger unit.

**Rhinocerotid:** A member of the family Rhinocerotidae, the group including modern rhinos, known from the Eocene to the present.

**Rhinocerotoid:** A member of the superfamily Rhinoceroidea, the group including modern rhinos and their relatives, known from the Paleocene to the present.

**Rhizolith:** A sedimentary structure formed by plant roots and found in paleosols; sometimes referred to as root traces.

**Riparian:** Pertaining to a riverbank setting.

**Ruminant:** An artiodactyl that regurgitates food (cud) from a specialized stomach for additional chewing as part of the digestive process. Ruminants include cattle, goats, sheep, and others.

**Rupelian:** The first part of the Oligocene Epoch; approximately 33.9 to 27.3 Ma.

**Sacrum:** Two or more fused vertebrae supporting the hip.

**Saltatorial:** An animal that moves by leaping.

**Sand:** A clastic particle smaller than a granule and larger than a silt grain, having a diameter in the range of 1/16 mm (0.0025 in) to 2 mm (0.08 in).

**Sandstone:** Clastic sedimentary rock of predominantly sand-sized grains.

**Scapula:** The main bone supporting the arm; the shoulder blade.

**Screenwashing or wet sieving:** A technique by which water is used in conjunction with screens of various sizes in order to separate fossils (particularly microfossils) from sediment and/or matrix.

**SDSMT:** South Dakota School of Mines and Technology; SDSM in older references.

**Sediment:** An eroded and deposited, unconsolidated accumulation of rock and mineral fragments.

**Sedimentary:** Refers to a consolidated and lithified rock consisting of clastic and/or chemical sediment(s). One of the three main classes of rocks, alongside igneous and metamorphic.

**Silica:** The compound  $\text{SiO}_2$ , the building block of the common mineral quartz.

**Silicate mineral:** A mineral with a framework of silica. Quartz is a common silicate.

**Silt:** Clastic sedimentary material intermediate in size between fine-grained sand and coarse clay (1/256 to 1/16 mm [0.00015 to 0.002 in]).

**Siltstone:** A clastic sedimentary rock composed of silt-sized grains.

**Slope:** The inclined surface of any geomorphic feature or measurement thereof. Synonymous with “gradient.”

**Soil:** Surface accumulation of weathered rock and organic matter capable of supporting plant growth and often overlying the parent material from which it formed.

**Sp.:** When used with a genus name, this indicates that the species has not been determined.

**Stem group (phylogenetics):** A paraphyletic group of organisms basal to and lacking certain traits of a derived clade (e.g., dinosaurs and pterosaurs are stem-birds).

**Stratification:** The accumulation or layering of sedimentary rocks in strata. Tabular, or planar, stratification refers to essentially parallel surfaces. Cross-stratification refers to strata inclined at an angle to the main stratification.

**Stratigraphy:** The study of the origin, occurrence, distribution, classification, correlation, and age of rock layers, especially sedimentary rocks.

**Stratotype:** The standard (original or subsequently designated), accessible, and specific sequence of rock for a named geologic unit that forms the basis for the definition, recognition, and comparison of that unit elsewhere.

**Stratum** (singular), **strata** (plural): A layer of rock/sediment distinguished by specific lithological characteristics.

**Structure** (geology): Three-dimensional features such as folds and faults.

**Structureless:** Rocks without visible stratification or other bedding features.

**Subduction:** The descent of part or all of a tectonic plate beneath another, less dense plate at a trench, resulting in the destruction of the descending plate.

**Subparictid:** A member of the family Subparictidae, an extinct group of carnivoran mammals related to bears known from the Eocene into the Miocene.

**Swale:** A shallow marshy depression or trough.

**Symphysis:** A fusion between two bones. Technically a true symphysis is cartilaginous, but the joint between the two halves of the lower jaw is also known as a symphysis.

**Syntype:** One of a group of specimens designated as a name-bearing series for an organism.

**Taxonomy:** The study of naming, defining, and classifying organisms into groups. Taxonomic groups or **taxa** (singular: **taxon**) are provided with a taxonomic ranking (the main ranks utilized are **domain, kingdom, phylum/division, class, order, family, genus, and species**, although additional ranks exist).

**Tayassuid:** A member of the family Tayassuidae, the group including peccaries, known from the Miocene to the present.

**Tetrapod:** A member of the superclass Tetrapoda, meaning “four feet”, although some members have lost some or all four limbs (e.g., snakes). Tetrapods include amphibians, reptiles, birds, and mammals.

**Tibia:** The stouter of the two bones of the lower hind limb; the shin bone.

**Transgression** (noun), **transgressive** (adjective): A marine encroachment, submerging land.

**Tuff:** A rock that contains more than 75% volcanic ash. Rock with significant but lesser ash content (25% to 75%) is called tuffaceous.

**Type section:** A geologic exposure that serves as the basis of definition for a stratigraphic unit.

**Ulna:** One of two bones of the forearm, it is the major contributor to the elbow joint with the upper arm (humerus).

**Ulnare:** One of the bones of the wrist.

**Unconformity:** A general term for any erosional or non-depositional surface between two rock units, representing a time gap in the rock record.

**Ungulate:** In general usage, a hoofed mammal (Ungulata also includes whales and relatives). Ungulates are known from the Paleocene to the present.

**UNL:** University of Nebraska–Lincoln.

**UNSM:** University of Nebraska State Museum.

**Ursid:** A member of the family Ursidae, a group of mammals including bears and relatives, known from the Eocene to the present.

**USGS:** United States Geological Survey.

**USNM:** United States National Museum of Natural History.

**Vertebra** (singular), **vertebrae** (plural): One of the bones of the spine; a backbone.

**Volcaniclastic:** Rocks and sediments made up of fragments of volcanic rock.

**Weathering:** The physical, chemical, and biological processes by which rock is broken down.

**Western Interior Seaway:** A shallow continental sea that covered much of the midsection of North America from the Arctic to the Gulf of Mexico between approximately 100 and 70 Ma, during the Cretaceous. Lowering sea levels and the growth of the Rocky Mountains caused it to recede.

**Whitneyan:** A North American Land Mammal “Age” of the Early Oligocene, approximately 32.0 to 30.0 Ma.

**YPM:** Yale Peabody Museum.

## Acknowledgments

We would like to begin by thanking all of the staff at Scotts Bluff National Monument (SCBL), Agate Fossil Beds National Monument (AGFO), and Badlands National Park (BADL) who assisted throughout this project. Special thanks are extended to AGFO/SCBL Superintendent Jay Sturdevant, AGFO/SCBL Natural Resources Program Manager Arthur Stiles, and other members of the AGFO/SCBL leadership team including Justin Cawiezel, Vince Davis, Eric Grunwald, Jontae Koke, and Anne Wilson. Their desire to properly manage, protect, and utilize the paleontological resources of SCBL helped drive this project forward and this report is enhanced thanks to their contributions.

We thank former SCBL resource manager Robert W. Manasek for his enthusiastic support of paleontology at SCBL over the years. His contributions were extremely helpful for work conducted leading up to this current inventory. We also thank Megan Rich and Nancy Russell for their work on the history of SCBL during the New Deal, which was valuable for the “History of Paleontological Work” section of this report. We thank Joseph Corsini of Eastern Oregon University for providing information on the status of specimens he collected from SCBL in 2006.

We would like to thank local resident Dave Fisher for his assistance with the fieldwork associated with this project and for his keen support of SCBL paleontology over the years. The paleontological resources recorded from within and protected at SCBL are indebted to Dave and others like him.

We greatly appreciate the administrative support and funding provided through the American Geosciences Institute (AGI). Namely, we wish to thank Ed Robeck and Sequoyah McGee for their assistance, which was invaluable to the completion of this inventory.

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## Dedication



Ken Mabery (left) speaking with members of an Afghan delegation in association with a former Sister Park Arrangement held between Scotts Bluff National Monument and Band-e Amir National Park, the first national park in Afghanistan.

*NPS / KEN MABERY*

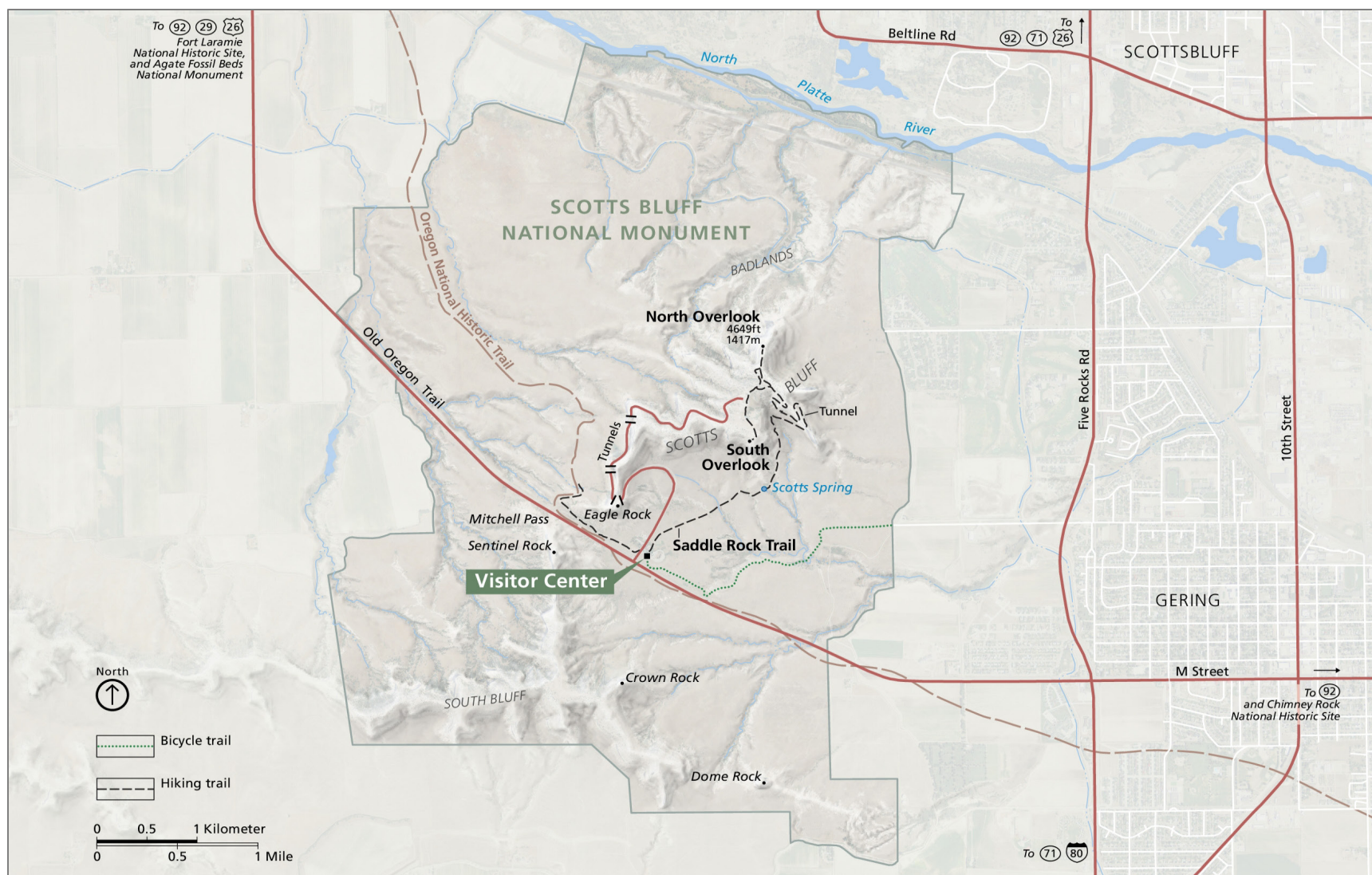
We dedicate the Scotts Bluff National Monument paleontological resource inventory to retired National Park Service ranger Ken Mabery. Ken's 46-year career with the NPS spanned from 1973 through his retirement in 2019. His tenure included serving as superintendent for four different NPS units, including Scotts Bluff National Monument where he served from 2008 through 2015. Ken's educational background in geology fostered his advocacy for and leadership in geology and paleontology within the NPS.



# Introduction

Scotts Bluff National Monument (SCBL) preserves 3,003 acres (12.15 km<sup>2</sup>; 4.69 mi<sup>2</sup>) of prairie, bluffs, and badlands in Scotts Bluff County, western Nebraska (Figure 1). This monument is on the western margin of the city of Gering, southwest of the city of Scottsbluff, and is bounded on the north by the North Platte River. Within the boundaries of SCBL are the two prominent natural and historic landmarks currently known as Scotts Bluff and South Bluff, divided by Mitchell Pass, as well as the smaller features Crown Rock, Dome Rock, Eagle Rock, Saddle Rock, and Sentinel Rock. Established in 1919 through a presidential proclamation by Woodrow Wilson, the enabling legislation for SCBL outlines the monument's purpose as the preservation of scenic, scientific, geologic, and historic components of the location (NPS 2015). Inherently included within such a purpose are the important paleontological resources protected by the monument, records of which extend at least as far back as the historic period of westward emigration in the mid-19<sup>th</sup> century (Effinger 1934). Today, two national historic trails commemorating that period pass through SCBL (California NHT and Pony Express NHT) and two others flank it, to the north (Mormon Pioneer NHT) and south (Oregon NHT). (This should not be taken to mean that people on the California Trail always went through what is now the monument and people on the Mormon or Oregon trails always went around it, as the routes of the national historic trails are by necessity idealized to a certain extent. Some maps may depict different routes for the trails, such as Figure 1 showing Oregon NHT passing through SCBL but not including the other three.)

This report provides detailed information on the paleontological resources of SCBL, including the history of paleontological work in the lands now within the monument, geologic units, taxonomic groups, localities, museum collections, research, interpretation, and management and protection. In addition to the main body of text, there are six appendices: Appendix A, tables of paleontological taxa arranged by stratigraphy; Appendix B, museum collections data; Appendix C, contact information for repositories; Appendix D, paleontological resource law and policy; Appendix E, paleontological locality data; and Appendix F, a geologic time scale.



**Figure 1.** Park map of SCBL.  
NPS

## **Significance of Paleontological Resources at SCBL**

SCBL preserves an excellent sequence of Oligocene and possibly Miocene rocks within the state of Nebraska. Within these geologic strata, an important fossil record detailing the paleobiodiversity and environmental transition of the region during the mid-Cenozoic (Oligocene–Miocene) is preserved at the monument. When coupled with similar but distinct records from BADL and AGFO, crucial insight into these past ecosystems can be recovered. Fossil communities from the strata found at SCBL and the aforementioned NPS units of western Nebraska and South Dakota appear to be rather local in character, and as such, the paleontological resources of SCBL possess a high likelihood of producing important new scientific discoveries.

## **Purpose and Need**

The NPS is required to manage its lands and resources in accordance with federal laws, regulations, management policies, guidelines, scientific principles, and specific resource management practices. Those authorities and guidance directly applicable to paleontological resources are cited below in Appendix D. Paleontological resource inventories have been developed by the NPS in order to compile information regarding the scope, significance, distribution (both temporal and geospatial), and management issues associated with fossil resources present within parks. This information is intended to increase awareness of park fossils and paleontological issues in order to inform management decisions and actions that comply with these laws, directives, and policies. Options for paleontological resource management are locality-specific, and may include no action, surveys, site monitoring, cyclic prospecting, stabilization and reburial, shelter construction, excavation, closure, patrols, and alarm systems or electronic surveillance. See Appendix D for additional information on applicable laws and legislation.

## **Project Objectives**

This park-focused paleontological resource inventory project was initiated to provide information to SCBL staff for use in formulating management activities and procedures that would enable compliance with related laws, regulations, policy, and management guidelines. Additionally, this project will facilitate future research, proper curation of specimens, interpretation for the public, and resource management practices associated with the paleontological resources of SCBL. Methods and tasks addressed in this inventory report include:

- Locating, identifying, and documenting paleontological resource localities through field reconnaissance and perusal of archives, using photography, GPS data, and standardized forms.
- Relocating and assessing historical localities.
- Assessing collections of SCBL fossils maintained within monument collections and in outside repositories.
- Documenting current information on faunal assemblages and paleoecological reconstructions.

- Interviewing current and past SCBL staff to gather information on the current status of paleontological resources, to aid in formulating plans for management, ideas for interpretation, and recommendations.
- Conducting a thorough search for relevant publications, unpublished geologic notes, and outside fossil collections from SCBL.

## History of Paleontological Work at SCBL

Fossils have long been known from SCBL and western Nebraska as a whole, with Native peoples of the Plains possessing awareness of local fossils. An example of this can be found in the story of a fossil tooth discovered in northwest Nebraska and explained by Oglala Lakota American Horse as belonging to a “Thunder Horse” that occasionally chased and killed bison, in association with thunderstorms—this story being recorded by Captain James H. Cook, discoverer of fossils at the nearby Agate Fossil Beds National Monument (AGFO) (Effinger 1934). While no such stories are directly known for SCBL, it is nevertheless probable that the fossils of the monument were long known to local indigenous inhabitants.

At SCBL specifically, some of the earliest documented reports of fossils are relayed by westward travelers along the emigrant trails. These reports, recorded in journals, include several quoted in a former exhibit at the monument’s visitor center: an 1843 report by pioneers Overton Johnson and William H. Winter of “great numbers of semi-petrified Turtles, from one to two feet across, imbedded in the sand, and many of them perfect”; an 1846 report by Phillip St. George Cooke of the Mounted Dragoons who mentions “a skeleton head of a small quadruped” that “seems totally deficient in holes or sockets for eyes”; and an 1847 report by Mormon pioneer William Clayton of “a very large bone almost petrified into stone” found at the base of a bluff. Such early reports by various groups highlight the importance of fossils within the broader historical narrative recorded and preserved at SCBL and were previously incorporated into an interpretive context at the monument (Figure 2).





**Figure 2.** Former exhibit at the SCBL Visitor Center highlighting some of the earliest accounts of fossils from SCBL and the surrounding region.

NPS / VINCE SANTUCCI

The 1840s, 1850s, and 1860s saw initial government-sponsored scientific exploration into the region broadly with many individuals starting to conduct geological and paleontological research, such as John Evans of the 1849 Owen Survey, Thaddeus A. Culbertson of the 1850 Smithsonian expedition, and the U.S. Geological Survey of the Territories led by F. V. Hayden and F. B. Meek during the 1850s and 1860s. Much of the fossil material collected by such expeditions was examined by Joseph Leidy of the Academy of Natural Sciences of Philadelphia, a founder of American vertebrate paleontology (Effinger 1934).

The early 1870s at SCBL are notable because of the multiple field expeditions of Yale University, in which numerous fossil specimens were collected from the White River Group strata of Scotts Bluff. Many of these specimens were collected by O. C. Marsh and his students from Yale and were eventually repositied in the Peabody Museum of Natural History. Some were described by Marsh (Marsh 1871, 1884) or later (Shufeldt 1915; Thorpe 1921a, 1921b). Expeditions by Yale University continued in the region through the early 1900s, with additional expeditions sent by Princeton University, the American Museum of Natural History, and numerous other institutions (University of Nebraska, University of South Dakota, Carnegie Museum of Natural History, Field Museum of Natural History, U.S. Geological Survey, South Dakota School of Mines, etc.) into the broader region throughout the late 1800s and early 1900s (Effinger 1934). Fieldwork conducted in western Nebraska, including what is now SCBL, in 1897 by N. H. Darton of the U.S. Geological Survey represented the first formal geologic investigation of the area and provided a foundational

understanding of the geologic strata of SCBL (Darton 1903). Reported collection of fossils from the Brule Formation (Orella Member) at SCBL in 1910 supposedly resulted in fossils from the monument being exhibited at the University of Nebraska State Museum (UNSM) in Lincoln (Pabian and Swinehart 1979); however, this has not been verified by later investigation, with UNSM having no record of such an expedition (G. Corner, UNSM curator, pers. comm. in Tweet et al. 2011). Through this varied assortment of field excursions in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, the geological and paleontological significance of the strata in western Nebraska and South Dakota, including that of SCBL, began to be properly recognized scientifically.

In 1934, William L. Effinger produced a literature review of the geology and paleontology at SCBL, taking a broad approach to examine the potential fossil content of the preserved geologic units of the monument (Effinger 1934). This project was produced in relation to a Civil Works Administration (CWA) contingent that was present at SCBL in 1933 and early 1934 (Cockrell 1983; Rich et al. 2025). Tunnel excavation associated with the construction of Summit Road conducted by the CWA at SCBL produced a number of fossil mammal specimens in February 1934, with the “remains of hyena, rhinoceros, deer, and oredons [oreodonts]” being discovered. These fossils were recovered with relative ease and largely intact due to the tunnel excavations taking place by hand rather than using machinery, as reported in a local newspaper in March 1934 (Barber 2001; Scottsbluff Daily Star-Herald 1934). The taxonomic identifications of these fossils reported in the newspaper, however, should be taken with caution, as there appear to be some misidentifications and/or misinterpretations (e.g., fossils likely belonging to *Hyaenodon* rather than “hyena”). The arrival of Civilian Conservation Corps (CCC) employees to SCBL in April 1935 saw the initiation and continuation of a number of projects at the monument, including the construction of a visitor center with a paleontology wing (Cockrell 1983). CCC workers were also involved in the collection of fossils, occasionally accompanying paleontologists into the field until the camp at SCBL closed in 1938 (Ryan et al. 1937). In 1933, Natasha D. Smith, a master’s student in the Department of Paleontology at the University of California, Berkeley whose research focused on fossil horses, was employed by the CWA’s Field Division of Education (later the Western Museum Laboratory) to create dioramas for various museums across the western United States, including models for exhibit use at SCBL (Figure 3) (NPS 2023; Rich et al. 2025). Also of historical note for this time period, Harold Cook, the rancher/paleontologist of Agate Springs Ranch (now AGFO), was custodian of SCBL from late 1934 into mid-1935.



**Figure 3.** A model of an extinct horse being created by Natasha Smith for use in a diorama at the visitor center of SCBL.

NPS

Occasional paleontological/geological field surveys of SCBL continued throughout the rest of the 20<sup>th</sup> century and into the 21<sup>st</sup> century. Included in this was the first field conference held for the Society of Vertebrate Paleontology in 1941, where SCBL was among the many stops across Nebraska intended for the observation of Cenozoic stratigraphy and paleontology (Schultz et al. 1941).

Work conducted by researchers from the University of Nebraska–Lincoln, namely Roger K. Pabian, James B. Swinehart III, and David B. Loope, further expanded upon the geological understanding of SCBL and also identified important fossil vertebrate tracks in the Gering Formation of the monument (Pabian and Swinehart 1979; Swinehart and Loope 1987). A 2002 conference abstract by Scott E. Foss and Valerie J. Naylor reported on a paleontological field survey of the Brule Formation (Orella Member) at SCBL that identified various significant fossils (*Stylemys*, *Merycoidodon*, *Leptomeryx*, and mammal burrows) from the monument. This survey also documented evidence of illegal fossil collection within the monument (Foss and Naylor 2002).



In the past couple of decades, various regional paleontologists and geologists have conducted work at SCBL, further expanding upon existing knowledge of the monument's resources. A research project led by Joseph Corsini of Eastern Oregon University saw paleontological fieldwork take place at SCBL in 2006, including collection of fossil turtles and gastropods from the White River Group. These fossils were examined in the context of Oligocene climatic and environmental changes across the broader region and supported data from other locations in western Nebraska (e.g., Toadstool Geologic Park) (Corsini et al. 2011). A 2009 geologic resources inventory report on SCBL provides useful baseline information on the geology of the monument (Graham 2009). An overview of the paleontological resources of SCBL was provided in a 2011 report assessing paleontological resources of NPS units within the Northern Great Plains Inventory and Monitoring Network (Tweet et al. 2011). This literature-based report synthesized the available information for SCBL at the time and provided an important foundation for subsequent work. Field-based mapping led by Emmett Evanoff between 2012 and 2015 contributed significantly to knowledge of the geology and paleontology of SCBL, including documentation of various fossil localities within the monument. Most recently, a compliance survey of paleontological resources along Summit Road was conducted by Ellen Starck, Emmett Evanoff, Wayne Thompson, and Kathy Brill in October 2024 (Starck et al. 2025).

This assortment of prior paleontological work conducted at SCBL over more than 180 years serves as a robust foundation and provides valuable baseline data for the work of the present paleontological resource inventory.

## Summary of 2025 Paleontological Survey

This paleontological resource inventory report for SCBL was produced through a combination of fieldwork and data collection led by Austin B. Shaffer in 2025. Historic occurrences and reports of fossil resources from SCBL were compiled from both published sources and gray literature. Field survey of the monument took place in June 2025, led by Emmett Evanoff, Austin B. Shaffer, and Ed Welsh (Figure 4). Fieldwork was assisted by SCBL Natural Resources Program Manager Arthur Stiles and SCBL volunteer Dave Fisher. Significant paleontological resources at SCBL were documented using GPS, photographs, and field notes, as appropriate. Work was conducted under permit SCBL-2025-SCI-0006.



**Figure 4.** Ed Welsh (left) and Emmett Evanoff (right) assessing the Brule Formation at SCBL during the 2025 paleontological field survey of the monument.

*NPS / AUSTIN SHAFFER*

Documentation and report writing were assisted through examination of relevant published literature, allowing for tentative identification of fossil taxa and specimens. Lists and tables containing 2025 inventory data can be found in Appendices A, B, and E (SCBL taxa, collections, and localities, respectively). Additional information may be accessed by qualified researchers through the NPS at SCBL.

# Geology

## Geologic History

The geologic strata of SCBL span the upper Paleogene to the lower Neogene, as well as Quaternary alluvium and colluvium.<sup>1</sup> The oldest rocks currently exposed at SCBL date to the Paleogene Period of the Cenozoic Era; no Paleozoic or Mesozoic strata are accessible at the surface at this time, although they almost certainly occur beneath the monument. During the Paleozoic and Mesozoic, the area surrounding and including SCBL would have experienced various terrestrial and shallow marine depositional environments over hundreds of millions of years, with multiple inland seas transgressing and regressing. For example, Upper Cretaceous shallow and marginal marine strata associated with the Western Interior Seaway (e.g., Pierre Shale, Fox Hills Formation) are exposed elsewhere in western Nebraska and, as mentioned, likely occur in the subsurface at SCBL (DeGraw 1973; Swinehart et al. 1985). Paleocene and Lower to Middle Eocene strata are also not present in the vicinity of SCBL (if any sediments were deposited, they have likely since been eroded).

The broader landscape of North America during the Cenozoic has been driven substantially by mountain-building, primarily the creation of the modern Rocky Mountains as a result of the shallow subduction of the Farallon plate (Weil and Yonkee 2023). As western North America was uplifted by this activity, much of the continental interior was placed in a rain shadow and experienced significant aridification. This drying landscape coincided with global cooling following the Early Eocene Climatic Optimum, such cooling culminating in the late Cenozoic icehouse conditions that began around the Eocene–Oligocene boundary (~34 million years ago, or Ma) (Fan et al. 2017). In the latest Eocene, a loess plateau emerged in the central Rocky Mountains (Wyoming and Colorado), persisting and expanding eastward across the Eocene–Oligocene boundary, as a result of continued continental aridification and global cooling (Fan et al. 2020). The eolian processes associated with this loess plateau dominated deposition during the Oligocene and Miocene of western Nebraska.

During the latest Eocene and Oligocene at SCBL and the surrounding region, southeastward-flowing rivers and southwesterly winds carved paleovalleys and westerly to southwesterly winds brought volcanoclastic material, initially from sources in the Great Basin of Nevada and Utah (Larson and Evanoff 1998) and later from southern Colorado (Swinehart et al. 1985). Associated fluvial and eolian environments produced the widespread deposits of the White River and Arikaree Groups, with these being separated by an unconformity caused by widespread fluvial erosion (Swinehart et al. 1985). Similar fluvial/eolian deposition continued later into the Miocene (e.g., Ogallala Group) with a decrease in volcanic input across the Neogene and changes in sediment source regions (Swinehart et al. 1985). Any deposits of Middle or Late Miocene age that may have been present at SCBL have since been eroded.

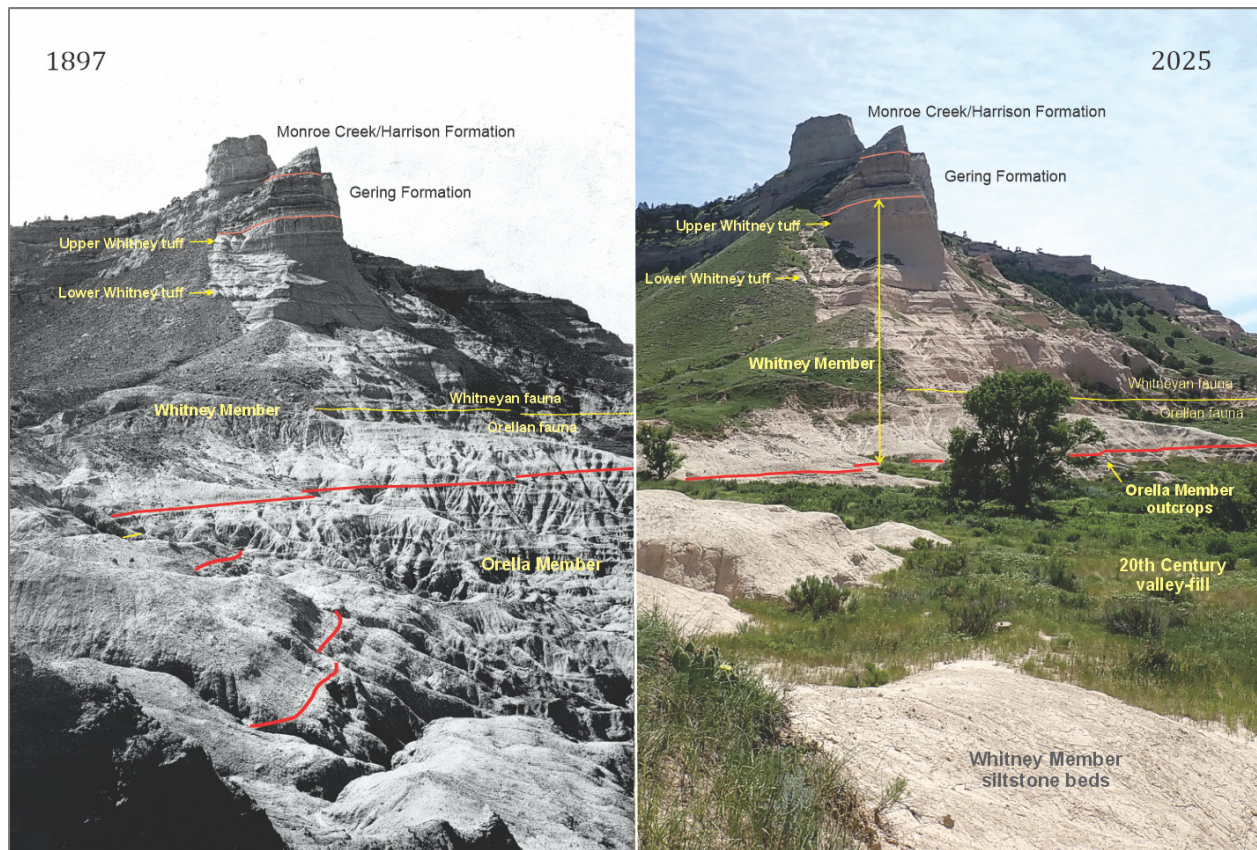
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<sup>1</sup> Note that “early” and “late” refer to geochronological age, whereas “lower” and “upper” refer to stratigraphic position, and “middle” applies to either; these terms are capitalized if officially defined, lowercase if not, e.g., Upper Cretaceous, early Cenozoic. Consult “List of Terms or Acronyms” for definitions of terminology used in this report.

In roughly the last five million years (Pliocene–Quaternary), there has been a shift to predominantly erosional rather than depositional conditions in western Nebraska (Swinehart et al. 1985). This interval also coincides with substantial fluvial and eolian reworking of the Arikaree and Ogallala Groups, which contributed to the development of the eolian Sand Hills dune field in central Nebraska (Mason et al. 2020). The Pleistocene Epoch of the Quaternary Period saw multiple advances and retreats of continental glaciers over much of North America (not reaching SCBL) and the development of substantial glacial loess elsewhere in Nebraska (Muhs et al. 2008). At SCBL, the erosion of mid-Cenozoic rocks and transport of sediment by the North Platte River have exposed the strata of the White River and Arikaree Groups and produced an abundance of alluvium and colluvium.

The geologic units present at SCBL include (in ascending order of stratigraphic position, lowest to highest) the Brule Formation (Lower Oligocene), the Gering Formation (middle Oligocene), the undivided middle Arikaree Group (Upper Oligocene–?Lower Miocene), and Quaternary sediments (Pleistocene–Holocene). These geologic units are depicted in a demarcated outcrop (Figure 5), a geologic map (Figure 6), and a summarized stratigraphic section (Figure 7). The geochronologic age, fossil content, and depositional environments of these units at SCBL are summarized in Table 1.





**Figure 5.** North face of Scotts Bluff with geologic units labeled, as photographed in 1897 and 2025. The large badlands valley seen in the 1897 image has been buried by sediment caught upstream of the Gering irrigation canal, which acts as a sediment trap. Red/pink lines are boundaries of lithostratigraphic units. The horizontal yellow line is the boundary between faunas of the Orellan and Whitneyan NALMAs. The left image was taken by N. H. Darton in 1897 (USGS image dnh00350) and annotated by Emmett Evanoff. The position of the Whitneyan/Orellan boundary is from Schultz and Stout (1955).

**LEFT: USGS / NELSON HORATIO DARTON; RIGHT: NPS / EMMETT EVANOFF**



# Geologic Map of Scotts Bluff National Monument

Nebraska

National Park Service  
U.S. Department of the Interior  
Geologic Resources Inventory  
Natural Resource Stewardship and Science

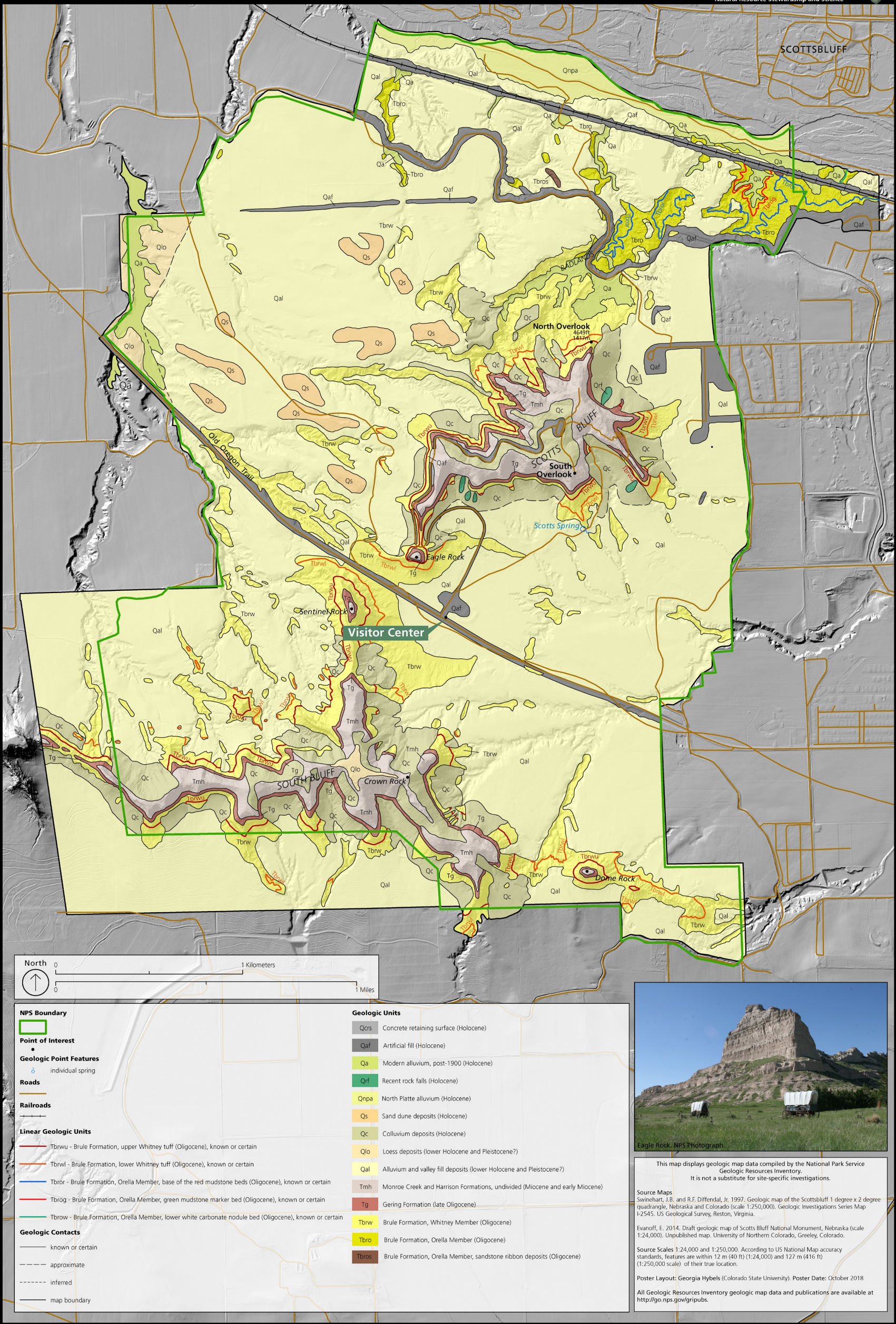
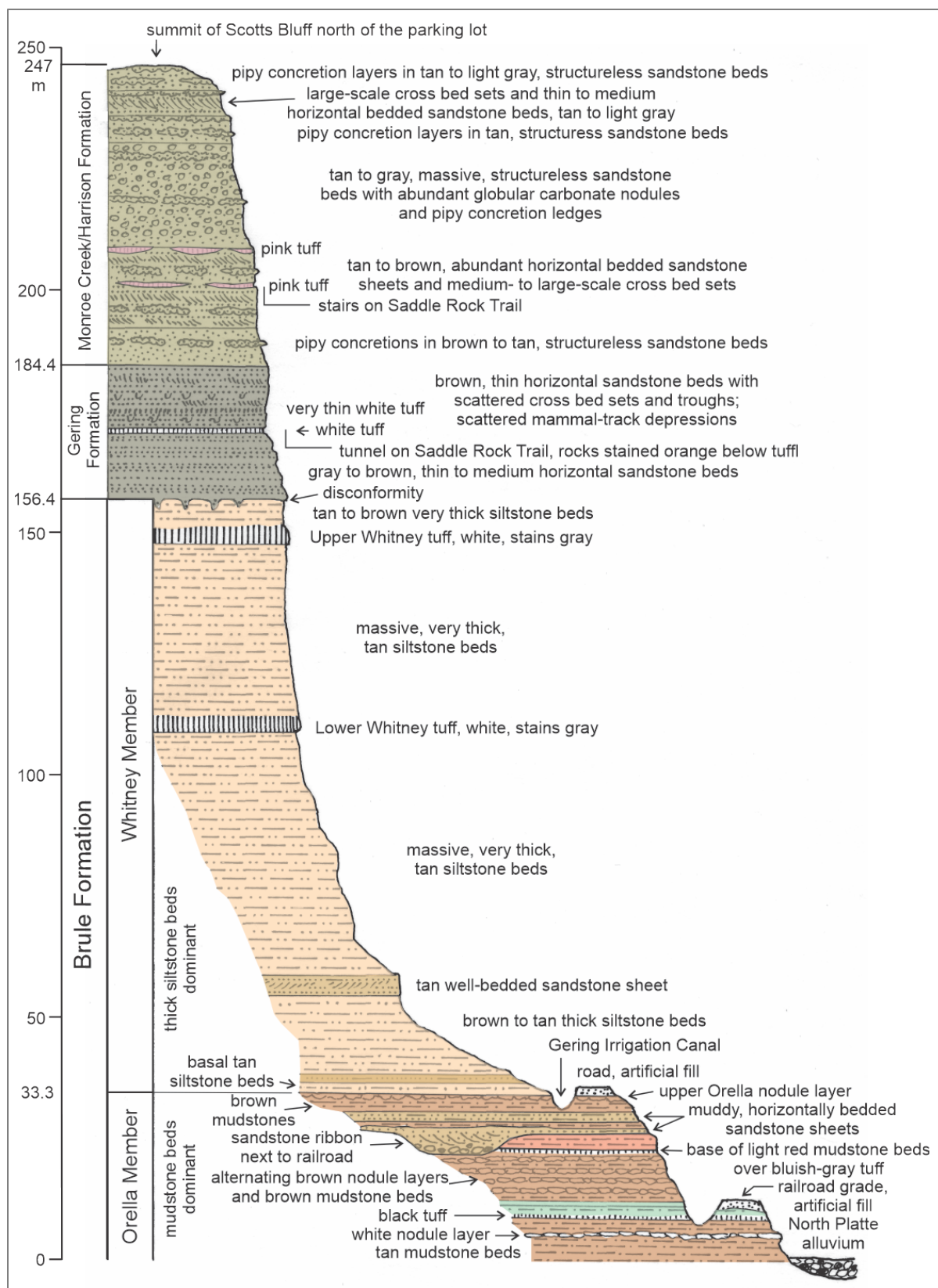


Figure 6. Geologic map of SCBL.  
NPS





**Figure 7.** A composite stratigraphic section for the exposed strata of SCBL.

NPS / EMMETT EVANOFF

**Table 1.** Summary of SCBL stratigraphy, fossils, and depositional settings in descending order of age, from youngest to oldest. Details and references can be found in the text.

| Geologic Unit                                       | Geochronologic Age            | Fossils Within SCBL                                                                                                                                                                                                                                                                                                                                                    | Depositional Environment                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quaternary sediments                                | Pleistocene–Holocene          | Bone fragments of undetermined mammals, very likely mammoth material                                                                                                                                                                                                                                                                                                   | Primarily alluvial and colluvial deposits                                                                                                                                                                                                                                                          |
| Arikaree Group (undivided)                          | Late Oligocene–?Early Miocene | Rhizoliths, invertebrate traces, rodents, and artiodactyls (hypertragulids, oreodonts)                                                                                                                                                                                                                                                                                 | Eolian sandsheets, dunes, and rare reworked fluvial deposits                                                                                                                                                                                                                                       |
| Gering Formation                                    | middle Oligocene              | Rhizoliths, invertebrate traces, oreodonts, and artiodactyl tracks                                                                                                                                                                                                                                                                                                     | Fluvial channel deposits                                                                                                                                                                                                                                                                           |
| Brule Formation (Whitney Member over Orella Member) | Early Oligocene               | Rhizoliths, gastropods, invertebrate traces, turtles, birds, herpetotheriids, leptictids, lagomorphs, rodents, hyaenodonts, carnivorans (nimravids, subparictids, canids), artiodactyls (camelids, oreodonts, protoceratids, entelodonts, leptomerycids, hypertragulids), perissodactyls (equids, hyracodontids, rhinocerotids), and vertebrate burrows and coprolites | <ul style="list-style-type: none"> <li>Whitney Member—Eolian and rare fluvial deposits, mostly loessites with very localized river channels and lateral floodplain deposits</li> <li>Orella Member—Fluvial-eolian, primarily reworked eolian dust deposits and fluvial channel deposits</li> </ul> |

## Geologic Units

### ***White River Group: Brule Formation (Lower Oligocene)***

**Description:** The Brule Formation comprises the badlands and the lower portion of the bluffs at SCBL. The “Brule Clay” was established by Darton (1903) based on strata of western Nebraska, with the Roundtop to Adelia measured section later established as the stratotype for the unit (Schultz and Stout 1955). At SCBL, the Brule Formation is divisible into the Orella Member and the overlying Whitney Member. Schultz and Stout (1955) considered the Whitney Member to be roughly coeval with the strata of the Poleslide Member of the Brule Formation at BADL; however, the respective subdivisions of the Brule Formation in Nebraska (Orella and Whitney Members) and in South Dakota (Scenic and Poleslide Members) have yet to be directly correlated on the basis of marker beds (LaGarry 1998). The composite stratotypes for both the Orella and Whitney Members are found at Toadstool Park in northwestern Nebraska (Schultz and Stout 1955).

The Orella Member (Figure 8) at SCBL consists of brown-gray to tan horizontal beds of mudstone of varying thickness, with intervals of red and light green-gray mudstone beds, rare thick brown siltstone beds, and well-bedded muddy sandstone sheets, as well as two arkosic pebbly sandstone ribbons and two volcanic tuff beds. The total thickness of the Orella Member at SCBL is 33.3 m (109 ft).





**Figure 8.** Typical badlands topography of the Orellia Member of the Brule Formation at SCBL.  
NPS / AUSTIN SHAFFER

Four marker beds are identified for the Orellia Member in the area of SCBL. The first is a very light gray nodular mudstone bed 0.2 m (0.7 ft) thick that occurs at the base of the White River Group exposures northeast of the monument boundary (it is not exposed within SCBL). This first marker bed was referred to as the “upper purplish white layer” by Schultz and Stout (1955), but it is not a volcanic tuff as in the case of the original upper purplish white layer in the Toadstool Park area of northwest Nebraska. The second marker bed is a persistent green-gray, thick mudstone bed that produces a green band across the lower Orellia Member outcrops. The third marker bed is the contact between brown structureless siltstone and nodular mudstone beds, and light reddish brown, thin- to medium-bedded, clayey mudstone beds. This marker overlies a light bluish gray volcanic ash. Both the red beds and the bluish tuff fill large-diameter vertebrate burrows extending down into the underlying units. The fourth marker bed of the Orellia Member at SCBL is the uppermost carbonate nodule bed developed on brown thick silty mudstone beds of the upper Orellia Member.

Several other beds are also distinctive. The lower tuff of the Orellia Member is a thin medium gray bed that is 0.1 m (0.3 ft) thick in the lower outcrops, 2.8 m (9.2 ft) below the persistent light green-gray mudstone of marker bed 2. The upper tuff is a thin bluish gray bed just below the red, well-



bedded mudstones of marker bed 3. A local white carbonate nodular bed occurs near the base of the Orella Member exposures at SCBL. Additionally, in the northeasternmost portion of the monument, coarse-grained, grayish-brown to gray arkosic sandstones with pebbles and cobbles occur in long, lenticular ribbon deposits. These sandstone ribbons are channel-belt deposits of two streams that stratigraphically occur 2.3 and 4.7 m (7.5 and 15.4 ft), respectively, above the base of the reddish-brown mudstones (marker 3). The upper contact of the Orella Member is at the top of the last widespread nodule bed developed on the mudstone interval, beneath the basal tan siltstone beds of the Whitney Member. The lower contact of the Orella Member (with the underlying Chadron Formation of the White River Group) is not exposed at SCBL.

The Whitney Member (Figure 9) has a total thickness of 123.1 m (404 ft) at SCBL, forming the lower portions of the bluffs at the monument. This member consists of massive structureless tan to light brown-gray siltstone and sandy siltstone beds ranging from thick to very thick (at times exceeding 10 m/33 ft thick), and rare widespread sheets of well-bedded, light brown-gray, silty sandstone typically 4 m (13 ft) thick. The Whitney Member at SCBL also includes two very light gray, very thick volcanic tuffs: the lower Whitney and upper Whitney tuffs. Geochronometric dating ( $^{40}\text{Ar}/^{39}\text{Ar}$ ) of these tuffs by Swisher and Prothero (1990) produced values of  $31.85 \pm 0.02$  Ma for the lower tuff and  $30.58 \pm 0.61$  Ma for the upper tuff, placing the member confidently within the Early Oligocene (Rupelian).



**Figure 9.** Outcrop of the Whitney Member of the Brule Formation on the northeast margin of Scotts Bluff at SCBL.

NPS / AUSTIN SHAFFER

The Orella and lower Whitney Members contain a vertebrate fauna associated with the Orellan North American Land Mammal “Age” (NALMA), whereas the middle and upper Whitney Member is associated with the Whitneyan NALMA. It is important to note that early workers in strata of the White River Group defined its subdivisions based on vertebrate fossils (Schultz and Stout 1955), confusing lithostratigraphic and biostratigraphic units. Following established international stratigraphic standards, however, the Brule Formation and its constituent subunits (the Orella and Whitney Members) are defined on the basis of lithostratigraphy, with the Whitney Member beginning with the first prominent structureless siltstone bed (well within the zone of the Orellan, rather than the Whitneyan NALMA).

Fossils found within SCBL: The Brule Formation has a rich diversity of fossils at SCBL, with numerous taxa from both the Whitney and Orella Members. Fossils observed and reported from this formation at SCBL include rhizoliths (“root traces”), gastropods, invertebrate traces, vertebrate burrows (Figure 10), and bones of turtles, birds, and numerous mammal taxa. These mammals include herpetotheriid metatherians, leptictids, lagomorphs, rodents, hyaenodonts, carnivorans, camelids, oreodonts, protoceratids, entelodonts, leptomerycids, hypertragulids, equids, hyracodonts, and rhinocerotids. Information on these taxa can be found in the “Taxonomy” section of this report.



**Figure 10.** Large vertebrate burrows in the Orella Member of the Brule Formation at SCBL. They are more resistant to weathering than the surrounding strata and therefore are exposed in relief.

*NPS / AUSTIN SHAFFER*

Fossils found elsewhere: A rich and diverse fossil assemblage is known from the Brule Formation of the Great Plains, including algae, plants, ostracods, gastropods, invertebrate traces, fish, and amphibians (Hoganson et al. 1998); lizards and snakes (Maddox and Wall 1998); turtles (Vlachos 2018; Wall and Maddox 1998); birds (Lawver and Boyd 2018); marsupials and other metatherians (Korth et al. 2021); leptictids (Korth et al. 2023); rodents and lagomorphs (Korth and Hageman 1988; Korth et al. 2019a, 2019b); eulipotyphlans (“true insectivores”) (Korth et al. 2023); bats (Czaplewski et al. 2019); hyaenodonts (Gustafson 1986); pantolestids (Boyd et al. 2014); feliform and caniform carnivorans (Barrett 2016; Hunt 2001; Tedford et al. 2009; Wang 1994; Wang et al. 1999, 2023; Welsh 2021); and numerous artiodactyls (Cook 1934; Foss 2001; Korth and Diamond 2002; Prothero



et al. 2022; Shreero et al. 2023; Thorpe 1937) and perissodactyls (Kocken 2022; Masciale 2010; Mead and Wall 1998; Prothero 1998; Wall and Heinbaugh 1999).

***Arikaree Group: Gering Formation (Middle Oligocene)***

Description: The Gering Formation, the basal unit of the Arikaree Group (Figure 11), has a thickness of 28 m (92 ft) at SCBL, as measured along Saddle Rock Trail. The unit consists of well-bedded, fine- to very fine-grained, light brown to light gray sandstone beds with two white volcanic ashes, 14.0 and 18.6 m (45.9 and 61.0 ft), respectively, above the base of the formation. Abundant thin to medium-scale horizontal beds occur in this unit at SCBL, locally deformed by tracks of large mammals and containing calcite crystal pseudomorphs after gypsum (Swinehart and Loope 1987). Two formal subdivisions of the Gering Formation have been broadly established (the lower Helvas Canyon and upper Mitchell Pass Members, the latter named for Mitchell Pass in SCBL) (Vondra et al. 1969); however, this distinction has not been followed by later authors (Swinehart and Diffendal 1997). The Gering Formation unconformably overlies the Whitney Member of the Brule Formation at SCBL and is conformably overlain by the undivided strata of the middle Arikaree Group (Tedford et al. 1996).



**Figure 11.** Thin-bedded, horizontally stratified outcrop of the Gering Formation at SCBL.

*NPS / AUSTIN SHAFFER*

Initially named by Darton (1903) based on strata of Wildcat Hills (or Wildcat Ridge), a type section for the Gering Formation was later established by Vondra et al. (1969) south of SCBL at Helvas



Canyon in Scotts Bluff County, Nebraska. The unit was redefined by Tedford et al. (1996) based on the mapping of Swinehart and Diffendal (1995), in which the “brown siltstone member” of the Brule Formation was excluded.

The strata of the uppermost Gering Formation, as preserved at SCBL, represent fluvial channel deposits within a broad, low-relief paleovalley (Tedford et al. 1996). The thickest fill within this paleovalley is found on the north side of Scotts Bluff. Mammalian biostratigraphy allows correlation of the Gering Formation’s fauna with the Arikareean NALMA (Tedford et al. 1996). Three ash layers within the Gering Formation have been radiometrically dated using  $^{40}\text{Ar}/^{39}\text{Ar}$  dating: the basal Twin Sisters pumice conglomerate ( $28.31 \pm 0.15$  Ma), the Chimney Rock ash ( $28.26 \pm 0.10$  Ma), and the Roundhouse Rock ash ( $28.07 \pm 0.18$  Ma). On the basis of these numerical age dates, deposition of the Gering Formation likely occurred over only a few hundred thousand years during the Oligocene (Tedford et al. 1996).

Fossils found within SCBL: The most abundant and easily observable fossils found in the Gering Formation at SCBL are vertebrate tracks (likely from numerous different mammalian taxa, including entelodonts) (Figure 12). Additionally, leptaucheniine oreodont (*Sespia ultima*) body fossils have been reported (Martin 1973). Rhizoliths and invertebrate traces are also observable in the strata of this unit at the monument. It is likely that further examination of the Gering Formation outcrops at SCBL will produce additional important fossil discoveries, given the rich fauna preserved in this unit in the nearby Wildcat Hills.



**Figure 12.** Abundant mammal tracks (visible in cross-section as deformation of layers and in occasional overhangs) in the Gering Formation at SCBL. Close-up of the lower-center beds in Figure 11.

NPS / AUSTIN SHAFFER



Fossils found elsewhere: The Gering Formation, particularly near SCBL in western Nebraska (Wildcat Hills), has been documented to contain a diverse mammalian fauna including metatherians, the small primate *Ekgmowechashala philotau*, rodents, lagomorphs, eulipotyphlans, bats, *Hyaenodon*, canids (including *Sunkahetanka geringensis*), *Nimravus brachyops*, horses, tapirs (*Miotapirus*), rhinocerotids, camelids, tayassuids, entelodonts, hypertragulids, leptomerycids, and oreodonts as well as other assorted fossils (e.g., plants, snails, fish, salamanders, frogs, snakes, lizards, turtles, birds) (Martin 1973). The fauna of the Gering Formation as preserved at SCBL and the nearby Wildcat Hills is depicted in the paleoart reconstruction that serves as the cover art for this report.

***Arikaree Group Undivided (Upper Oligocene–?Lower Miocene)***

Description: The strata of the Arikaree Group (Figure 13) that conformably overlie the Gering Formation at SCBL consist of light gray and grayish-brown, very fine to fine-grained, silty, volcanoclastic sandstones that typically possess indistinct stratification or lack it (cross-stratification does occur locally) (Swinehart and Loope 1987; Tedford et al. 1996). As measured along Saddle Rock Trail to the top of Scotts Bluff, the unit is 62.6 m (205 ft) thick with eolian deposition predominating.



**Figure 13.** Eolian strata of the undivided middle Arikaree Group at SCBL.  
NPS / AUSTIN SHAFFER

In northwestern Nebraska, along Pine Ridge between Harrison and Crawford, equivalent strata are divided into the Monroe Creek and Harrison Formations; however, at SCBL and other nearby locations in the North Platte River Valley, there are no consistent and reliable marker beds or lithologic criteria to differentiate these units (Swinehart et al. 1985; Tedford et al. 1996). As such, these strata are described as the undivided middle Arikaree Group in this report (Monroe Creek/Harrison Formation of Figures 5–7).

Two intervals of the undivided middle Arikaree Group along Saddle Rock Trail exhibit medium- to very large-scale crossbed sets. Two thin, very light pink-gray volcanic tuffs also occur at 16.6 and 23.1 m (54.5 and 75.8 ft) above the base of the unit. The sandstone beds of this unit are locally cemented from groundwater into elongate cylindrical calcareous nodules, referred to as “pipy concretions.” Locally abundant globular nodules are scattered throughout the sandstone beds, with some of these nodules in the upper beds occurring in vertical stacks thereby indicating the presence of ancient root systems.

Mammalian biostratigraphy recovers the fauna of the undivided middle Arikaree Group as that of the Arikareean NALMA (Tedford et al. 1996). A dated ash bed (Olsen’s third ash) lies within these undivided strata and a  $^{40}\text{Ar}/^{39}\text{Ar}$  date of  $27.79 \pm 0.30$  Ma has been recovered from samples outside SCBL (Tedford et al. 1996). However, an upper bound for the age of the strata at SCBL cannot be established; it can only be reliably stated that the strata are older than the Agate ash. This ash layer was initially dated to 21.3 Ma via biotite-based  $^{40}\text{K}/^{40}\text{Ar}$  by Evernden et al. (1964) and later corrected to 21.9 Ma (Dalrymple 1979; MacFadden and Hunt 1998). As such, the top of the undivided Arikaree Group strata at SCBL may be as young as the Early Miocene.

Fossils found within SCBL: The undivided middle Arikaree Group contains an abundance of rhizoliths (Figure 14) and invertebrate traces at SCBL. The invertebrate ichnofossils of the monument have been featured in multiple publications and include an ichnotaxon, *Ancorichnus coronus*, that was named on the basis of specimens from SCBL (Frey et al. 1984; Stanley and Fagerstrom 1974; Toots 1975). Additionally, occasional vertebrate body fossils have been found, including a skull of the rodent *Promylagaulus* discovered in 2015, as well as fossils of the rodent *Alwoodia*, the hypertragulid *Nanotragulus*, and the oreodont *Sespia* reported by Tedford et al. (1996).





**Figure 14.** Rhizoliths in the undivided middle Arikaree Group at SCBL.  
NPS / AUSTIN SHAFFER

Fossils found elsewhere: The strata of the middle and upper Arikaree Group elsewhere in western Nebraska and other parts of the western Great Plains, including areas where it is differentiated into the constituent Monroe Creek and Harrison Formations, contain a diverse fauna typical of the Arikareean NALMA, alongside invertebrate traces and occasional plant material (e.g., rhizoliths, phytoliths). The fauna of the Arikaree Group includes metatherians, rodents, lagomorphs, eulipotyphlans, carnivores, numerous artiodactyl and perissodactyl ungulates, and more (e.g., amphibians, reptiles, birds) (Tedford et al. 2004; Tweet et al. 2011). Vertebrate burrows (e.g., the “Devil’s Corkscrew” *Daemonelix*) also occur prominently in some locations, such as AGFO.

#### ***Quaternary Sediments (Pleistocene–Holocene)***

Description: Quaternary sediments at SCBL (Figure 15) consist of a mix of older and younger deposits that cover much of the monument’s area and unconformably overlie the older strata of the Arikaree and White River Groups.





**Figure 15.** Quaternary sediments overlying strata of the Brule Formation (Orella Member) at SCBL.  
NPS / AUSTIN SHAFFER

The older deposits of the early Holocene and Pleistocene consist of loess deposits and alluvium/valley-fill deposits. The latter represents the oldest Quaternary sediments of SCBL and are well-bedded but unconsolidated, light gray to tan, muddy sands with scattered granules and pebbles derived from Arikaree Group sandstone beds. The alluvium and valley-fill deposits include thin to medium horizontal beds separated at intervals by dark gray organic-rich layers representing buried soils. In some places, the Quaternary valley-fills exceed 15 m (49 ft) thick on the ancient badlands topography. The loess deposits of SCBL are unconsolidated thick structureless beds of tan to light gray silty muds, thickest in the western margin of the monument (more than 8 m/26 ft thick). These beds cap the smooth surfaces on top of the older alluvium/valley-fill deposits and occur at the top center of South Bluff.

The younger Holocene deposits of SCBL include colluvium deposits, sand dune deposits, alluvium of the North Platte River, and recent rock falls. The colluvium deposits consist of unconsolidated material ranging from sand-sized to large blocks on the flanks of the bluffs, whereas the sand dune deposits are unconsolidated brown, well-sorted, fine- to very fine-grained sand capping ridges on the west side of Scotts Bluff. Recent rock falls are the product of sandstone blocks falling from the cliffs atop the bluffs. Other anthropogenic material is also found at the monument, including artificial fill and modern alluvium. The latter is unconsolidated light gray to brown, gravelly to muddy sand that accumulated in northern gullies after the 1899 to 1903 construction of the Gering Ditch and later construction of the Union Pacific Railroad. This modern alluvium reaches more than 10 m (33 ft) thick on the south side of the Gering Ditch below the north point of Scotts Bluff.

Fossils found within SCBL: Bone fragments were observed in the Quaternary sediments at SCBL during the 2025 field inventory (Figure 16). Such fragments are uncommon, and no diagnostic material was observed, although it is probable that they belong to a large mammal given their size. Collections data from Harvard University's Museum of Comparative Zoology indicates the occurrence of likely Columbian mammoth (*Mammuthus columbi*) material from SCBL. Future surveys of Quaternary sediments at the monument may produce additional diagnostic material.





**Figure 16.** Large bone fragments observed in Quaternary sediments at SCBL during the 2025 field inventory.

*NPS / AUSTIN SHAFFER*

Fossils found elsewhere: Various isolated occurrences of upper Quaternary fossils are known from the immediate vicinity of SCBL. Notable examples include: bison and gastropods from the Scottsbluff Bison Quarry 15 km (9 mi) west-southwest of SCBL (Hill and Boehm 2017; Schultz and Eiseley 1935); a muskox skull found in an irrigation ditch 19 km (12 mi) northeast of SCBL (Hay 1924); and a mammoth from the Hunter Ranch site near Meriden, Wyoming, 56 km (35 mi) southwest of SCBL (Walker et al. 1985). Additional Quaternary fossils are also known from slightly further afield; see Tweet et al. (2011) for further information.

# Taxonomy

See Appendix A for full lists of taxa. Locality data for fossil sites can be found in Appendix E.

## Fossil Vertebrates

### ***Class Mammalia: Order Artiodactyla (Even-Toed Ungulates)***

Artiodactyls, or even-toed ungulates, are hoofed mammals that represent some of the most abundant fossils found at SCBL. This group, which in the modern day includes camels, pigs, whales, hippos, and ruminants, is currently represented at SCBL by fossils from six families. These include Merycoidodontidae (oreodonts), Camelidae (camels), Hypertragulidae and Leptomerycidae (microdeer), Protoceratidae, and Entelodontidae.

One of the most ubiquitous extinct groups found at SCBL is the oreodonts (Merycoidodontidae). Fossils of these pig-like hoofed mammals are found in great abundance at SCBL, particularly in the rocks of the Brule Formation (Figure 17). Many of the specimens recovered from the monument are quite well preserved and include largely complete skulls and partial skeletons (Figure 18). Multiple species and subfamilies are represented at SCBL. Merycoidodontines (*Merycoidodon*) and miniochoerines (*Miniochoerus*) occur in abundance in the Orella Member of the Brule Formation whereas leptaucheniines (*Leptauchenia* and *Sespia*) dominate the Whitney Member and Arikaree Group strata. Most oreodonts were likely low-level browsers; despite their pig or sheep-like appearance, they were likely close relatives of camels (Spaulding et al. 2009; Stevens and Stevens 2007).





**Figure 17.** Oreodont (cf. *Miniochoerus*) skull in situ within the Brule Formation (Whitney Member) at SCBL.

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**Figure 18.** Partial skeleton of an oreodont (Merycoidodontidae) from SCBL after preparation by Kathy Brill.

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Camels (Camelidae) are known from body fossils in the Brule Formation of SCBL, represented by the genus *Poebrotherium* (Figure 19). This genus commonly occurs in the White River Group strata of the Great Plains, seemingly having had broad environmental preferences (found in open savanna, riparian woodland, and streamside swale deposits). It likely acted as a browser or mixed feeder (Wall and Hauptman 2001). It is also probable that some of the Gering Formation tracks belong to camels as well (albeit likely different taxa) (Loope 1986).





**Figure 19.** Fossil camel (cf. *Poebrotherium*) in the Brule Formation (Orella Member) at SCBL.  
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Two extinct families of ruminant artiodactyls have been identified from fossils at SCBL. The families Hypertragulidae and Leptomerycidae both contain small deer-like ruminants sometimes colloquially referred to as “microdeer”, with members of both families reminiscent of modern mouse-deer and musk deer. The evolutionary relationships of the two families have been debated; however, recent analyses have found hypertragulids to be basal ruminants and leptomerycids as relatives to modern mouse-deer (Tragulidae) (Métais and Vislobokova 2007). At SCBL, the hypertragulids *Hypisodus* and *Nanotragulus* are reported from the Brule Formation (Whitney Member) and the undivided middle Arikaree Group, respectively (Cook 1934; Tedford et al. 1996). Leptomerycids, in the form of *Leptomeryx evansi* (Figure 20) and possible material attributable to *Santuccimeryx*, were observed in the Orella Member of the Brule Formation. Both of these leptomerycid genera are recorded from similar strata elsewhere in western Nebraska (Korth and Diamond 2002; Shreero et al. 2023).

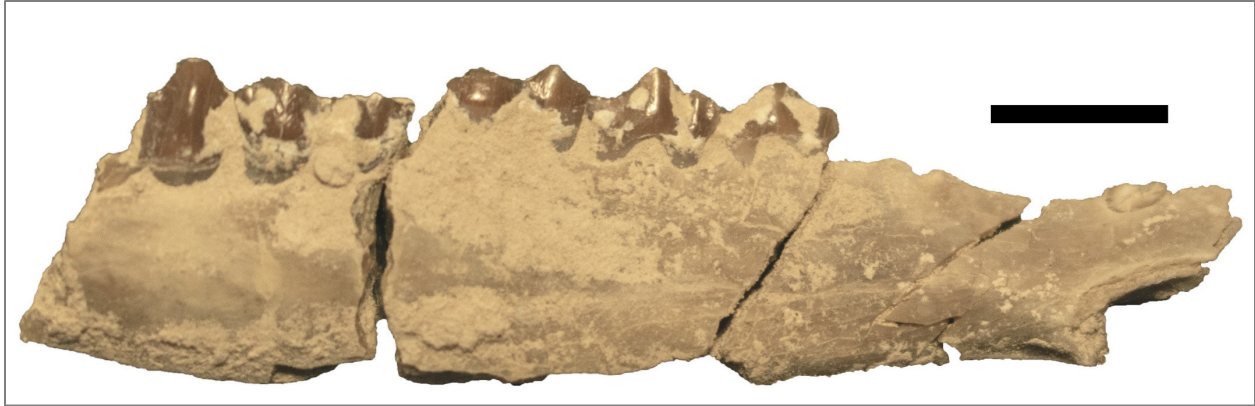




**Figure 20.** Leptomerycid (*Leptomeryx evansi*) partial mandible found in the Brule Formation (Orella Member) at SCBL during the 2025 field inventory.

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Fragmentary skeletal material, including mandibular (Figure 21) and limb elements, discovered in the Orella Member of the Brule Formation at SCBL during the 2025 field inventory are tentatively attributed to cf. *Pseudoprotoceras*. Protoceratidae is an extinct family of artiodactyls with uncertain evolutionary relationships (possibly related to either ruminants or camels), whose later members are characterized by the presence of distinctive horns (e.g., the Y-shaped “slingshot” horns of *Syndyoceras*). Protoceratids were likely not as cursorial as other artiodactyls, such as camels and ruminants, and may have been more adapted for “marshy forests” than open plains (Prothero and Ludtke 2007). This possible protoceratid material would represent a significant range extension, if attribution to this genus is correct, and may represent a new species. Preparation and further assessment of this fossil material, which was collected (currently uncataloged and reposit at SCBL), may confirm or refute these preliminary conclusions.



**Figure 21.** Partial mandible (cf. *Pseudoprotoceras*) discovered at SCBL during the 2025 field inventory. Scale bar = 1 cm (0.4 in).

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While most of the fossil artiodactyls known from SCBL were relatively small herbivores, the entelodonts (Entelodontidae) instead likely represent large omnivores. While often colloquially referred to as “big pigs” or “hell pigs”, entelodonts have been consistently placed as close relatives of hippos and whales in recent years (Spaulding et al. 2009; Yu et al. 2023). These extinct large mammals with imposing jaws seem to have had relatively generalized diets and may have been water-dependent, overlapping to some extent ecologically with modern bears, hippos, and pigs (Foss 2001; Rivals et al. 2023). Only a single entelodont body fossil can be reliably tied to SCBL (MCZ VPM-7232, a skull of *Archaeotherium mortoni* collected by S. W. Garman in 1882 from the Brule Formation). Tracks from the Gering Formation at SCBL have also been tentatively referred to entelodonts on the basis of size and general morphology (Loope 1986).

***Class Mammalia: Order Perissodactyla (Odd-Toed Ungulates)***

The odd-toed ungulates, or perissodactyls, while generally not as diverse or abundant as their even-toed ungulate counterparts at SCBL, are nevertheless represented by two primary lineages: the horses (Equidae) and the rhinos (Rhinocerotidae).

The equids of the White River Group have long been a topic of taxonomic confusion between the genera *Meshippus* and *Miohippus*, both coined by O. C. Marsh in the late 19<sup>th</sup> century. However, in recent years, multiple researchers have analyzed these horses and argued for synonymy of the two genera, with *Miohippus* having priority (Kocken 2022; Masciale 2010). Therefore, the generic name *Miohippus* is utilized here. At SCBL, the species *Miohippus bairdi* has been recognized from the Orella Member of the Brule Formation (Figure 22), with additional indeterminate equid fossils known from the Whitney Member as well. These early equids were relatively small, cursorial (similar to their modern relatives), adapted to browsing vegetation, and seemingly preferred riparian woodland habitats (Zanazzi and Kohn 2008).





**Figure 22.** Equid (cf. *Miohippus*) partial mandible in situ and associated loose tooth observed in the Brule Formation (Orella Member) at SCBL.

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Rhinocerotoidae, the superfamily that contains modern rhinoceroses and their extinct relatives, is represented at SCBL by the genera *Hyracodon* and *Subhyracodon* (both from the Orella Member of the Brule Formation). The former genus, colloquially referred to as the “running rhino”, is a hornless highly cursorial member of the family Hyracodontidae that occurs in relatively high abundance at SCBL (Figure 23). *Hyracodon* was roughly the size of modern sheep and adapted to browsing on tough low vegetation (Mead and Wall 1998; Prothero 1998). Conversely, the genus *Subhyracodon* is a tapir-sized, hornless early representative of the true rhinoceros family (Rhinocerotidae). The skull of *Subhyracodon* is rather long and slender (dolichocephalic), suggesting a selective browsing ecology, and isotopic analysis indicates a possible preference for open habitats and moderate water dependency (Mead and Wall 1998; Zanzizzi and Kohn 2008).



**Figure 23.** *Hyracodon* skull collected from the Brule Formation of SCBL by Ellen Starck, Kathy Brill, and Wayne Thompson in 2024.

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One other perissodactyl fossil from the Orella Member at SCBL may be representative of an additional family. In the stratigraphic section figure for Scotts Bluff National Monument published in Schultz and Stout (1955), there is reference to a “titanotheres metapodial” found near the localized channel deposits. Pending the relocation and examination of this fossil (if collected), we consider the possibility that it was misattributed to the family Brontotheriidae (historically “titanotheres”). We find it probable that this specimen instead represents the family Amynodontidae—a hornless group with semi-aquatic, hippo-like members such as *Metamynodon*—with such an identification being more consistent biostratigraphically. For instance, *Metamynodon* fossils are often associated with Orellan channel sandstones at BADL (Wall and Heinbaugh 1999). If indeed representative of a brontothere, this would imply either reworking of the fossil or a significant range extension. However, until the actual metapodial found at SCBL is relocated, we consider any taxonomic attributions tentative.

#### ***Class Mammalia: Order Carnivora (Carnivorans)***

Carnivorans, a group of largely carnivorous mammals, are recorded in the fossils of three families at SCBL: Nimravidae, Canidae, and Subparictidae. This group is predominantly known from the Orella Member of the Brule Formation at the monument.

The “false sabertooth cats” of the extinct family Nimravidae are known from cranial material preserved in the Brule Formation (Orella Member) at SCBL. This includes a skull (UNSM 25521) attributed to the genus *Dinictis* currently housed at the University of Nebraska State Museum and a skull discovered in situ during the 2025 field inventory (Figure 24). Nimravids were basal members of the feliform (cat-like) lineage and convergent with the later true sabertooth cats of the subfamily Machairodontinae (family Felidae). As ambush predators, nimravids likely had some preference for



more closed, forested habitats (Castellanos 2025). Additional work at SCBL may produce additional species of nimravids in the Brule Formation.



**Figure 24.** Nimravid skull discovered in situ within the Orella Member of the Brule Formation at SCBL during the 2025 field inventory.

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Canids, members of the dog family Canidae, are diverse in the Oligocene and Miocene fossil record of North America and include three subfamilies: Hesperocyoninae, Borophaginae, and Caninae (Tedford et al. 2009; Wang 1994; Wang et al. 1999). At SCBL, hesperocyonines are known via the species *Hesperocyon gregarius* from the Orella Member of the Brule Formation. This early dog was relatively small in size and seemingly transitional between arboreal ancestors and cursorial descendants, having some degree of scansorial (climbing) adaptations (Wang 1993). In addition to this, a specimen (AMNH FM 88394) reposit at the American Museum of Natural History (AMNH) is attributed to the borophagine *Phlaocyon annectens*. Recorded from an uncertain stratigraphic position at SCBL, *Phlaocyon* was remarkably convergent with modern raccoons (Procyonidae), likely omnivorous with a preference for wooded habitats, unlike some other members of Borophaginae which are colloquially known as “bone-crushing dogs” and were ecologically similar to modern hyenas (Wang and Tedford 2008; Wang et al. 1999).



Additional fossil material from the Orella Member at SCBL currently reposited at the AMNH may represent a third family of fossil carnivorans from the monument. AMNH FM 81577 from SCBL is currently attributed to the genus *Parictis*, a member of the family Subparictidae. This family is closely related to modern bears (Ursidae), but members were more raccoon-like in appearance (Wang et al. 2023). Additional examination of the AMNH specimen may elucidate whether the fossil truly belongs to *Parictis*.

**Class Mammalia: Clade Glires (Rodents, Rabbits, Hares, Pikas)**

The clade Glires, containing the orders Rodentia (rodents) and Lagomorpha (rabbits, hares, pikas), is recorded from an assortment of small fossils at SCBL. Fossil rodents are known from four families at the monument: Cricetidae and Ischyromyidae from the Brule Formation, and Mylagaulidae and Aplodontidae from the undivided middle Arikaree Group. Conversely, lagomorphs are represented by a single early diverging genus, *Palaeolagus* from the Brule Formation.

In the Brule Formation, rodent fossil material has thus far been reliably attributed to Ischyromyidae indet. and cf. *Eumys elegans* (Figure 25) from the Orella Member, as well as *Eumys brachyodus* from the Whitney Member. A number of cricetid rodents are recorded from the Brule Formation elsewhere in western Nebraska and it is likely that further examination of material at SCBL will recognize additional such taxa from the monument (Korth 2018). While the family Cricetidae is extant and diverse in North America today, the squirrel-like ischyromyids are now extinct.



**Figure 25.** A cricetid (cf. *Eumys elegans*) rodent mandible observed in channel deposits of the Brule Formation (Orella Member) during the 2025 field inventory at SCBL.

NPS / AUSTIN SHAFFER



The undivided middle Arikaree Group at SCBL has not produced as much fossil material as the earlier Brule Formation, yet *Promylagaulus* (Figure 26) and *Alwoodia* are recorded from these strata at the monument (Tedford et al. 1996). These two genera belong to the extinct horned gopher family (Mylagaulidae) and extant mountain beaver family (Aplodontidae), respectively.



**Figure 26.** *Promylagaulus* skull in situ within sandstone of the undivided middle Arikaree Group prior to the specimen's collection in 2015.

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A single genus of stem lagomorphs (*Palaeolagus*) is recorded in the fossil record at SCBL. This animal is recorded in the Orella and Whitney Members of the Brule Formation at SCBL (Figure 27) and is abundant in the White River Group of the Great Plains. Exhibiting a mosaic of features seen in modern ochotonids (pikas) and leporids (rabbits and hares), *Palaeolagus* likely functioned similarly ecologically, burrowing and feeding primarily on low-lying vegetation. While historically considered to be an early leporid, recent anatomical studies support *Palaeolagus* as basal to Leporidae and Ochotonidae (Ruf et al. 2021; Wolniewicz and Fostowicz-Frelik 2021).





**Figure 27.** Lagomorpha (cf. *Palaeolagus*) mandible observed in the Whitney Member of the Brule Formation at SCBL.

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### ***Class Mammalia: Other***

In addition to the four aforementioned major groups of mammals (Artiodactyla, Perissodactyla, Carnivora, Glires), a handful of other distinct mammal lineages are known from fossils at SCBL. These include two groups of micromammals (Leptictidae, Herpetotheriidae), one family of large carnivores (Hyaenodontidae), and one family of herbivorous megamammals (Elephantidae).

Two families of early diverging insectivorous micromammals are represented from the Brule Formation at SCBL: Leptictidae and Herpetotheriidae, belonging to the clades Eutheria (placental mammals and their closest relatives) and Metatheria (marsupial mammals and their closest relatives), respectively. Leptictids are currently represented in the Brule Formation of SCBL by the genus *Leptictis* (Figure 28). These small insectivores were somewhat convergent with modern elephant shrews and may have been saltatorial burrowers (Meehan and Martin 2010, 2012). Herpetotheriids were small, mouse-sized marsupial relatives, historically considered relatives of modern opossums but recently supported as being stem marsupials (Hayes 2005; Ladevèze et al. 2020). At SCBL, the genus *Herpetotherium* is recorded in the Brule Formation (Figure 29). Additional leptictid and



herpetotheriid taxa are known elsewhere in the Brule Formation (Korth et al. 2021; Meehan and Martin 2010, 2012) and may be identified at SCBL in the future.



**Figure 28.** Leptictid (cf. *Leptictis*) mandible fragment in the Whitney Member of the Brule Formation at SCBL.

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**Figure 29.** Herpetotheriid (*Herpetotherium* cf. *fugax*) mandible fragment found in the Whitney Member of the Brule Formation of SCBL.

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Alongside the aforementioned carnivorans, the large carnivorous *Hyaenodon* is also known from the Brule Formation of SCBL. A member of the order Hyaenodonta, recovered in recent analyses to be related to Carnivora and Pholidota (pangolins) in the clade Ferae, *Hyaenodon* likely had a dietary niche somewhere between modern hyenas and lions, with consumption of bone indicated by dental microwear (Bastl et al. 2012; Zack et al. 2025).

Putative Columbian mammoth (*Mammuthus columbi*) material (including MCZ VPM-10927, a calcaneum) has been recovered from the Quaternary sediments of SCBL or just outside. Remains of these large elephants have been found across North America, including the Great Plains, and they likely had diverse dietary habits, from browsing to grazing (Rivals et al. 2012; Widga et al. 2017).

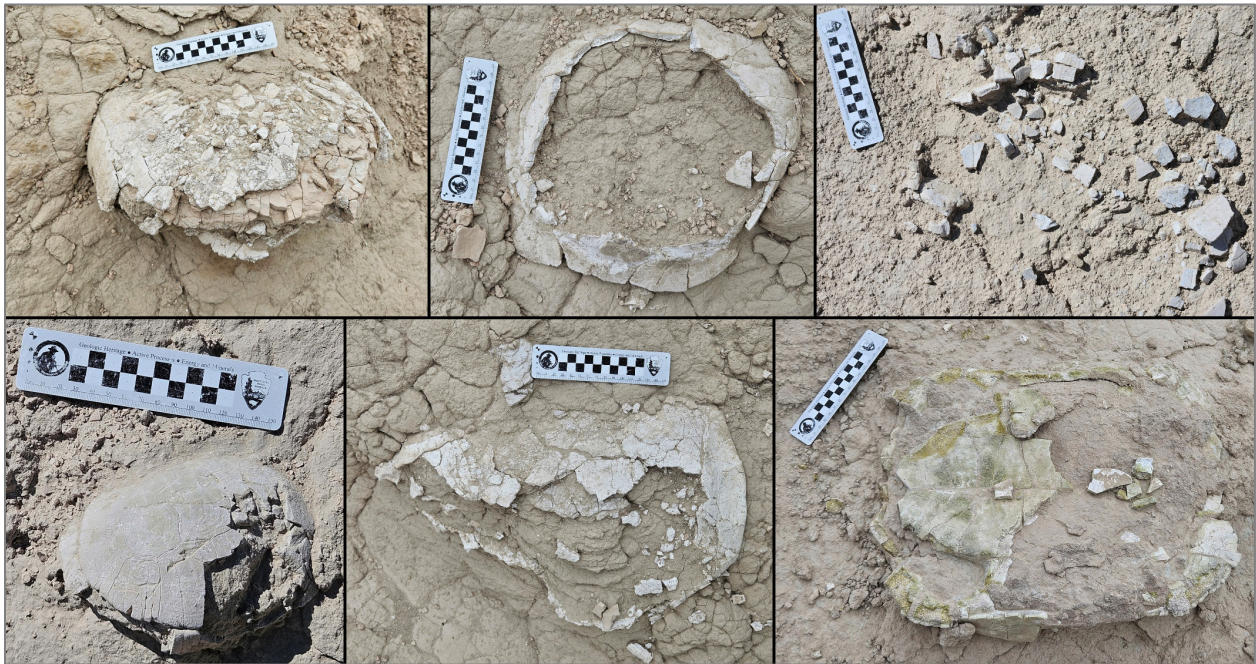
#### **Clade Sauria: Order Testudines (Turtles)**

Turtles are easily among the most common fossils found at SCBL. Their shells, at various stages of erosion, can be observed throughout the Brule Formation (Orella and Whitney Members) at the monument (Figures 30 and 31). The fossil shells vary in color from white to green and many of these turtles also preserve additional non-shell elements. Three valid species of turtle are currently recognized from the Chadronian–Arikarean NALMAs of the region: the tortoises (Testudinidae) *Stylemys nebraskensis* and *Oligopherus laticuneus*, and the pond turtle (Emydidae, Deirochelyinae) “*Trachemys*” *antiqua* (Vlachos 2018). While the turtle fossils of SCBL have historically been referred only to *Stylemys*, it has been noted that shells of differing forms and sizes are present (Corsini 2015; Corsini et al. 2011) (Figure 31). While it does appear that *Stylemys* is present at SCBL, more in-depth examination of well-preserved specimens is necessary to precisely determine the turtle diversity (and possible new taxa) at SCBL. As such, the turtle specimens from SCBL are here tentatively retained taxonomically as cf. Testudinidae.





**Figure 30.** Exposed green turtle carapace in the Whitney Member of the Brule Formation at SCBL.  
NPS / AUSTIN SHAFFER



**Figure 31.** Turtle shells at various stages of erosion as observed in the Orella Member of the Brule Formation at SCBL during the 2025 field inventory. Also note the substantial size difference between the two examples at the far left.

NPS / AUSTIN SHAFFER

**Clade Sauria: Class Aves (Birds)**

Fragmentary bird fossils are known from the Brule Formation at SCBL. While many such fossils are unfortunately non-diagnostic, certain examples do shed some light on the Oligocene bird fauna of the monument.

Two partial humeri from SCBL have been previously named as possible galliform birds: one (from the Brule Formation) serving as the holotype for *Archaeaelectornis sibleyi* and the other (of uncertain stratigraphic position) serving as a cotype for *Archaeophasianus mioceanus* (Crowe and Short 1992; Ducey 1992; Shufeldt 1915). While initially referred to the families Gallinuloididae and Phasianidae, respectively, subsequent assessment indicates that both species may instead fall outside of living lineages of Galliformes, rather being early diverging members of the landfowl lineage (Ksepka et al. 2023; Mayr 2022).

An additional uncataloged fossil within the collections at SCBL, collected from the Orella Member of the Brule Formation, appears to be a large avian ulnare (Figure 32). This fossil is potentially representative of the family Bathornithidae, a group of large, possibly flightless, predatory birds related to the extinct phorusrhacids (“terror birds”) and extant seriemas of South America (Mayr 2022).





**Figure 32.** Possible bathornithid ulnare from the Orella Member of the Brule Formation at SCBL. Scale bar = 1 cm (0.4 in).

*NPS / AUSTIN SHAFFER*

### **Fossil Invertebrates**

Invertebrate body fossils are not abundant at SCBL; however, gastropods have been reported from the Whitney Member of the Brule Formation at the monument (Figure 33). These land snail shells appear to belong to the family Helminthoglyptidae, an extant group found across the Americas in the modern-day and observed as fossils elsewhere in White River strata of the Great Plains (Roth 1996). Additional work may resolve the specific taxonomy of these gastropods at SCBL.





**Figure 33.** Helminthoglyptid land snail shell observed in the collections at the SCBL Visitor Center. Scale bar = 1 cm (0.4 in).

*NPS / AUSTIN SHAFFER*

### **Ichnofossils**

Trace fossils occur throughout the rock units of SCBL and include plant, invertebrate, and vertebrate examples. Plant traces, specifically rhizoliths, and invertebrate feeding traces are both locally abundant and ubiquitous throughout the Brule Formation and Arikaree Group of SCBL. Good examples of these ichnofossil types can be observed in the eolian deposits of the undivided middle Arikaree Group (Figure 34).



**Figure 34.** Invertebrate feeding traces on the underside of a ledge in the undivided middle Arikaree Group at SCBL.

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Invertebrate ichnofossils have been reported from the Arikaree Group of SCBL in three publications (Frey et al. 1984; Stanley and Fagerstrom 1974; Toots 1975). One feeding trace ichnotaxon, *Ancorichnus coronus*, has been named based on specimens from SCBL (Frey et al. 1984). Additionally, insect burrows (cf. *Pallichnus*) possibly made by dung beetles are recorded from the Orella Member of the Brule Formation at SCBL (Figure 35). Similar traces are known from White River Group strata of BADL and northeastern Colorado (Hembree and Hasiotis 2007; Retallack 1984).





**Figure 35.** Dung beetle trace (cf. *Pallichnus*) in the Orella Member of the Brule Formation at SCBL.  
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The Gering Formation of SCBL contains an abundance of vertebrate tracks, many of which appear to be bilobed hoof prints of artiodactyls. The largest of these tracks may have been made by entelodonts, while various smaller tracks may represent camels or other small artiodactyls (Loope 1986). These tracks are visible in both cross-section (Figure 36) and in occasional overhanging ledges.





**Figure 36.** Bilobed artiodactyl hoof tracks in cross-section within a fallen block of the Gering Formation at SCBL.

*NPS / AUSTIN SHAFFER*

Vertebrate coprolites (Figure 37) are also recorded in the Orella Member of the Brule Formation at SCBL. Coprolites similar to those found at SCBL are known from other White River Group strata of the Great Plains, including at BADL, and in some instances these coprolites contain important microvertebrate fossils (Edwards and Yatkola 1974; Hunt et al. 2012; Parris and Holman 1978).





**Figure 37.** Vertebrate coprolite observed in the Orella Member of the Brule Formation at SCBL.  
*NPS / AUSTIN SHAFFER*

Among the more unique paleontological features of SCBL are numerous large burrows, locally abundant in the Orella Member (Figure 10) and interpreted as having been made by vertebrates. These burrows are 2 to 4 m (7 to 13 ft) long with elliptical cross sections around 0.3 m (1 ft) across and 0.15 to 0.2 m (0.5 to 0.7 ft) deep. They extend down at low angles into the tan mudstone beds below the blue tuff. Typically, they are single elongated chambers, but occasional bifurcated forms do exist (Figure 38). The distal ends of the burrows extend 1.0 to 1.2 m (3.3 to 3.9 ft) below the base of the red mudstone. They are obvious in outcrop because they are filled with either blue ash, or the red mudstone that overlies the blue ash. Of the 30 burrows measured at SCBL, six were filled with blue ash and 24 were filled with red mudstone. These two kinds of burrow fill indicate distinct times of burrow occupation.



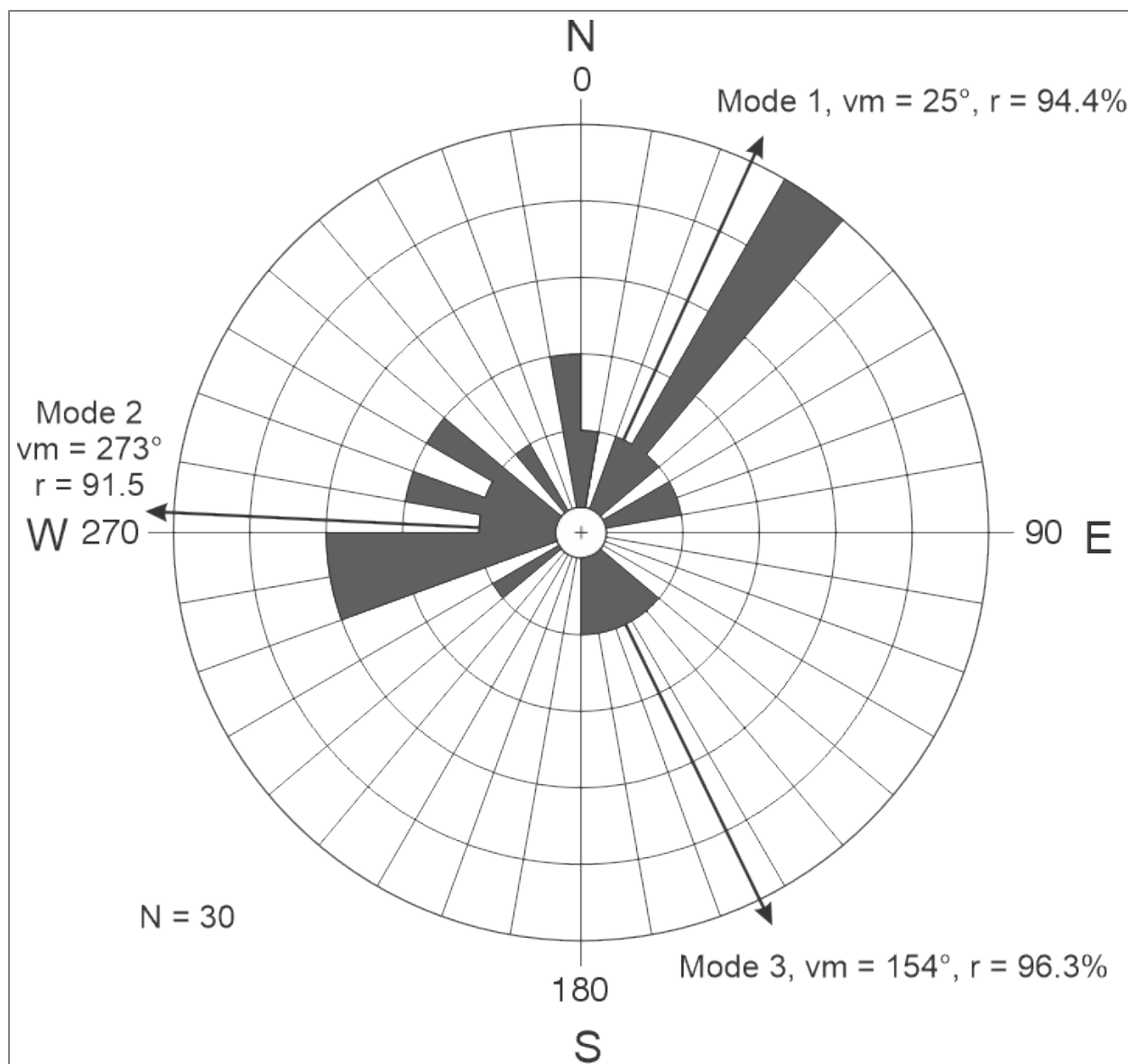


**Figure 38.** Large vertebrate burrow in the Orella Member of the Brule Formation at SCBL depicting bifurcated morphology.

*NPS / AUSTIN SHAFFER*

The azimuths of 30 large vertebrate burrows were measured along their axis of elongation. The azimuths were measured from their upper openings toward their lower distal ends. A rose diagram of these measurements (Figure 39) indicates that the burrows are oriented in almost every direction. When taken as a whole, the vector magnitude ( $r$ ) of all of the azimuths is only 28.5% (if all of the measurements were in the same direction, the  $r$  value would be 100%; conversely, if the measurements were in all directions, the  $r$  value would be 0.0%). The low value of  $r$  for all combined values indicates the burrows extend in all directions randomly. However, the azimuth data show three clusters of measurements with strong directionality (called modes). The first cluster (mode 1) includes orientations from the NNW to the NE ( $350^\circ$  to  $60^\circ$ ) and has an  $r$  value of 94.4%. The second cluster (mode 2) includes orientations from the NW to the WSW ( $235^\circ$  to  $325^\circ$ ) with an  $r$  value of 91.5%. The third cluster is small but distinct towards the SE ( $130^\circ$  to  $175^\circ$ ) with an  $r$  value of 96.3%. The vector-magnitude values indicate there is a significant directionality to the burrows, with some extending to the northeast and opening to the southwest (mode 1); some extending to the west and opening to the east (mode 2); and a small set extending to the southeast and opening to the northwest (mode 3). The angles between the vector means ( $vm$ ) of the modes are  $112^\circ$  between modes 1 and 2;  $119^\circ$  between modes 2 and 3; and  $129^\circ$  between modes 1 and 3. When averaged, these angles become  $120^\circ$ . The significance of these grouped and evenly spaced clusters of burrows is unknown, but further studies of the morphology of the three clusters of burrows and their relative geospatial distributions may provide additional paleoenvironmental and/or taxonomic information.





**Figure 39.** Rose diagram showing the orientation of large burrows in the Orella Member of the Brule Formation at SCBL. Azimuth cluster groups (modes 1–3), vector magnitude ( $r$ ) values, and vector means ( $vm$ ) are depicted.

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A large burrow observed during the 2025 field inventory appears to occur in close association with a turtle shell (Figure 40). It is worth noting that turtle fossils with evolutionary affinities to extant burrowing gopher tortoises are recorded from the White River Group and that vertebrate burrows, primarily ascribed to mammalian carnivores, are known from the younger Arikaree Group strata at AGFO (Hunt 1984; Hunt et al. 2018; Hutchison 1996; Vlachos 2018). While we suspect that these burrows may have been made by turtles, we refrain from confidently assigning the Orella burrows of SCBL to Testudines until more detailed assessment can occur.



**Figure 40.** Tortoise shell preserved in close association with the distal end of a large burrow in the Orella Member of the Brule Formation at SCBL.  
*NPS / AUSTIN SHAFFER*

# Biostratigraphy

## Historical Records from SCBL and Biochronologic Context

Fossil mammal faunae have been an invaluable resource in correlating biochronologic zones across terrestrial ecosystems in North America, beginning in the Late Cretaceous and continuing throughout the Cenozoic (Wood et al. 1941; Woodburne 1987, 2004). There are currently 23 North American Land Mammal “Ages” (NALMAs) spanning nearly 84 million years of time (Woodburne 2004). NALMAs are established in recognition of distinctive taxonomic assemblages and are defined on the basis of first appearances and last appearances of taxa. Placing strata in NALMAs requires the presence of at least one taxon with a known biostratigraphic range. The more taxa that are present, the tighter the range that can be established based on their overlap.

Historical fossil collections pertaining to the region go as far back as the famous 1870 Yale Expedition and have continued through other major museum collections (e.g., National Museum of Natural History [USNM], Museum of Comparative Zoology [MCZ], University of Nebraska State Museum [UNSM]). These collection records and records from the 2025 field inventory help to clarify the NALMAs and their respective interval zones, in order to provide specific biostratigraphy for SCBL. The vast majority of historical collections from the monument were in the Brule Formation, the most accessible and productive unit. The upper strata of the Arikaree Group have a limited record due to limited accessible exposures. Published records document biochronologically informative material from SCBL, primarily oreodonts (Schultz and Falkenbach 1956, 1968; Thorpe 1937). Unpublished records should be treated as tentative, with further study needed to verify taxonomic identities. There is also a lack of stratigraphic control recorded with many of these specimens from older collections, so we rely herein on correlation of fauna with previously established biozones (Prothero and Emry 2004; Prothero and Whittlesey 1998; Tedford et al. 2004).

The current understanding of biozonation in the White River Group was established by Prothero and Whittlesey (1998) as well as Prothero and Emry (2004). These authors refined the subdivisions (i.e., interval zones) within the major NALMA units originally provided by the Wood committee (Wood et al. 1941) (Figure 41). The most recent review of NALMAs spanning the Late Oligocene through Miocene (Arikareean through Hemphillian NALMAs) was conducted by Tedford et al. (2004).



| Age Epoch | NALMA      | Interval Zone                                                                                                                              | Type Area / Correlated Section                                                                                                                                                                            |
|-----------|------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Oligocene | Arikarean  | Ar1<br>28.0-----<br>No formal Interval Zone<br>The most widespread FAD taxa distributed through correlated sections is <i>Nanotragulus</i> | No designated type area. Correlated sections: Brown Siltstone Member, Brule Formation, NE<br>Gering Formation, NE<br>Sharps Formation, SD<br>Between AB Tuff and Deep Creek Tuffs, John Day Formation, OR |
|           |            | 30.0-----<br><i>Merycoidodon major</i>                                                                                                     | 30-103 meters above Scenic-Poleslide contact, south side of Sheep Mountain Table, SD                                                                                                                      |
|           | Whitneyan  | Wh2<br>31.4-----<br><i>Leptauchenia major</i>                                                                                              | 0-30 meters above Scenic-Poleslide contact, south side of Sheep Mountain Table, SD                                                                                                                        |
|           |            | Wh1<br>32.0-----<br><i>Merycoidodon bullatus</i>                                                                                           | Upper Nodular Zone, Sheep Mountain Table, SD                                                                                                                                                              |
|           | Orellan    | Or4<br>32.5-----<br><i>Miniochoerus gracilis</i>                                                                                           | 27-50 meters above PWL, Boner Ranch, WY                                                                                                                                                                   |
|           |            | Or3<br>33.1-----<br><i>Miniochoerus affinis</i>                                                                                            | 17-27 meters above PWL, Boner Ranch, WY                                                                                                                                                                   |
|           |            | Or2<br>33.4-----<br><i>Hypertragulus calcaratus</i>                                                                                        | 7-17 meters above 5 tuff, Douglass area, WY                                                                                                                                                               |
|           |            | Or1<br>33.7-----                                                                                                                           |                                                                                                                                                                                                           |
| Eocene    | Chadronian | Ch4<br>34.7-----<br><i>Miniochoerus chadronensis</i>                                                                                       | 25 meters below to 7 meters above PWL, Boner Ranch section, WY                                                                                                                                            |
|           |            | Ch3<br>35.7-----<br><i>Leptomeryx mammifer</i>                                                                                             | 50 feet below Ash B to 50 feet above Ash G, Flagstaff Rim, WY                                                                                                                                             |
|           |            | Ch2<br>36.5-----<br><i>Leptomeryx yoderi</i>                                                                                               | Lone Tree Gulch section, Flagstaff Rim, WY                                                                                                                                                                |
|           |            | Ch1<br>37.0-----<br><i>Bathygenys</i>                                                                                                      | Reeves Bonebed section, Trans-Pecos, TX                                                                                                                                                                   |
|           |            |                                                                                                                                            |                                                                                                                                                                                                           |

**Figure 41.** NALMAs representing the White River and basal Arikaree Groups present at nearby Badlands National Park (BADL) with respective interval zones, type areas, and correlated sections based on Prothero and Emry (2004).

NPS / ED WELSH

Published records were reviewed and cross-referenced with biochronologic works to ascertain which biozones can be confirmed through peer-reviewed work. Museum collection records (Appendix B) were also utilized to find potential unpublished records of taxa that might provide insight into potential previously unrecognized NALMAs or interval zones. Previously reported taxa were also assessed diligently to affirm taxonomic validity, since some historical records use names that have since changed taxonomically. For example, *Miniochoerus affinis*, *Platychoerus platycephalus*, and *Miniochoerus battlecreekensis* have been recovered and published from SCBL (Schultz and Falkenbach 1956), but the latter two taxa have since been synonymized with *M. affinis* (Stevens and Stevens 1996).

### Chadronian NALMA (Not Present, Despite Previous Reports)

The basal exposures and corresponding fossil record at SCBL are in need of clarification since the findings of this inventory conflict with previously published observations. Schultz and Stout (1955) provided the first major stratigraphic review of SCBL, with a heavy focus on the White River Group. Though the Chadron Formation is not confirmed from the monument, Schultz and Stout cite a “Titanotheres metapodial” (Brontotheriidae) that was recovered from the “Orella A” section (see the

“Taxonomy” section above and the “Orellan NALMA” subsection below for discussion of this specimen). LaGarry (1998) proposed a revision of the Brule Formation in Nebraska, reassigning “Orella A” to the Big Cottonwood Creek Member of the Chadron Formation. However, the Chadron Formation is not exposed at SCBL, as observed during the 2025 field inventory. The fossil collection records also support the lack of a Chadronian fauna. No characteristic taxon exclusive to the earliest Orellan or Chadronian has ever been recovered or confirmed. For the earliest Orellan (*Hypertragulus calcaratus* Interval Zone; Or1), SCBL does have the first appearance taxa *Leptomeryx evansi* and *Hypertragulus calcaratus*; however, these taxa continue throughout the Orellan and into the Whitneyan. No Chadronian leptomerycids (e.g., *Leptomeryx speciosus* [Ch4] or *Leptomeryx mammifer* [Ch3]) have been recovered or reported from the monument. No strictly earliest Orellan taxa have been confirmed by SCBL. *Poebrotherium eximium* is cited in the Yale Peabody Museum (YPM) collections (see Appendix B) and does make its last appearance in the earliest Orellan. However, the YPM *P. eximium* specimen is an unpublished and unverified record. Another species that might affirm this interval is the last appearance taxon *Miniochoerus chadronensis*. Miniochoerine oreodonts appear to be the most common macrofaunal component in the Brule Formation at SCBL, but only two species within this subfamily are present (as well as abundant): *Miniochoerus affinis* and *M. gracilis*.

### Orellan NALMA

The Orellan NALMA represents the beginning of the Oligocene and is probably the best sampled and represented fauna in the White River Group. It is subdivided into four interval zones, which can be easily distinguished by the presence of specific oreodont species.

*Miniochoerus affinis* is the oldest miniochoerine oreodont recovered and reported from the monument (Schultz and Falkenbach 1956; Appendix B). Therefore, the oldest biozone we can confirm at SCBL is the late early Orellan (*Miniochoerus affinis* Interval Zone; Or2). Exploration within the lowermost Brule Formation exposure at SCBL recovered *Miniochoerus gracilis*, the first appearance taxon for the early late Orellan (*Miniochoerus gracilis* Interval Zone; Or3). *M. gracilis* has been previously reported (Schultz and Falkenbach 1956) and is well represented in museum collection records (Appendix B). It is most likely that the basal exposures of the Orella Member at SCBL span the Or2–Or3 transition. The channel sandstone that contained the “Titanothera metapodial” of Schultz and Stout (1955) cuts into the *Miniochoerus gracilis* Interval Zone and is a more likely equivalent to the “*Metamynodon* channels” found at BADL in South Dakota.

*Metamynodon* (Amynodontidae) is commonly found in river channel deposits of the lower Scenic Member (Orella Member equivalent) of BADL, channels that also cut into beds containing the lowest occurrence of *Miniochoerus gracilis*. *Metamynodon* material is rare in Nebraska and metapodials of this taxon are large enough to easily be mistaken as a brontothere. Thus, the brontothere material cited by Schultz and Stout (1955) is likely misidentified material from *Metamynodon*. Further study of the original material could confirm this and further support biostratigraphic conclusions for the monument.

The latest Orellan (*Merycoidodon bullatus* Interval Zone; Or4) is characterized by the first appearance of *Merycoidodon bullatus*, which has been reported from Scotts Bluff as the cotypes of

*Subdesmatochoerus* (originally “Eporeodon”) *socialis* (Schultz and Falkenbach 1954). This is the only recovered taxon that characterizes this zone.

### **Whitneyan NALMA**

The Whitneyan is subdivided into two interval zones: the early Whitneyan (*Leptauchenia major* Interval Zone; Wh1) and the late Whitneyan (*Merycoidodon major* Interval Zone; Wh2) (Prothero and Emry 2004; Prothero and Whittlesey 1998). Each interval zone is based on the first appearance of its namesake taxon. However, from cross-referencing old taxonomic names with current synonyms and correlating each occurrence with stratigraphic records from each locality, it has been difficult to distinguish Wh1 and Wh2. Both *Leptauchenia major* and *Merycoidodon major* can be found sharing lowest occurrences in the “*Leptauchenia* beds” in South Dakota and Nebraska (“Zone D” in Schultz and Falkenbach 1954, 1956, 1968; Schultz and Stout 1955). The Whitneyan NALMA is therefore in need of careful review using sites and specimens with tight stratigraphic control.

### **Arikareean–Hemingfordian NALMAs**

The Arikareean is the temporally longest NALMA that may be represented at SCBL, spanning much of the middle to Late Oligocene and earliest Miocene (Tedford et al. 2004). There are four subdivisions, with the middle two interval zones (Ar2–Ar3) being the longest temporally. The fauna collected from the upper units at SCBL are few and have scant locality and horizon information, making it difficult to narrow which biozones are represented. Only the earliest Arikareean (Ar1) can be confirmed confidently. Historic collections from SCBL representing the Arikareean are primarily oreodonts. Other than representatives of Ar1, the other taxa could also represent the Hemingfordian NALMA (although this remains unverified at present).

Thorpe (1937) referred to a specimen of *Eporeodon montanus* (YPM VP 012446) (syn. *Mesoreodon chelonys*; Stevens and Stevens 1996) from Scotts Bluff in the same geologic horizon as the holotype, being “top of lower Brule, in a soft, sandy deposit”. The geologic site description is reminiscent of the Gering Formation at SCBL. Thorpe (1937) also refers to *Leptauchenia nitida* (syn. *Sespia nitida*; Hoffman and Prothero 2004) from the monument, but doesn’t provide specimen details, locality/horizon data, or specimen numbers (likely YPM VP 012670 and 012670.A). However, all records of *S. nitida* in the Great Plains region are considered restricted to Ar1 (Hoffman and Prothero 2004). This is likely a co-occurrence with *Mesoreodon chelonys* in the Gering Formation, confidently representing the earliest Arikareean NALMA at SCBL.

Collection records from YPM, MCZ, and USNM contain the only taxa recovered from the strata overlying the Gering Formation. However, none of these specimens can be found in published reports and taxonomic identifications should therefore be taken as tentative. YPM records include *Ticholeptus* sp. and *Merychyus* sp. (see Appendix B). Additional collections from MCZ include cf. *Promerycochoerus* sp. and *Merycochoerus magnus* (see Appendix B). USNM contains a specimen of *Brachycrus rusticus* in their collection from SCBL (see Appendix B). *Promerycochoerus* and *Merychyus* have wide ranges at the generic level and are of little biostratigraphic utility without more specific taxonomic attribution, since the former spans the entire Arikareean and Hemingfordian and the latter spans the last half of the Arikareean through the Clarendonian. The material from



*Promerycochoerus* could potentially co-occur with the Gering Formation material but could also co-occur with *Merychys* in Ar3–4. Specific-level identification for *Promerycochoerus* and *Merychys*, along with collateral stratigraphic records, is necessary to verify any of the later subdivisions of the Arikareean NALMA.

The uppermost beds at SCBL seemingly contain a Hemingfordian fauna, but further study and clarification are needed as occurrence records for index taxa are based only on collection database data, with the specific identifications not verified by peer-reviewed research. Until the relevant taxa can be verified from the upper units at SCBL, the Hemingfordian record is questionable.

*Merycochoerus magnus* might extend as far back as the late middle Arikareean (Ar3), but this is based on vague and unconfirmed information from the Paleobiology Database. However, Stevens et al. (2023) restrict *M. magnus* to the Hemingfordian. *Ticholeptus* has its first appearance in the Hemingfordian and last appearance in the Barstovian (Schultz and Falkenbach 1947; Stevens et al. 2023). *Brachycrus rusticus* is another taxon restricted to the Hemingfordian, which reduces confidence of any Arikareean fauna being present beyond Ar1. It should also be noted that *B. rusticus* has not been reported outside of sites in Wyoming (Stevens et al. 2023). If this identification of *B. rusticus* can be confirmed, it would be a geographic range extension for this taxon into Nebraska. Though *Promerycochoerus* and *Merychys* could co-occur in the latter half of the Arikareean (Ar3–Ar4), these genera also co-occur with *Ticholeptus*, *Merycochoerus magnus*, and *Brachycrus rusticus* within the early Hemingfordian (He1).

Pending further study of the aforementioned curated but unpublished material, the Hemingfordian may be present at SCBL. Though some reported taxa continue into the Barstovian, there is no presence of characteristic, first appearance, or index fauna. Also, there are no sedimentary units present that would contain Barstovian fauna (e.g., Olcott Formation). USNM lists *Aelurodon* (USNM V 3944) in their collection records, which makes its first appearance in the early Barstovian (Ba1). Wang et al. (1999) provided a thorough accounting of every identifiable borophagine canid held in all major museum collections but never cited or confirmed a taxonomic identification for USNM V 3944 nor cited any medium-to-large bone-crushing canid from SCBL. Only small-bodied canids (e.g., *Hesperocyon*, *Archaeocyon*) have been cited from SCBL in literature (Wang 1994; Wang et al. 1999). It is within the realm of possibility that USNM V 3944 might be a misidentified *Protomarctus*, which is closely related and similar in size to early *Aelurodon*. *Protomarctus* would be the only *Aelurodon*-like borophagine canid that could be found in a Hemingfordian fauna.

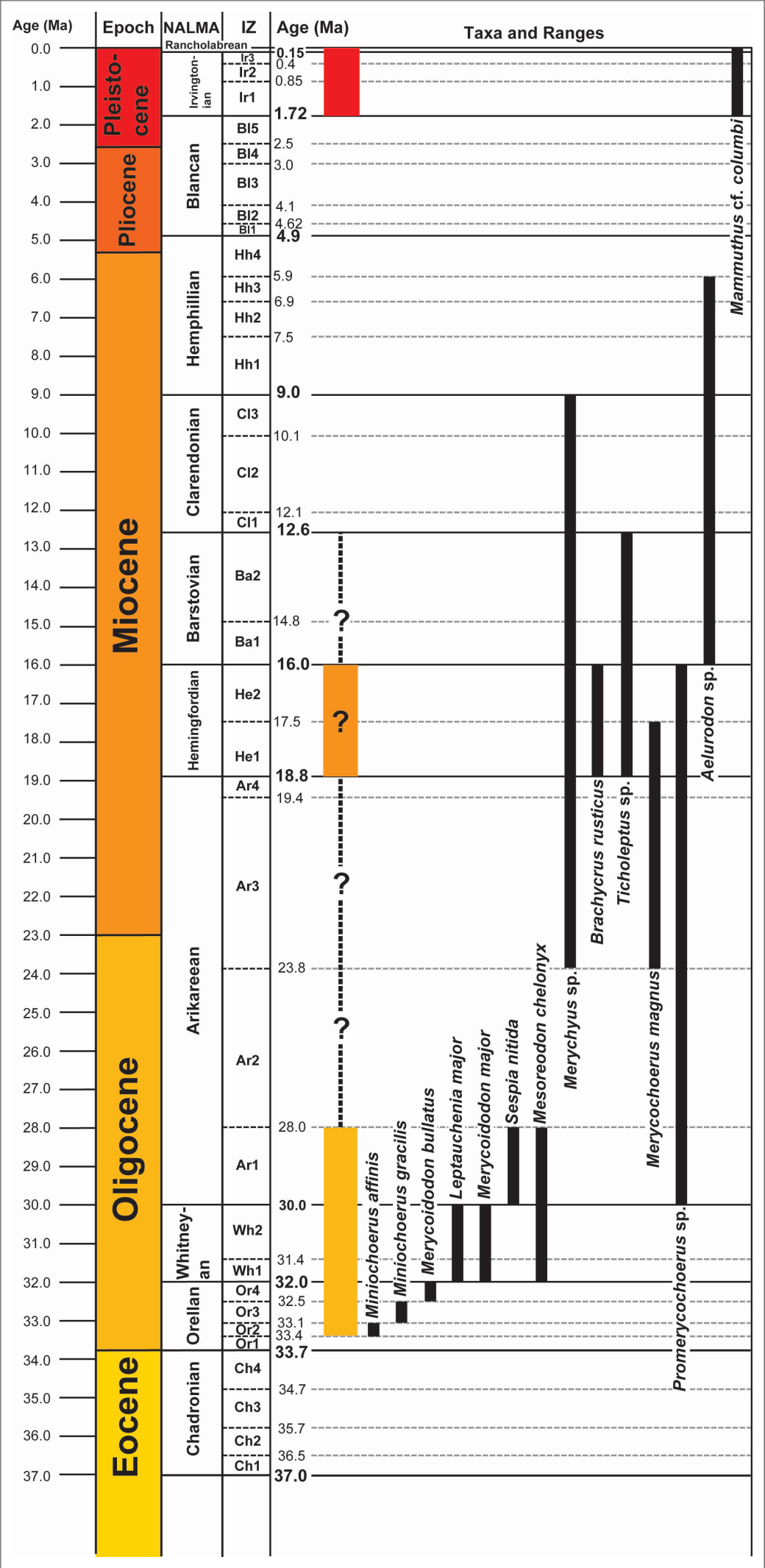
It is important to reiterate that the museum records containing many of the reported taxa for the late Arikareean and Hemingfordian (e.g., *Merychys*, *Promerycochoerus*, *Merycochoerus*, *Brachycrus*) have not been verified by peer-reviewed research and should therefore be considered tentative. It is also worth noting that many of the YPM, USNM, and MCZ collections records are simply attributed to Scotts Bluff County, Nebraska, and therefore may in actuality originate from outside the boundary of SCBL. Verification of the specimens in question and/or discovery of additional fossil material from the uppermost Arikaree Group at SCBL is necessary for the confirmation of the presence of these biozones.

### **Irvingtonian–Rancholabrean NALMAs**

Potential Irvingtonian and/or Rancholabrean fauna are reported from SCBL. MCZ collection records include podial elements of *Mammuthus* cf. *columbi* (MCZ VPM-10927 and MCZ VPM-10929), which would support the presence of Pleistocene deposits at the monument. The exact locality or localities where these specimens were discovered is not certain. [MCZ records](#) report them and three other now-lost proboscidean specimens (MCZ VPM-10928, another calcaneum; MCZ VPM-10930, fragments; and MCZ VPM-10931, a fibula) as coming from “Scotts Bluff”, received from “L. Agassiz”. Assuming the name to be Louis Agassiz, a reasonable assumption given the late-19<sup>th</sup> century dates on the same records page and the absence of other people with the same first initial and last name associated with Harvard in that time frame, Agassiz would have had to come into possession of the specimens before his death in 1873. There is no record that he ever visited Scotts Bluff, so presumably he received them from someone else; potentially information about the specimens exists in his personal correspondence. It does not appear that he included them in a publication, and they did not reach the attention of Oliver Perry Hay for his compilation of Pleistocene mammal finds of central North America (Hay 1924). Possibly they were overlooked by Hay because they were originally cataloged under Mammalogy, not Vertebrate Paleontology. At any rate, Scotts Bluff County was not established until 1888, and Scottsbluff the city was not founded until 1899, so the only usage of “Scotts Bluff” that would have been current in Agassiz’ lifetime is for the landform itself. Therefore, it is quite likely that the specimens came from within the modern boundaries of the monument, or if not within, then certainly from a very close distance. Because all of the identifiable specimens pertain to the hind feet or lower hindlimb, it would not be surprising if they were found associated and represent the same individual. However, there is no other information about the discovery, such as other taxa from the site, that would help narrow the mammoth locality as either Irvingtonian or Rancholabrean.

### **Summary**

At this time, three NALMAs are definitely represented at SCBL: Orellan, Whitneyan, and Arikareean, spanning from the late early Orellan (Or2) to the earliest Arikareean (Ar1). This range as presently defined encompasses a little more than 5 million years (33.4–28.0 Ma; Figure 42). The Hemingfordian is plausibly represented but unconfirmed. Finally, the presence of *Mammuthus* cf. *columbi* indicates a Pleistocene NALMA, either Irvingtonian or Rancholabrean, but more taxa are needed to establish which.



**Figure 42.** NALMAs represented at SCBL with ranges included for biochronologically useful taxa. Colored bars on the left indicate confirmed biozones at SCBL. Question marks and hatched lines indicate potential ranges yet to be confirmed.



# Fossil Localities

## **Paleontological Localities within SCBL**

During the 2025 inventory, a total of 51 paleontological localities were documented within the boundaries of SCBL. Of these 51 documented localities, approximately 41% (21 localities) represent SCBL fossil localities documented prior to the 2025 inventory, while more than half (~59%; 30 localities) were newly documented during the 2025 field inventory. Details on these localities are on file at SCBL and are available to qualified researchers.

The fossil localities documented at SCBL are overwhelmingly from the Brule Formation (Orella and Whitney Members). Only two of the documented localities are in the Gering Formation, three in the undivided Arikaree Group, and one in the Quaternary sediments. While the highly fossiliferous Brule Formation numerically dominates the currently documented localities, it is likely that future surveys of all of the geologic units at SCBL will reveal additional paleontological resources and localities, being limited in number at present due to outcrop accessibility.

### ***Brule Formation (Orella Member)***

Twenty-seven fossil localities are herein documented in the Orella Member of the Brule Formation at SCBL: seven documented prior to the 2025 field inventory and 20 new sites. These localities occur in high abundance in surveyed areas, and it is very likely that additional surveys of the monument will yield more localities and important scientific data.

### ***Brule Formation (Whitney Member)***

At present, 18 fossil localities are documented from this unit at SCBL: ten documented prior to the 2025 field inventory and eight new sites. Additional survey of such exposures may yield important data and should be a focus of future fieldwork.

### ***Gering Formation***

Due in part to the limited accessibility of Gering Formation exposures at SCBL (largely exposed in sheer cliff faces), only two fossil localities are documented. Future survey of Gering Formation exposures could also yield important paleontological discoveries.

### ***Arikaree Group Undivided***

The undivided middle Arikaree Group, save for ubiquitous rhizoliths and invertebrate burrows, does not appear to be as fossiliferous as other geologic units at SCBL (e.g., Brule Formation). Nevertheless, three fossil localities documented prior to the 2025 field inventory shed light on the fauna of this unit. Although limited in its overall fossil preservation, future surveys of this geologic unit, particularly with attention to eolian lag deposits, may yield additional paleontological resources.

## **Paleontological Localities near SCBL**

Other sites in western Nebraska act as important sources of paleontological resources and provide crucial points of comparison for the fossils of SCBL. This includes the fossil-rich strata of the White River Group at BADL and the Arikaree Group at AGFO. Prolific paleontological resources can be

found at both of these NPS units. Information on the diverse fossil resources found at these two parks can be found in Benton et al. (2015) and Hunt et al. (2018), respectively.

Mid-Cenozoic paleontological resources are also recorded nearby from NPS-affiliate Chimney Rock National Historic Site, about 31 km (19 mi) southeast of SCBL, and Wildcat Hills, about 10 km (6 mi) south of SCBL. Fossils found at these locations include artiodactyls, perissodactyls, carnivorans (e.g., *Nimravus*, *Sunkahetanka geringensis*), a primate (*Ekgmowechashala*), a worm lizard (*Rhineura*), rhizoliths, and invertebrate traces (Brattstrom 1958; Martin 1973; Meehan 1994; Schwartman et al. 1989; Swisher 1982; Tweet et al. 2011).

Additionally, the Scottsbluff Bison Quarry, 14 km (9 mi) west-southwest of SCBL, provides important information on local Quaternary paleontological resources, preserving gastropods and *Bison antiquus* alongside human artifacts (Hill and Boehm 2017; Schultz and Eiseley 1935).

## Cultural Resource Connections

There are many ways for paleontological resources to have connections to cultural resources. Examples of paleontological resources in cultural contexts include, but are not limited to: fossils used by people for various purposes, such as petrified wood used for tools, spear points, and other artifacts, or fossil shells picked up as charms or simply because they looked interesting; associations of prehistoric humans with paleontological resources, such as kill sites of mammoths, prehistoric bison, and other extinct animals; incorporation of fossils into cultural records, such as fossils in American Indian lore, “tall tales” of mountain men, and emigrant journals; and fossils in building stone. Kenworthy and Santucci (2006) presented an overview and cited selected examples of National Park Service fossils found in cultural resource contexts.

As previously detailed in the “History of Paleontological Work at SCBL” section, fossils play a role in the history of the monument, with historical reports of paleontological resources recorded in multiple journals of mid-19<sup>th</sup> century westward travelers along the emigrant trails. These historical accounts of fossils by pioneers and other individuals provide an important overlap between paleontological and cultural resources and an interesting area for future inquiry and interpretation. Additionally, given the archeological history of SCBL and the nearby area (e.g., Scottsbluff Bison Quarry), there exists a distinct potential for paleontological resources to occur within archeological sites. No definitive examples from the monument have yet been identified, but a few fossil bone fragments have been recovered during archeological work and are repositied at the Midwest Archeological Center (see below under “Museum Collections and Paleontological Archives”).



# Museum Collections and Paleontological Archives

## Museum Collections and Curation

### **Park Collections**

Only a single currently cataloged paleontological specimen was conclusively located at SCBL during this inventory: SCBL 1582, a *Hyracodon* skull that is currently on exhibit at the SCBL Visitor Center. One other specimen, SCBL 11596 (two complete snail shells), is recorded as being located at SCBL and may have been observed (Figure 33); however, the absence of any data associated with the observed specimen precludes such a conclusion. As of June 2025, there are 245 catalog listings in the NPS Museum Collection Management System (MCMS) for SCBL. Of these, 41 of the specimens have been deaccessioned and 142 records do not appear to originate from the strata of SCBL. This leaves 62 currently cataloged specimens that are likely to have originated from SCBL. Outside of SCBL 1582 and SCBL 11596, the rest of the cataloged specimens are recorded as being located elsewhere. A few specimens are currently listed as on loan for preparation (this may be outdated, however) and one specimen (SCBL 11597, a jacketed turtle) is listed as repositied at the University of Nebraska State Museum at the University of Nebraska–Lincoln (UNL). However, the majority of the 62 cataloged fossil specimens from SCBL are reported to be repositied at the Independence Multi-Park Facility (IMPF) in Independence, Missouri (Appendix B). Future examination of this material may provide useful scientific insights into the paleontology of SCBL, expanding on the information found in this report.

In addition to the currently cataloged material, a small number of uncataloged paleontological specimens are located in the SCBL collections “vault” at the SCBL Visitor Center, as of the time of writing. Unfortunately, most of these specimens lack any associated data (e.g., provenance, collection history) and, as such, provide little scientific information. In addition to their limited scientific utility, although it appears probable that these specimens originate from SCBL, it is difficult, if not impossible in most cases, to ascertain whether they were truly collected within SCBL.

One uncataloged paleontological specimen at SCBL that fortunately has associated data is a rather large avian ulnare (Figure 32). This specimen, collected in 2021 from the Orella Member of the Brule Formation, may belong to a bathornithid bird. Three fossil collections were made from the Brule Formation during the 2025 field inventory: an assortment of microfossils (including mandibular fragments) from the Whitney Member, a partial oreodont (*Miniochoerus gracilis*) skull from the Orella Member, and a fragmentary artiodactyl (cf. *Pseudoprotoceras*) skeleton from the Orella Member. These specimens are all currently repositied at SCBL.

### **Collections in Other Repositories**

As a result of the numerous historic paleontological field expeditions that were made to the Scotts Bluff area, particularly in the late 1800s and early 1900s, a substantial number of relevant fossil specimens are held at external repositories. Specimen data for some institutions (e.g., University of Nebraska State Museum [UNSM], American Museum of Natural History [AMNH]) permit confident attribution of fossils/taxa to SCBL; however, in other instances, relatively imprecise locality

information (e.g., “Scotts Bluff County”) results in only a tentative connection to SCBL. The city of Scottsbluff presents another potential ambiguity in the usage of “Scotts Bluff”/“Scott’s Bluff” after its establishment in 1899. Future examination of such collections data may elucidate which of these specimens actually originate from within the monument boundary. At present, we consider 16 UNSM fossil specimens and 14 AMNH fossil specimens to have originated from SCBL, and a further 103 fossil specimens from the Museum of Comparative Zoology (MCZ), 53 fossil specimens from the National Museum of Natural History (USNM), and 145 fossil specimens from the Yale Peabody Museum (YPM) as having potentially originated from the monument (Appendix B). It is probable that further examination of collections data will reveal additional relevant specimens at these and/or other institutions. A dedicated collections-based inventory of fossil specimens tied to SCBL is recommended. See Appendix C for repository contact information.

Turtle fossils collected from the Brule Formation of SCBL during the 2006 fieldwork led by Joseph Corsini (permit SCBL-2006-SCI-0001) are currently provisionally housed at Eastern Oregon University (EOU; La Grande, Oregon) (J. Corsini, pers. comm., July 2026). SCBL staff have reached out concerning the ultimate storage of these specimens, most likely the IMPF if through NPS.

Additional fossils collected from SCBL in recent years are currently housed at BADL and remain to be properly cataloged. They include the mylagaulid rodent skull collected from the undivided Arikaree Group (Figure 26) and a *Hyracodon* skull collected from the Brule Formation (Figure 23). Renovation of the BADL collections facilities taking place at the time of writing limits the ability to assemble a complete list of fossils from SCBL housed at this repository.

A small number of paleontological or potentially paleontological specimens from SCBL are held at another NPS facility, the Midwest Archeological Center (MWAC) in Lincoln, Nebraska. They were discovered incidentally during archeological activities. Tweet visited this facility in May 2016 and evaluated the specimens. Most were likely modern bone (SCBL 3665, 3670–3674, 3678), but two appeared to include fossil bone fragments (SCBL 10113 and 10114). These two catalog numbers present a total of five bone fragments, none larger than 2.5 cm (1 in).

### **Type Specimens**

Type specimens for four currently valid fossil taxa are likely to have been collected from SCBL or the immediate vicinity:

*Ancorichnus coronus* Frey, Pemberton, and Fagerstrom, 1984, an invertebrate ichnotaxon, was established based on a holotype (UNSM 17102) and three paratypes (UNSM 17100, UNSM 17101, and UNSM 17103), all collected from the undivided Arikaree Group of SCBL.

The holotype mandible (AMNH FM 81507; formerly HC 505) for *Hypisodus ironsi* Cook, 1934, a hypertragulid artiodactyl, was collected from the Whitney Member of the Brule Formation at Mitchell Pass. The specimen is currently repositied at the American Museum of Natural History.

*Archaeophasianus mioceanus*, originally *Phasianus mioceanus*, was named by Shufeldt (1915) on the basis of cotypes from Chimney Rock (now within the NPS-affiliate Chimney Rock National

Historic Site) and “Scott’s Bluff” (YPM 908 and YPM 909, respectively). This possible galliform bird was recovered from uncertain strata (stated as “Miocene”).

UNSM 5774, a humerus from a possible galliform bird that represents the holotype for *Archaelectrornis sibleyi* Crowe and Short, 1992, was collected from the Brule Formation at UNSM locality Sf-101 (Crowe and Short 1992). It is probable that this specimen originates from within the boundaries of SCBL; however, given certain inconsistencies in the information available for this locality (e.g., location description not matching the provided coordinates), there remains a possibility that this type specimen was not recovered from within SCBL.

Additional type specimens have also been described from the area of Scotts Bluff and therefore potentially SCBL, but their corresponding taxa are no longer considered valid. These include: YPM VP 011762 (holotype for *Amphicyon angustidens* Marsh, 1871, now considered a dubious name) from “Miocene” rocks of the North Platte at Scotts Bluff; YPM 13118 and YPM 13119 (cotypes for *Eporeodon socialis* Marsh, 1884, now considered a junior synonym of *Merycoidodon bullatus*), originally misidentified as from the John Day Basin but actually from the Scotts Bluff area (Thorpe 1921a); and YPM 12752 (holotype for *Merycoidodon platycephalus* Thorpe, 1921b, now considered a junior synonym of *Miniochoerus affinis*) from “near Scott’s Bluff”.

## **Archives**

### **NPS Paleontology Archives**

All data, references, images, maps and other information used in the development of this report are maintained in the NPS Paleontology Archives and Library. These records consist of both park-specific and servicewide information pertaining to paleontological resources documented throughout the NPS. If any resources are needed by NPS staff at SCBL or additional questions arise regarding paleontological resources, contact the NPS Paleontology Program at [paleontology@nps.gov](mailto:paleontology@nps.gov). Park staff are also encouraged to communicate new discoveries to the NPS Paleontology Program, not only when support is desired, but in general, so that this information can be incorporated into the archives. A description of the Archives and Library can be found in Santucci et al. (2018).

### **E&R Files**

E&R files (from “Examination and Report on Referred Fossils”) are unpublished internal USGS documents. For more than a century, USGS paleontologists identified and prepared informal reports on fossils sent to the survey by other geologists, for example to establish the relative age of a formation or to help correlate beds. The system was eventually formalized as a two-part process including a form sent by the transmitting geologist and a reply by the survey geologist. Sometimes the fossil identifications were incorporated into publications, but in many cases this information is unpublished. These E&R files include documentation of numerous fossil localities within current NPS areas, usually predating the establishment of the NPS unit in question and frequently unpublished or previously unrecognized. Extensive access to the original files was granted to the NPS by the USGS beginning in 2014 (Santucci et al. 2014). No E&R files are yet known for SCBL.



# Park Paleontological Research

## Current and Recent Research

At the time of writing, four permits have been issued for projects at SCBL of which paleontological resources played a significant role. These are listed below in chronological order by research permit number.

- SCBL-2006-SCI-0001, principal investigator Joe Corsini of Eastern Oregon University, project “*White River Turtles and Associated Fauna: Relationship to Regional Oligocene Environment and Climate*”, issued for 2006–2009.
- SCBL-2013-SCI-0001, principal investigator Emmett Evanoff, project “*Detailed Geologic Mapping at Scotts Bluff National Monument and Chimney Rock National Historical Landmark, Nebraska*”, issued for 2012–2014; this project was continued in 2015 under SCBL-2015-SCI-0005.
- SCBL-2015-SCI-0006, principal investigator Emmett Evanoff, project “*Paleontologic survey of the Brule Formation at Scotts Bluff National Monument*”, issued for 2015.
- SCBL-2025-SCI-0006, principal investigator Austin Shaffer, project “*Scotts Bluff National Monument Paleontological Resource Inventory*”, issued for 2025.

## Paleontological Research Permits

See the [National Park Service Natural Resource Management Reference Manual DO-77](#) section on Paleontological Resource Management, subsection on Scientific Research and Collection. NPS Management Policies 2006, section 4.8.2.1 on Paleontological Resources, states that

*The Service will encourage and help the academic community to conduct paleontological field research in accordance with the terms of a scientific research and collecting permit (NPS 2006).*

Any collection of paleontological resources from an NPS area must be made under an approved research and collecting permit. The NPS maintains an online Research Permit and Reporting System (RPRS) database for researchers to submit applications for research in NPS areas. Applications are reviewed at the park level and either approved or rejected. Current and past paleontological research and collecting permits and the associated Investigator’s Annual Reports (IARs) are available on the [RPRS website](#). Additional information on NPS law and policy can be found in Appendix D.

## Recommended Research

Potential future research topics related to SCBL paleontological resources were identified during the 2025 inventory. These topics are listed below in no particular order:

- Dedicated paleontological surveys of specific strata (e.g., Whitney Member of the Brule Formation, Quaternary sediments, undivided Arikaree Group) or specific fossil taxa (e.g., mammals, birds) at SCBL

- In-depth examination of fossil material from SCBL and comparison to analogous or coeval fossil faunas from the region (e.g., BADL, AGFO, Wildcat Hills, southeast Wyoming, northeast Colorado)
- Screenwashing of abandoned anthills in and/or near fossiliferous geologic units to assess microfossil diversity at SCBL (Figure 43)
- Collections-based inventory of paleontological specimens that plausibly originate from SCBL (including external repositories)
- Detailed biostratigraphic assessment of the strata at SCBL, determining the relationship between the fossil mammal taxa present and the corresponding lithostratigraphic units (drawing regional parallels)
- Examination of paleosols at SCBL to investigate paleoecological/paleoenvironmental change in the mid-Cenozoic



**Figure 43.** Ed Welsh examining an anthill for microfossils from the Brule Formation during the 2025 field inventory.

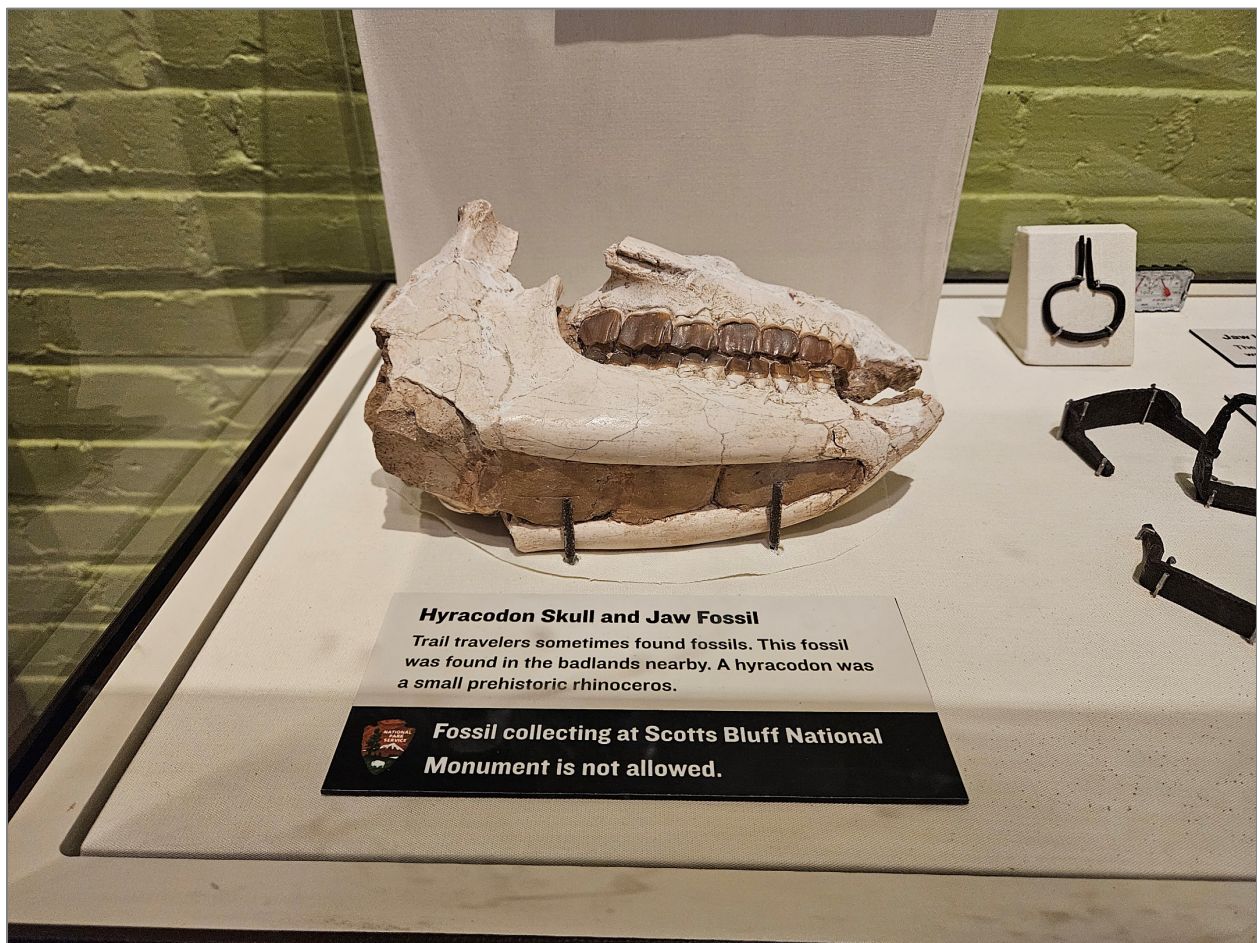
*NPS / AUSTIN SHAFFER*



# Interpretation

## Current Long Range Interpretive Plan

A long-range interpretive plan was produced for SCBL in 2008. This document mentions the significant paleontological resources found within the monument and includes an interpretive theme related to the geologic processes and features visible at SCBL. This interpretive theme is tied to fossils and changing environments/climates through time (NPS 2008). Historically, paleontological resources were featured prominently in exhibits at SCBL, with multiple displays dedicated to the fossils of the area (Figure 2). At present, however, fossils are only minimally exhibited at the SCBL Visitor Center (Figure 44), in part due to management concerns over poaching. Geology is still featured prominently on many wayside signs at SCBL, and the monument's website has multiple pages covering geology and paleontology, including [Geology and Paleontology](#) and [Paleontology at Scotts Bluff National Monument](#). Given the significance of the paleontological resources present at SCBL, it is recommended that further interpretation of fossils at the monument takes place, while remaining cognizant of and avoiding inadvertent encouragement of poaching.



**Figure 44.** A *Hyracodon* skull (SCBL 1582) currently on exhibit at the Scotts Bluff National Monument Visitor Center.

NPS / AUSTIN SHAFFER



## **Recommended Interpretive Themes**

### ***I. General Paleontological Information***

All of the following interpretation topics include a section instructing visitors how to be paleontologically aware while in SCBL. The ranger will provide the visitor with advice on why fossils are important, how paleontologists look for fossils, what to do if fossils are found, and reminders to be aware that fossils exist and should be respected within park boundaries.

- Fossils are non-renewable resources that possess scientific and educational information and provide insight into what Earth was like thousands and even hundreds of millions of years ago.
- When paleontologists survey for paleontological resources, the most important tool for planning is a geologic map. Paleontological resources are more common in certain geologic units, so knowing where those units are exposed is important for a successful search. Other tools that a paleontologist takes into the field include a field notebook for recording data and observations, small picks and brushes, consolidants to stabilize fossils, GPS, camera, topographic maps, and appropriate first aid and safety equipment. It might be helpful to provide examples of these items for visitors when giving an interpretive talk.
- If a fossil is found in SCBL by a visitor, the visitor should photograph it and notify a ranger of where the resource was found, but most importantly, they should leave the fossil where they found it. It is extremely important for scientific and resource management purposes for locational information to be preserved. Visitors should be informed that NPS fossils are protected by law.

### ***II. Fossils of SCBL***

- A program could be developed to educate the public on what types of fossils are present in SCBL and what they tell scientists about Earth's dynamic history. The goal of this program is to increase visitors' understanding of local geology and paleontology. Therefore, information regarding fossils from the vicinity of SCBL can be included.

### ***III. Further Interpretation Themes***

SCBL should be sure to promote its paleontological resources and provide additional opportunities or programs for visitors to learn about fossils on National Fossil Day, celebrated annually on Wednesday of the second full week in October (National Earth Science Week). For more information on this event, visit [National Fossil Day](#). The NPS coordinates the National Fossil Day partnership and hosts fossil-focused events across the country. Conducting one or more paleontology-focused activities on this day would be a perfect opportunity to not only increase public awareness about paleontological resources in SCBL, but also to connect with other parks and museums that are also participating in this national event. The NPS Geologic Resources Division can assist with planning for National Fossil Day activities and provide [Junior Paleontologist Program](#) supplies including activity booklets, badges, posters and other fossil-related educational resources.

# Paleontological Resource Management and Protection

## National Park Service Policy

Paleontological resources are non-renewable remains of past life preserved in a geologic context. At present, there are 433 official units of the National Park System, plus national rivers, national trails, and affiliated units that are not included in the official number. Of these, 288 are known to have some form of paleontological resources, and paleontological resources are mentioned in the enabling legislation of 18 units. Fossils possess scientific and educational values and are of great interest to the public; therefore, it is exceedingly important that appropriate management attention be placed on protecting, monitoring, collecting, and curating these non-renewable paleontological specimens from federal lands. In March 2009, the Paleontological Resources Preservation Act (PRPA) was signed into law as part of the Omnibus Public Land Management Act of 2009. The new paleontology-focused legislation includes provisions related to inventory, monitoring, public education, research and collecting permits, curation, and criminal/civil prosecution associated with fossils from designated Department of the Interior (DOI) lands. More information on laws, policies, and authorities governing NPS management of paleontological resources is detailed in Appendix D. Paleontological resource protection training is available for NPS staff through the NPS Paleontology Program. The Paleontology Program is also available to provide support in investigations involving paleontological resource theft or vandalism.

Between 2009 and 2022, an interagency coordination team including representatives from the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), National Park Service (NPS) and U.S. Fish & Wildlife Service (FWS) developed the DOI final regulations for PRPA. In 2022, the DOI [Paleontological Resources Preservation Act final regulation](#) was published in the Federal Register and approved by the Office of Management and Budget. For more information regarding this act, visit [Laws, Regulations & Policies](#) at the NPS Fossils and Paleontology website.

The 2006 National Park Service Management Policies (section 4.8.2.1) state

*... Paleontological resources, including both organic and mineralized remains in body or trace form, will be protected, preserved, and managed for public education, interpretation, and scientific research. The Service will study and manage paleontological resources in their paleoecological context (that is, in terms of the geologic data associated with a particular fossil that provides information about the ancient environment).*

*Superintendents will establish programs to inventory paleontological resources and systematically monitor for newly exposed fossils, especially in areas of rapid erosion. Scientifically significant resources will be protected by collection or by on-site protection and stabilization. The Service will encourage and help the academic community to conduct paleontological field research in accordance with the terms of a scientific research and collecting permit. Fossil localities and associated geologic data will be adequately documented when specimens are collected. Paleontological resources found in an archeological context are also subject to the policies for archeological resources.*

*Paleontological specimens that are to be retained permanently are subject to the policies for museum objects.*

*The Service will take appropriate action to prevent damage to and unauthorized collection of fossils. To protect paleontological resources from harm, theft, or destruction, the Service will ensure, where necessary, that information about the nature and specific location of these resources remains confidential, in accordance with the National Parks Omnibus Management Act of 1998.*

*All NPS construction projects in areas with potential paleontological resources must be preceded by a preconstruction surface assessment prior to disturbance. For any occurrences noted, or when the site may yield paleontological resources, the site will be avoided or the resources will, if necessary, be collected and properly cared for before construction begins. Areas with potential paleontological resources must also be monitored during construction projects.*

Fossils have scientific, aesthetic, cultural, educational, and tourism value, and impacts to any of these values impair their usefulness. Effective paleontological resource management protects fossil resources by implementing strategies that mitigate, reduce, or eliminate loss of fossilized materials and their relevant data. Because fossils are representatives of adaptation, evolution, and diversity of life through deep time, they have intrinsic scientific values beyond just the physical objects themselves. Their geological and geospatial contexts provide additional critical data concerning paleoenvironmental, paleogeographic, paleoecologic, and a number of other conditions that together allow for a more complete interpretation of the physical and biological history of the Earth. Therefore, paleontological resource management must act to protect not only the fossils themselves, but to collect and maintain other contextual data as well.

In general, losses of paleontological resources result from naturally occurring physical processes, by direct or indirect human activities, or by a combination of both. These processes or activities influence the stability and condition of in situ paleontological resources (Santucci and Koch 2003; Santucci et al. 2009). The greatest loss of associated contextual data occurs when fossils are removed from their original geological context without appropriate documentation. Thus, when a fossil weathers and erodes from its surrounding sediments and geologic context, it begins to lose significant ancillary data until, at some point, it becomes more a scientific curiosity than a useful piece of scientific data. A piece of loose fossil “float” can still be of scientific value. However, when a fossil has been completely removed from its original context, such as an unlabeled personal souvenir or a specimen with no provenance information in a collection, it is of very limited scientific utility. Similarly, inadvertent exhumation of fossils during roadway construction or a building excavation may result in the loss or impairment of the scientific and educational values associated with those fossils. It is not necessary to list here all of the natural and anthropogenic factors that can lead to the loss of paleontological resources; rather it is sufficient to acknowledge that anything that disturbs native sediment or original bedrock has the potential to result in the loss of the paleontological resources that occur there, or the loss of associated paleontological resource data.



Cave localities are in a distinct class for management due to the close connection with archeological resources and unique issues affecting cave resources. See Santucci et al. (2001) for additional discussion of paleontological resources in cave settings.

Management strategies to address any of these conditions and factors could also incorporate the assistance of qualified specialists to collect and document resources rather than relying solely on staff to accomplish such a large task at SCBL. Active recruitment of paleontological research scientists should also be used as a management strategy.

### **Baseline Paleontology Resource Data Inventories**

A baseline inventory of paleontological resources is critical for implementing effective management strategies, as it provides information for decision-making. This inventory report has compiled information on previous paleontological research done in and near SCBL, taxonomic groups that have been reported within SCBL boundaries, and localities that were previously reported. This report is intended to serve as a baseline source of information for future research, inventory reports, monitoring, and paleontological decisions. The Paleontological Resource Inventory and Monitoring report for the Northern Great Plains Network compiled by Tweet et al. (2011) and the references cited within were important baseline paleontological resource data sources for this SCBL-specific report.

### **Paleontological Resource Monitoring**

Paleontological resource monitoring is a significant part of paleontological resource management, and one that usually requires little to implement beyond time and equipment already on hand, such as cameras and GPS units. Monitoring enables the evaluation of the condition and stability of in situ paleontological resources (Santucci and Koch 2003; Santucci et al. 2009). A monitoring program revolves around periodic site visits to assess conditions compared to a baseline for that site, with the periodicity depending on factors such as site productivity, accessibility, and significance of management issues. For example, a highly productive site which is strongly affected by erosion or unauthorized collection, and which can be easily visited by park staff, would be scheduled for more frequent visits than a less productive or less threatened site.

A monitoring program is generally implemented after an inventory has been prepared for a park and sites of concern have been identified, with additional sites added as necessary. Because each park is different, with different geology and paleontology among other factors, ideally each park which has in situ fossils or significant accumulations of reworked fossils would have its own monitoring protocol to define its monitoring program. Data accumulated via monitoring is used to inform further management decisions, such as the following questions: Is the site suitable for interpretation and education? Does the site require stabilization from the elements? Is collection warranted? Is there a need for some form of law enforcement presence?

Collection is recommended to be reserved for fossils possessing exceptional value (e.g., rare or high scientific significance) or at immediate risk of major degradation or destruction by human activity and natural processes. Therefore, paleontological resource monitoring is a more feasible potential

management tool. The first step in the establishment of a monitoring program is identification of localities to be monitored, as discussed previously. Locality condition forms are then used to evaluate factors that could cause loss of paleontological resources, with various conditions at each locality rated as good, fair, or poor. Risks and conditions are categorized as Disturbance, Fragility, Abundance, and Site Access. “Disturbance” evaluates conditions that promote accelerated erosion or mass wasting resulting from human activities. “Fragility” evaluates natural conditions that may influence the degree to which fossil transportation is occurring. Sites with elevated fragility exhibit inherently soft, rapidly eroding sediment or mass wasting on steep hillsides. A bedrock outcrop that is strongly lithified has low fragility. “Abundance” judges both the natural condition and number of specimens preserved at the locality as well as the probability of being recognized as a fossil-rich area by non-paleontologists, which could lead to unpermitted collecting. “Site Access” assesses the risk of a locality being visited by large numbers of visitors or the potential for easy removal of large quantities of fossils or fossil-bearing sediments. A locality with high access would be in close proximity to public use areas or other access (along trails, at roadcuts, at beach or river access points, and so on).

Each of the factors noted above may be mitigated by management actions. Localities exhibiting a significant degree of disturbance may require either active intervention to slow accelerated erosion, periodic collection and documentation of fossil materials, or both. Localities developed on sediments of high fragility naturally erode at a relatively rapid rate and would require frequent visits to document and/or collect exposed fossils in order to prevent or reduce losses. Localities with abundant or rare fossils, or high rates of erosion, may be considered for periodic monitoring in order to assess the stability and condition of the locality and resources, in regard to both natural processes and human-related activities. Localities that are easily accessible by road or trail would benefit from the same management strategies as those with abundant fossils and by occasional visits by park staff, documentation of in situ specimens, and/or frequent law enforcement patrols. Further information on paleontological resource monitoring can be found in Santucci and Koch (2003) and Santucci et al. (2009).

The 2018 Natural Resource Condition Assessment for SCBL examines paleontological resources (alongside other natural resources) at the monument and highlights the high risk and significant concern posed by: (1) weathering and erosion; and (2) fossil poaching and vandalism (Dibner et al. 2018). With high rates of erosion and documented cases of fossil poaching at SCBL, these management issues remain of significant concern for the fossil resources of the monument.

### **Foundation Documents and Resource Stewardship Strategies**

Foundation documents and Resource Stewardship Strategies are two types of park planning documents that may contain and reference paleontological resource information. A foundation document is intended to provide basic guidance about a park for planning and management. It briefly describes a given park and its purpose, significance, fundamental resources and values, other important resources and values, and interpretive themes. Mandates and commitments are also identified, and the state of planning is assessed. Foundation documents may include paleontological information and are also useful as a preliminary assessment of what a park’s staff know about their

paleontological resources, the importance they place on these resources, and the present state of these non-renewable resources. A foundation document for SCBL has been published (NPS 2015). This foundation document discusses paleontological resources at SCBL extensively. Four fundamental resources/values are identified for SCBL, one of which is Geology and Paleontology (the bluffs, the badlands, and their embedded fossils). The foundation document explores the current conditions and trends, threats and opportunities, existing data and plans, data/GIS needs, and planning needs related to this fundamental resource (NPS 2015). Paleontological resources are also briefly mentioned in the 1998 General Management Plan for SCBL, with the significance of these fossils being noted (NPS 1998).

A dedicated Fossil Management Plan was developed for SCBL in 2014, following recognition of the significance of the paleontological resources of the monument and with the intention to support proper management of said resources in accordance with the enabling legislation of SCBL. This document was produced through collaboration between a number of regional paleontologists, geologists, NPS staff, and local enthusiasts. Additional guidance on the management of paleontological resources (including conservation, collection, and curation) is contained in the plan and it serves as an important reference for paleontological resource management at SCBL (NPS 2014).

A Resource Stewardship Strategy (RSS) is a strategic plan intended to help park managers achieve and maintain desired resource conditions over time. It offers specific information on the current state of resources and planning, management priorities, and management goals over various time frames. An RSS for SCBL has not yet been published.

## **Geologic Maps**

A geologic map is the fundamental tool for depicting the geology of an area. Geologic maps are two-dimensional representations of the three-dimensional geometry of rock and sediment at or beneath the land surface (Evans 2016). Colors and symbols on geologic maps correspond to geologic map units. The unit symbols consist of an uppercase letter indicating the age and lowercase letters indicating the formation's name. The NPS Geologic Resources Inventory (GRI) has been digitizing existing maps of NPS units and making them available to parks for resource management.

Geologic maps are one of the foundational elements of a paleontological resource management program. Knowing which sedimentary rocks and deposits underlie a park and where they are exposed are essential for understanding the distribution of known or potential paleontological resources. The ideal scale for resource management in the 48 contiguous states is 1:24,000 (maps for areas in Alaska tend to be coarser). Whenever possible, page-sized geologic maps derived from GRI files are included in paleontological resource inventory reports for reference, but it is recommended that GRI source files be downloaded from IRMA for use. The source files can be explored in much greater detail and incorporated into the park GIS database. Links to the maps digitized by the GRI for SCBL can be found in IRMA, including a [regional map](#) and a more detailed, [monument-focused map](#). In addition to a digital GIS geologic map, the GRI program also produces a park-specific report discussing the geologic setting, distinctive geologic features and processes within the park,



highlighting geologic issues facing resource managers, and describing the geologic history leading to the present-day landscape of the park. The report for SCBL is Graham (2009).

### ***Paleontological Resource Maps***

Managing paleontological resources requires an understanding of their distribution, which may be depicted in multiple ways. In areas with a diversity of rock types, some of which are non-fossiliferous, a paleontological resource potential map is useful. This kind of map depicts the presence, potential presence, or absence of fossil resources at the level of geologic formations using a simple “stoplight” pattern (green = fossils present in park; yellow = fossils not yet known in park but present elsewhere; red = unfossiliferous). It gives a quick indication of areas where fossils may be discovered, which in turn can provide suggestions for areas to survey or monitor, or areas where the discovery of fossils may be of concern during work that disturbs the ground (roadwork, building construction, etc.). At SCBL, all of the formations that are exposed in the monument are fossiliferous, so a paleontological resource potential map would be solid green and therefore not useful beyond illustrating that it is a fossiliferous setting throughout. The Bureau of Land Management has developed a potential fossil yield classification (PFYC) system, which assigns classifications to formations based on the abundance and types of fossils (e.g., fossils of large vertebrates receive more weighting than marine invertebrates). Creating a map of this form for SCBL would potentially be more useful for management, but again there would likely be little differentiation of geologic units, in this case due to their paleontological similarity. In addition, terrestrial formations often have a patchy distribution of fossils due to the distribution of environments at the time of deposition, so assigning one classification is necessarily a blunt instrument in a relatively small area such as SCBL. Therefore, continued field inventory to develop a “heat map” of localities is recommended as the best way to establish the distribution of paleontological resources for management purposes.

## Paleontological Resource Management Recommendations

The paleontological resource inventory at SCBL has documented rich paleontological resources. This report captures the scope, significance, and distribution of fossils at SCBL and provides recommendations to support the management and protection of the monument's non-renewable paleontological resources.

- SCBL staff should be encouraged to observe exposed rocks and sedimentary deposits for fossil material while conducting their usual duties. To promote this, staff should receive guidance regarding how to recognize common local fossils. When opportunities arise to observe paleontological resources in the field and take part in paleontological field studies with trained paleontologists, staff should take advantage of them, if funding and time permit. Paleontological resource guides (particularly SCBL-specific) and virtual/in-person trainings can also assist in this.
- SCBL staff should photo-document and monitor any occurrences of paleontological resources that may be observed in situ. Fossils and their associated geologic context (surrounding rock) should be documented but left in place unless they are subject to imminent degradation. A Geologic Resource Monitoring Manual published by the Geological Society of America and NPS Geologic Resources Division (GRD) includes a chapter on paleontological resource monitoring (Santucci et al. 2009). Santucci and Koch (2003) also present information on paleontological resource monitoring.
- Fossil theft is one of the greatest threats to the preservation of paleontological resources and any methods to minimize these activities should be utilized by staff. Any occurrence of paleontological resource theft or vandalism should be investigated by a law enforcement ranger. When possible, incidents should be fully documented, and the information submitted for inclusion in the annual law enforcement statistics.
- Fossils found in a cultural context should be documented like other fossils but will also require the input of an archeologist or a cultural resource specialist. Any fossil which has a cultural context may be culturally sensitive as well (e.g., subject to NAGPRA) and should be regarded as such until otherwise established. The Geologic Resources Division can coordinate additional documentation/research of such material.
- SCBL may fund and recruit paleontology interns as a cost-effective means of enabling some level of paleontological resource support. The Scientists in Parks Program is an established program for recruitment of geology and paleontology interns. Regional partnerships (e.g., BADL, AGFO, University of Nebraska–Lincoln, South Dakota School of Mines and Technology) may also be utilized to support paleontological resource management at SCBL. Trained volunteers are an additional option to assist with the stewardship and monitoring of paleontological localities.
- Many areas in SCBL are susceptible to mass wasting, which can damage paleontological resources contained in the displaced material or in the area impacted by the displaced material. Remediation of mass wasting events should take paleontological resources into

account, especially in areas with known concentrations. Consultation with staff at other areas with similar issues, such as BADL and Colorado National Monument, may be helpful for establishing best practices.

- Contact the NPS Paleontology Program for technical assistance with paleontological resource management issues.

If fossil specimens are found by SCBL staff, it is recommended they follow the steps outlined below to ensure proper paleontological resource management.

- Photo-document the specimen without moving it from its location, if it is loose. Include a common item, such as a coin, pen, or pencil for scale if a ruler or scale bar is not available.
- If a GPS unit is available, record the location of the specimen. If GPS is not available, record the general location within SCBL and height within the outcrop, if applicable. If possible, revisit the site when a GPS unit is available. Most smartphones also have the ability to record coordinates; if no GPS unit is available, attempt to record the coordinates with a phone.
- Write down associated data, such as rock type, general description of the fossil, type of fossil if identifiable, general location in SCBL, sketch of the fossil, position within the outcrop or if it is loose on the ground, any associated fossils, and any other additional information.
- Do not remove the fossil unless it is loose in an area of heavy traffic, such as a public trail, and is at risk of being taken or destroyed. If the specimen is fragile, determine whether consolidants are needed to prevent damage and if removing the fossil will cause unnecessary damage. If the fossil is removed, be sure to wrap in soft material, such as tissue paper, and place in a labeled plastic bag with associated notes.



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## Appendix A: Paleontological Species

The data in the following tables document fossil taxa that are recorded or potentially recorded at SCBL in a stratigraphic context. Rows are organized systematically, placing taxa of the same broad groups together. Columns are organized by stratigraphic unit, presented in ascending order (oldest to youngest) left to right. If a taxon is present in a given stratigraphic unit at a locality that can be placed within SCBL, that cell is marked “Y”; if there is some question about the stratigraphic position or whether the locality is within SCBL, the cell is marked “?”. A null record is marked “–”.

Many of the taxonomic identifications are provisional and subject to change, pending in-depth assessment of relevant material(s). This publication is not intended to settle taxonomic usage. “[Taxon] indet.” refers to fossils that are taxonomically indeterminate at a high level at the present time; e.g., a mammalian mandible fragment lacking precise diagnostic features may be classified as “Artiodactyla indet.” The abbreviation “sp.” means “species” and indicates that a fossil has not received a specific classification at present. The abbreviation “cf.” comes from the Latin *confer* and, when placed before a taxonomic name, means the fossil is comparable to that taxon but the identification is tentative.

Stratigraphic units are abbreviated in Tables 2–5 for the sake of space and are as follows, in descending order (youngest to oldest):

- Tma = undivided middle Arikaree Group
- Tg = Gering Formation
- Tbrw = Brule Formation, Whitney Member
- Tbro = Brule Formation, Orella Member

**Table 2.** Fossil plant and invertebrate taxa (body and trace fossils) from SCBL in stratigraphic context.

| Clade          | Taxon                      | Fossil Material   | Tbro | Tbrw | Tg | Tma |
|----------------|----------------------------|-------------------|------|------|----|-----|
| Plantae        | Plantae indet.             | rhizoliths        | Y    | ?    | Y  | Y   |
| “Invertebrata” | “Invertebrata” indet.      | traces            | ?    | Y    | Y  | Y   |
|                | <i>Ancorichnus coronus</i> | feeding traces    | –    | –    | –  | Y   |
|                | cf. <i>Pallichnus</i>      | dung beetle balls | Y    | –    | –  | –   |
|                | Helminthoglyptidae indet.  | snail shells      | –    | Y    | –  | –   |



**Table 3.** Non-mammalian fossil taxa from SCBL in stratigraphic context.

| Class    | Order          | Family          | Taxon                             | Tbro | Tbrw | ? |
|----------|----------------|-----------------|-----------------------------------|------|------|---|
| –        | –              | –               | Vertebrata indet.                 | Y    | Y    | – |
| Reptilia | Testudines     | ?Testudinidae   | cf. Testudinidae                  | Y    | Y    | – |
| Aves     | –              | –               | Aves indet.                       | Y    | ?    | – |
|          | ?Galliformes   | –               | <i>Archaeaelectornis sibleyi</i>  | ?    | ?    | – |
|          | ?Galliformes   | –               | <i>Archaeophasianus mioceanus</i> | –    | –    | Y |
|          | ?Cariamiformes | ?Bathornithidae | cf. Bathornithidae                | Y    | –    | – |

**Table 4.** Fossil mammalian taxa from SCBL in stratigraphic context.

| Order        | Family            | Taxon                                  | Tbro | Tbrw | Tg | Tma | ? |
|--------------|-------------------|----------------------------------------|------|------|----|-----|---|
| –            | Herpetotheriidae  | <i>Herpetotherium</i> cf. <i>fugax</i> | –    | Y    | –  | –   | – |
| Leptictida   | Leptictidae       | <i>Leptictis</i> sp.                   | Y    | –    | –  | –   | – |
|              | Leptictidae       | cf. <i>Leptictis</i>                   | –    | Y    | –  | –   | – |
| Lagomorpha   | –                 | <i>Palaeolagus haydeni</i>             | Y    | –    | –  | –   | – |
|              | –                 | cf. <i>Palaeolagus</i>                 | –    | Y    | –  | –   | – |
| Rodentia     | Aplodontidae      | <i>Alwoodia</i> sp.                    | –    | –    | –  | Y   | – |
|              | Cricetidae        | cf. <i>Eumys elegans</i>               | Y    | –    | –  | –   | – |
|              | Cricetidae        | <i>Eumys brachyodus</i>                | –    | Y    | –  | –   | – |
|              | Ischyromyidae     | Ischyromyidae indet.                   | Y    | –    | –  | –   | – |
|              | Mylagaulidae      | <i>Promylagaulus</i> sp.               | –    | –    | –  | Y   | – |
| Hyaenodonta  | Hyaenodontidae    | <i>Hyaenodon horridus</i>              | Y    | –    | –  | –   | – |
| Carnivora    | Nimravidae        | Nimravidae indet.                      | Y    | –    | –  | –   | – |
|              | Nimravidae        | <i>Dinictis</i> sp.                    | Y    | –    | –  | –   | – |
|              | Subparictidae     | <i>Parictis</i> sp.                    | Y    | –    | –  | –   | – |
|              | Canidae           | <i>Hesperocyon gregarius</i>           | Y    | –    | –  | –   | – |
|              | Canidae           | <i>Phlaocyon annectens</i>             | –    | –    | –  | –   | Y |
| Artiodactyla | –                 | Artiodactyla indet.                    | –    | –    | Y  | –   | – |
|              | Camelidae         | <i>Poebrotherium</i> sp.               | Y    | –    | –  | –   | – |
|              | Merycoidodontidae | <i>Merycoidodon bullatus</i>           | Y    | –    | –  | –   | – |
|              | Merycoidodontidae | <i>Merycoidodon culbertsoni</i>        | Y    | –    | –  | –   | – |
|              | Merycoidodontidae | <i>Miniochoerus affinis</i>            | Y    | –    | –  | –   | – |
|              | Merycoidodontidae | <i>Miniochoerus gracilis</i>           | Y    | –    | –  | –   | – |
|              | Merycoidodontidae | cf. <i>Miniochoerus</i>                | –    | Y    | –  | –   | – |
|              | Merycoidodontidae | <i>Leptauchenia decora</i>             | –    | Y    | –  | –   | – |
|              | Merycoidodontidae | <i>Leptauchenia major</i>              | –    | Y    | –  | –   | – |

**Table 4 (continued).** Fossil mammalian taxa from SCBL in stratigraphic context.

| Order                   | Family            | Taxon                            | Tbro | Tbrw | Tg | Tma | ? |
|-------------------------|-------------------|----------------------------------|------|------|----|-----|---|
| Artiodactyla<br>(cont.) | Merycoidodontidae | <i>Sespia nitida</i>             | –    | Y    | –  | –   | – |
|                         | Merycoidodontidae | <i>Sespia ultima</i>             | –    | –    | Y  | –   | – |
|                         | Merycoidodontidae | <i>Sespia</i> sp.                | –    | –    | –  | Y   | – |
|                         | Protoceratidae    | <i>Pseudoprotoceras</i> sp.      | Y    | –    | –  | –   | – |
|                         | Entelodontidae    | <i>Archaeotherium mortoni</i>    | Y    | –    | –  | –   | – |
|                         | ?Entelodontidae   | cf. Entelodontidae (tracks)      | –    | –    | Y  | –   | – |
|                         | Leptomerycidae    | <i>Leptomeryx evansi</i>         | Y    | –    | –  | –   | – |
|                         | Leptomerycidae    | cf. <i>Santuccimeryx</i>         | Y    | –    | –  | –   | – |
|                         | Hypertragulidae   | <i>Hypisodus ironsi</i>          | –    | Y    | –  | –   | – |
|                         | Hypertragulidae   | <i>Nanotragulus</i> sp.          | –    | –    | –  | Y   | – |
| Perissodactyla          | Equidae           | Equidae indet.                   | –    | Y    | –  | –   | – |
|                         | Equidae           | <i>Miohippus bairdi</i>          | Y    | –    | –  | –   | – |
|                         | Hyracodontidae    | <i>Hyracodon nebraskensis</i>    | Y    | –    | –  | –   | – |
|                         | Hyracodontidae    | <i>Hyracodon</i> sp.             | –    | Y    | –  | –   | – |
|                         | ?Amynodontidae    | ?Amynodontidae                   | Y    | –    | –  | –   | – |
|                         | Rhinocerotidae    | <i>Diceratherium tridactylum</i> | –    | –    | –  | –   | Y |
|                         | Rhinocerotidae    | <i>Subhyracodon occidentalis</i> | Y    | –    | –  | –   | – |

**Table 5.** Fossil vertebrate taxa that have potentially been recovered from SCBL in stratigraphic context. Note that imprecise locality data precludes confident assignment of representative fossils to SCBL and thus these taxa are not considered in discussion elsewhere in this report.

| Class    | Order        | Family            | Taxon                            | Geologic Unit(s) |
|----------|--------------|-------------------|----------------------------------|------------------|
| Reptilia | Squamata     | Anguidae          | <i>Peltosaurus granulatus</i>    | Brule Fm.        |
| Mammalia | –            | Ischyromyidae     | <i>Ischyromys typus</i>          | ?                |
|          | Hyaenodonta  | Hyaenodontidae    | <i>Hyaenodon cruentus</i>        | Brule Fm.        |
|          | Carnivora    | Palaeogalidae     | <i>Palaeogale lagophagus</i>     | Brule Fm.        |
|          | Carnivora    | Nimravidae        | <i>Hoplophoneus occidentalis</i> | ?                |
|          | Carnivora    | Nimravidae        | <i>Hoplophoneus primaevus</i>    | ?                |
|          | Carnivora    | Amphicyonidae     | <i>Daphoenus</i> sp.             | Brule Fm.        |
|          | Carnivora    | Canidae           | <i>Mesocyon</i> sp.              | Brule Fm.        |
|          | Carnivora    | Canidae           | <i>Aelurodon</i> sp.             | Arikaree Gp.     |
|          | Artiodactyla | Camelidae         | Camelidae indet.                 | Gering Fm.       |
|          | Artiodactyla | Camelidae         | <i>Poebrotherium eximium</i>     | ?                |
|          | Artiodactyla | Camelidae         | <i>Poebrotherium wilsoni</i>     | ?                |
|          | Artiodactyla | Merycoidodontidae | <i>Brachycrus rusticus</i>       | Gering Fm.       |

**Table 5 (continued).** Fossil vertebrate taxa that have potentially been recovered from SCBL in stratigraphic context. Note that imprecise locality data precludes confident assignment of representative fossils to SCBL and thus these taxa are not considered in discussion elsewhere in this report.

| Class               | Order          | Family            | Taxon                           | Geologic Unit(s) |
|---------------------|----------------|-------------------|---------------------------------|------------------|
| Mammalia<br>(cont.) | Artiodactyla   | Merycoidodontidae | <i>Merychys</i> sp.             | ?                |
|                     | Artiodactyla   | Merycoidodontidae | <i>Merycochoerus magnus</i>     | Brule Fm.        |
|                     | Artiodactyla   | Merycoidodontidae | <i>Mesoreodon chelonyx</i>      | ?                |
|                     | Artiodactyla   | Merycoidodontidae | <i>Miniochoerus gracilis</i>    | Arikaree Gp.     |
|                     | Artiodactyla   | Merycoidodontidae | cf. <i>Promerycochoerus</i>     | ?                |
|                     | Artiodactyla   | Merycoidodontidae | <i>Ticholeptus</i>              | ?                |
|                     | Artiodactyla   | Tayassuidae       | <i>Perchoerus</i> sp.           | ?                |
|                     | Artiodactyla   | Hypertragulidae   | <i>Hypertragulus calcaratus</i> | ?                |
|                     | Artiodactyla   | Hypertragulidae   | <i>Hypertragulus sequens</i>    | Brule Fm.        |
|                     | Artiodactyla   | Hypertragulidae   | <i>Hypisodus alacer</i>         | ?                |
|                     | Artiodactyla   | Hypertragulidae   | <i>Hypisodus minimus</i>        | ?                |
|                     | Perissodactyla | Equidae           | <i>Miohippus</i> sp.            | Brule Fm.        |
|                     | Perissodactyla | Hyracodontidae    | <i>Hyracodon leidymanus</i>     | Brule Fm.        |
|                     | Perissodactyla | Rhinocerotidae    | Rhinocerotidae indet.           | Gering Fm.       |

In addition to the vertebrate body fossils, vertebrate trace fossils have also been observed in SCBL but are not attributed to any taxa beyond the level of order. They include vertebrate burrows and coprolites in the Orella Member of the Brule Formation and artiodactyl tracks in the Gering Formation.

### Quaternary Taxa

At present, the only fossil taxa reliably identified from SCBL are Mammalia indet. and (very likely) *Mammuthus* cf. *columbi*. Additional examination of Quaternary sediments at the monument may expand this list.

## Appendix B: Museum Collections Data

The following tables, Tables 6 through 13, include information on the confirmed and potential SCBL fossil specimens housed in the collections at SCBL (Table 6), IMPF (Table 7), UNSM (Table 8), AMNH (Table 9), MCZ (Table 10), USNM (Table 11), YPM (Table 12), and those listed in MCMS as on loan for preparation (Table 13). Geologic units have been abbreviated for space (Fm. = Formation; Mbr. = Member). As mentioned previously in the report and in the relevant table captions below, many of the specimens housed in external repositories are included based on imprecise locality information (e.g., Scotts Bluff County) and thus, may not actually originate from within the boundaries of SCBL. Additionally, the taxonomic identifications are tentative, as the vast majority of specimens were not observed during this inventory so as to verify/refute the previous identifications. As such, these data are subject to change and should be considered with caution.

### Monument Collections

**Table 6.** SCBL paleontological specimens currently housed at the SCBL Visitor Center. Additional uncataloged fossil material of uncertain provenance also housed at SCBL is not listed here.

| Catalog #  | Taxa                                                                                                        | Element(s)                                | Geologic Unit             |
|------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------|
| SCBL 1582  | <i>Hyracodon</i>                                                                                            | Skull and mandible                        | –                         |
| SCBL 11596 | Gastropoda indet.                                                                                           | Two complete shells                       | Brule Fm. (?Whitney Mbr.) |
| N/A        | cf. Bathornithidae                                                                                          | Ulnare                                    | Brule Fm. (Orella Mbr.)   |
| N/A        | <i>Pseudoprotoceras</i> sp.                                                                                 | Partial skeleton                          | Brule Fm. (Orella Mbr.)   |
| N/A        | <i>Miniochoerus gracilis</i>                                                                                | Partial skull                             | Brule Fm. (Orella Mbr.)   |
| N/A        | <i>Eumys brachyodus</i> , cf. <i>Leptictis</i> , <i>Herpetotherium</i> cf. <i>fugax</i> , Vertebrata indet. | Microfossils (incl. mandibular fragments) | Brule Fm. (Whitney Mbr.)  |

### Collections in Other Repositories

**Table 7.** SCBL paleontological specimens currently housed at the Independence Multi-Park Facility (IMPF).

| Catalog # | Taxon                           | Element(s)                     | Geologic Unit             |
|-----------|---------------------------------|--------------------------------|---------------------------|
| SCBL 1055 | cf. Testudinidae                | Nearly complete shell          | Brule Fm. (?Whitney Mbr.) |
| SCBL 1080 | <i>Merycoidodon culbertsoni</i> | Skull and mandible             | ?                         |
| SCBL 1104 | cf. Testudinidae                | Complete shell                 | Brule Fm.                 |
| SCBL 1105 | cf. Testudinidae                | Shell                          | ?                         |
| SCBL 1491 | <i>Miohippus</i>                | Mandible fragments             | ?                         |
| SCBL 1518 | <i>Miniochoerus gracilis</i>    | Skull and mandible             | ?                         |
| SCBL 1530 | <i>Merycoidodon culbertsoni</i> | Mandible fragment              | ?                         |
| SCBL 1535 | cf. Equidae                     | Skull, scapulae, and limb bone | ?                         |



**Table 7 (continued).** SCBL paleontological specimens currently housed at the Independence Multi-Park Facility (IMPF).

| Catalog # | Taxon                            | Element(s)                                    | Geologic Unit           |
|-----------|----------------------------------|-----------------------------------------------|-------------------------|
| SCBL 1583 | <i>Hyracodon</i>                 | Mandible                                      | ?                       |
| SCBL 1587 | <i>Diceratherium tridactylum</i> | Skull and mandible                            | ?                       |
| SCBL 1593 | <i>Hyracodon</i>                 | Cranial/mandibular fragments                  | ?                       |
| SCBL 1594 | <i>Hyracodon</i>                 | Mandible fragment                             | ?                       |
| SCBL 1595 | <i>Miniochoerus gracilis</i>     | Skull fragment                                | ?                       |
| SCBL 1596 | <i>Miniochoerus gracilis</i>     | Assorted fragments (incl. cranial/mandibular) | ?                       |
| SCBL 1606 | <i>Poebrotherium</i>             | Assorted fragments (incl. mandibular)         | ?                       |
| SCBL 1610 | <i>Eumys elegans</i>             | Assorted fragments (incl. mandibular)         | ?                       |
| SCBL 1612 | <i>Palaeolagus</i>               | Skull and mandible                            | ?                       |
| SCBL 1618 | Gastropoda indet.                | Complete shell                                | ?                       |
| SCBL 1620 | <i>Miohippus</i>                 | Mandible fragments                            | ?                       |
| SCBL 1624 | Vertebrata indet.                | Coprolites                                    | ?                       |
| SCBL 1628 | <i>Leptauchenia</i>              | Cranial/mandibular fragments                  | ?                       |
| SCBL 1632 | <i>Ischyromys</i>                | Mandible fragments                            | ?                       |
| SCBL 1636 | <i>Hypisodus</i>                 | Cranial/mandibular fragments                  | ?                       |
| SCBL 1643 | <i>Palaeolagus</i>               | Assorted fragments (incl. cranial/mandibular) | ?                       |
| SCBL 1650 | <i>Merycoidodon culbertsoni</i>  | Assorted fragments (incl. cranial/mandibular) | ?                       |
| SCBL 1653 | <i>Merycoidodon culbertsoni</i>  | Skull and mandible                            | ?                       |
| SCBL 1654 | <i>Merycoidodon culbertsoni</i>  | Skull and mandible                            | ?                       |
| SCBL 1655 | <i>Merycoidodon</i>              | Skull and mandible                            | ?                       |
| SCBL 1710 | cf. Testudinidae                 | Shell                                         | ?                       |
| SCBL 1893 | cf. Testudinidae                 | Shell                                         | ?                       |
| SCBL 1907 | <i>Merycoidodon culbertsoni</i>  | Assorted fragments (incl. cranial)            | ?                       |
| SCBL 2105 | <i>Hesperocyon</i>               | Skull                                         | ?                       |
| SCBL 2475 | <i>Merycoidodon culbertsoni</i>  | Skull and mandible                            | ?                       |
| SCBL 2617 | Mammalia indet.                  | Mandible fragment                             | ?                       |
| SCBL 2863 | <i>Miniochoerus gracilis</i>     | Fragments                                     | ?                       |
| SCBL 2871 | Rodentia indet.                  | Partial skull                                 | Brule Fm. (Orella Mbr.) |
| SCBL 2874 | Mammalia indet.                  | Skull                                         | Brule Fm. (Orella Mbr.) |
| SCBL 2875 | Mammalia indet.                  | Limb fragment                                 | Brule Fm. (Orella Mbr.) |
| SCBL 2876 | <i>Leptictis</i>                 | Skull                                         | ?                       |
| SCBL 2877 | <i>Merycoidodon</i>              | Skull and associated bones                    | ?                       |

**Table 7 (continued).** SCBL paleontological specimens currently housed at the Independence Multi-Park Facility (IMPF).

| Catalog #  | Taxon                                     | Element(s)          | Geologic Unit           |
|------------|-------------------------------------------|---------------------|-------------------------|
| SCBL 4358  | Rodentia indet.                           | Fragments           | Brule Fm. (Orella Mbr.) |
| SCBL 4359  | <i>Miohippus</i> and <i>Poebrotherium</i> | Fragments           | Brule Fm. (Orella Mbr.) |
| SCBL 11416 | <i>Subhyracodon</i>                       | Mandible            | ?                       |
| SCBL 11419 | <i>Merycoidodon</i>                       | Skull and mandible  | ?                       |
| SCBL 11567 | cf. <i>Stylemys</i>                       | Partial shell       | ?                       |
| SCBL 11569 | <i>Merycoidodon</i>                       | –                   | ?                       |
| SCBL 11570 | cf. <i>Stylemys</i>                       | Shell               | ?                       |
| SCBL 11571 | cf. <i>Stylemys</i>                       | Fragmented plastron | ?                       |
| SCBL 11572 | <i>Leptomeryx</i>                         | Mandible            | ?                       |
| SCBL 11573 | <i>Hypertragulus</i>                      | Mandible            | ?                       |
| SCBL 11574 | <i>Poebrotherium</i>                      | Mandible and ulna   | ?                       |
| SCBL 11591 | ? <i>Poebrotherium</i>                    | Tooth fragment      | ?                       |
| SCBL 11592 | ? <i>Poebrotherium</i>                    | Limb fragment       | ?                       |
| SCBL 11593 | ? <i>Poebrotherium</i>                    | Mandible fragment   | ?                       |
| SCBL 11594 | ? <i>Poebrotherium</i>                    | Mandible fragment   | ?                       |
| SCBL 11595 | ? <i>Poebrotherium</i>                    | Skull fragment      | ?                       |

**Table 8.** SCBL paleontological specimens currently housed at the University of Nebraska State Museum (UNSM).

| Catalog #  | Taxon                          | Type?    | Element(s)                 | Geologic Unit           |
|------------|--------------------------------|----------|----------------------------|-------------------------|
| SCBL 11597 | cf. <i>Stylemys</i>            | –        | Jacketed fossil            | ?                       |
| UNSM 5774  | <i>Archaelectornis sibleyi</i> | HOLOTYPE | Humerus                    | Brule Fm.               |
| UNSM 17100 | <i>Ancorichnus coronus</i>     | PARATYPE | Invertebrate trace         | Arikaree Gp.            |
| UNSM 17101 | <i>Ancorichnus coronus</i>     | PARATYPE | Invertebrate trace         | Arikaree Gp.            |
| UNSM 17102 | <i>Ancorichnus coronus</i>     | HOLOTYPE | Invertebrate trace         | Arikaree Gp.            |
| UNSM 17103 | <i>Ancorichnus coronus</i>     | PARATYPE | Invertebrate trace         | Arikaree Gp.            |
| UNSM 25521 | <i>Dinictis</i> sp.            | –        | Skull                      | Brule Fm. (Orella Mbr.) |
| UNSM 28151 | <i>Miniochoerus affinis</i>    | –        | Partial skull and mandible | Brule Fm. (Orella Mbr.) |
| UNSM 28318 | <i>Miniochoerus affinis</i>    | –        | Partial skull and mandible | Brule Fm. (Orella Mbr.) |
| UNSM 28120 | <i>Miniochoerus affinis</i>    | –        | Partial skull              | Brule Fm. (Orella Mbr.) |
| UNSM 28157 | <i>Miniochoerus affinis</i>    | –        | Partial skull              | Brule Fm. (Orella Mbr.) |
| UNSM 28174 | <i>Miniochoerus affinis</i>    | –        | Partial skull              | Brule Fm. (Orella Mbr.) |
| UNSM 28041 | <i>Miniochoerus affinis</i>    | –        | Partial skull and mandible | Brule Fm. (Orella Mbr.) |

**Table 8 (continued).** SCBL paleontological specimens currently housed at the University of Nebraska State Museum (UNSM).

| Catalog #  | Taxon                        | Type? | Element(s)                 | Geologic Unit           |
|------------|------------------------------|-------|----------------------------|-------------------------|
| UNSM 28318 | <i>Miniochoerus gracilis</i> | –     | Partial skull              | Brule Fm. (Orella Mbr.) |
| UNSM 28514 | <i>Miniochoerus affinis</i>  | –     | Partial skull              | Brule Fm. (Orella Mbr.) |
| UNSM 28236 | <i>Miniochoerus affinis</i>  | –     | Partial skull and mandible | Brule Fm. (Orella Mbr.) |

**Table 9.** SCBL paleontological specimens currently housed at the American Museum of Natural History (AMNH).

| Catalog #        | Taxon                         | Type?    | Element(s)                 | Geologic Unit            |
|------------------|-------------------------------|----------|----------------------------|--------------------------|
| AMNH FM 26900    | Merycoidodontidae indet.      | –        | –                          | ?                        |
| AMNH FM 26901    | Merycoidodontidae indet.      | –        | –                          | ?                        |
| AMNH FM 26902    | <i>Hyracodon nebraskensis</i> | –        | Partial mandible           | ?                        |
| AMNH FM 63978    | <i>Hesperocyon gregarius</i>  | –        | –                          | Brule Fm. (Orella Mbr.)  |
| AMNH FM 75651    | <i>Hyaenodon horridus</i>     | –        | –                          | Brule Fm. (Orella Mbr.)  |
| AMNH FM 81507    | <i>Hypisodus ironsi</i>       | HOLOTYPE | –                          | Brule Fm. (Whitney Mbr.) |
| AMNH FM 81577    | <i>Parictis</i> sp.           | –        | –                          | Brule Fm. (Orella Mbr.)  |
| AMNH FM 81596    | <i>Leptictis</i> sp.          | –        | –                          | ?                        |
| AMNH FM 82410    | <i>Poebrotherium</i> sp.      | –        | –                          | ?                        |
| AMNH FM 85884    | <i>Hesperocyon gregarius</i>  | –        | –                          | ?                        |
| AMNH FM 85885    | <i>Hesperocyon gregarius</i>  | –        | –                          | ?                        |
| AMNH FM 88394    | <i>Phlaocyon annectens</i>    | –        | –                          | ?                        |
| AMNH F:AM 105726 | <i>Palaeolagus haydeni</i>    | –        | Partial skull and mandible | Brule Fm. (Orella Mbr.)  |
| AMNH F:AM 105727 | <i>Palaeolagus</i> sp.        | –        | Partial mandible           | ?                        |

**Table 10.** Paleontological specimens currently housed at the Museum of Comparative Zoology (MCZ) that may originate from SCBL. Note that many of these specimens are simply documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #     | Taxon                         | Element(s)          | Geologic Unit             | Collection History       |
|---------------|-------------------------------|---------------------|---------------------------|--------------------------|
| MCZ VPRA-1195 | <i>Peltosaurus granulosus</i> | Lower jaws          | Brule Fm. (?Whitney Mbr.) | 20 Mar 1934, R.V. Witter |
| MCZ VPRA-1196 | <i>Peltosaurus granulosus</i> | Upper jaws          | Brule Fm. (?Whitney Mbr.) | 28 Mar 1934, R.V. Witter |
| MCZ VPM-5009  | <i>Hypertragulus sequens</i>  | Mandible and molars | Brule Fm.                 | 31 Aug 1933, R.V. Witter |
| MCZ VPM-5010  | <i>Leptomeryx</i> sp.         | Mandible and molars | Brule Fm.                 | 31 Aug 1933, R.V. Witter |
| MCZ VPM-5011  | <i>Hypertragulus sequens</i>  | Mandible            | Brule Fm.                 | 09 Mar 1934, R.V. Witter |
| MCZ VPM-5012  | <i>Leptomeryx</i> sp.         | Mandible and molars | Brule Fm.                 | 09 Mar 1934, R.V. Witter |
| MCZ VPM-5013  | <i>Leptomeryx</i> sp.         | Maxilla? and teeth  | Brule Fm.                 | 11 Mar 1934, R.V. Witter |
| MCZ VPM-5017  | <i>Hypisodus</i> sp.          | Jaws                | Brule Fm.                 | 28 Mar 1934, R.V. Witter |
| MCZ VPM-5018  | <i>Hypisodus</i> sp.          | Maxilla? and teeth  | Brule Fm.                 | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5019  | <i>Hypisodus</i> sp.          | Molars              | Brule Fm.                 | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5022  | <i>Hypisodus</i> sp.          | Jaws                | Brule Fm.                 | 16 Oct 1934, R.V. Witter |
| MCZ VPM-5024  | <i>Poebrotherium</i> sp.      | Mandible            | Brule Fm.                 | 31 Aug 1933, R.V. Witter |
| MCZ VPM-5025  | <i>Poebrotherium</i> sp.      | Maxilla?            | Brule Fm.                 | 20 Mar 1934, ?           |
| MCZ VPM-5026  | <i>Poebrotherium</i> sp.      | Mandible and molars | Brule Fm.                 | 23 Jul 1933, R.V. Witter |
| MCZ VPM-5027  | <i>Miohippus</i> sp.          | Mandible and molars | Brule Fm.                 | 20 Mar 1934, R.V. Witter |
| MCZ VPM-5029  | <i>Mesocyon</i> sp.           | Mandibles           | Brule Fm.                 | 20 Mar 1934, R.V. Witter |
| MCZ VPM-5030  | <i>Mesocyon</i> sp.           | Mandible            | Brule Fm.                 | 14 Sep 1933, R.V. Witter |
| MCZ VPM-5038  | <i>Palaeogale lagophagus</i>  | Mandible            | Brule Fm.                 | 20 Mar 1934, R.V. Witter |
| MCZ VPM-5044  | <i>Peratherium</i> sp.        | Maxilla? and teeth  | Brule Fm.                 | 28 Mar 1934, R.V. Witter |
| MCZ VPM-5045  | <i>Peratherium</i> sp.        | Molars              | Brule Fm.                 | 20 Mar 1934, R.V. Witter |
| MCZ VPM-5055  | <i>Eumys brachyodus</i>       | Mandible            | Brule Fm.                 | 28 Mar 1934, R.V. Witter |
| MCZ VPM-5059  | <i>Eumys brachyodus</i>       | Mandible            | Brule Fm.                 | 11 Mar 1934, R.V. Witter |
| MCZ VPM-5061  | <i>Eumys brachyodus</i>       | Mandible            | Brule Fm.                 | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5062  | <i>Eumys brachyodus</i>       | Mandible            | Brule Fm.                 | 01 May 1934, R.V. Witter |



**Table 10 (continued).** Paleontological specimens currently housed at the Museum of Comparative Zoology (MCZ) that may originate from SCBL. Note that many of these specimens are simply documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #    | Taxon                        | Element(s)          | Geologic Unit | Collection History       |
|--------------|------------------------------|---------------------|---------------|--------------------------|
| MCZ VPM-5066 | ?                            | Mandible            | Brule Fm.     | 16 Feb 1934, R.V. Witter |
| MCZ VPM-5095 | <i>Perchoerus</i> sp.        | Teeth               | ?             | 20 Mar 1934, R.V. Witter |
| MCZ VPM-5101 | <i>Merycoidodon bullatus</i> | Partial skull       | Brule Fm.     | 11 Mar 1934, R.V. Witter |
| MCZ VPM-5102 | <i>Merycoidodon bullatus</i> | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5103 | <i>Merycoidodon bullatus</i> | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5104 | <i>Merycoidodon bullatus</i> | Mandible            | Brule Fm.     | 21 Sep 1933, R.V. Witter |
| MCZ VPM-5105 | <i>Merycoidodon bullatus</i> | Maxilla?            | Brule Fm.     | 13 Sep 1933, R.V. Witter |
| MCZ VPM-5106 | <i>Merycoidodon bullatus</i> | Maxilla?            | Brule Fm.     | 08 Aug 1934, R.V. Witter |
| MCZ VPM-5107 | <i>Merycoidodon bullatus</i> | Skull               | Brule Fm.     | 09 Mar 1934, R.V. Witter |
| MCZ VPM-5176 | <i>Palaeolagus</i> sp.       | Jaws                | Brule Fm.     | 1934, R.V. Witter        |
| MCZ VPM-5208 | <i>Leptauchenia decora</i>   | Mandibles and teeth | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5209 | <i>Leptauchenia</i> sp.      | Mandible fragment   | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5210 | <i>Leptauchenia</i> sp.      | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5211 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5212 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5213 | <i>Leptauchenia</i> sp.      | Maxilla fragment?   | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5214 | <i>Leptauchenia</i> sp.      | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5215 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5216 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5217 | <i>Leptauchenia</i> sp.      | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5218 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5219 | <i>Leptauchenia</i> sp.      | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5220 | <i>Leptauchenia</i> sp.      | Mandible            | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-5221 | <i>Leptauchenia</i> sp.      | Maxilla?            | Brule Fm.     | 08 Apr 1934, R.V. Witter |

**Table 10 (continued).** Paleontological specimens currently housed at the Museum of Comparative Zoology (MCZ) that may originate from SCBL. Note that many of these specimens are simply documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #    | Taxon                        | Element(s)                | Geologic Unit | Collection History                    |
|--------------|------------------------------|---------------------------|---------------|---------------------------------------|
| MCZ VPM-5222 | <i>Leptauchenia</i> sp.      | Maxilla?                  | Brule Fm.     | 08 Apr 1934, R.V. Witter              |
| MCZ VPM-5223 | <i>Leptauchenia</i> sp.      | Mandible                  | Brule Fm.     | 28 Mar 1934, R.V. Witter              |
| MCZ VPM-5224 | <i>Leptauchenia</i> sp.      | Skull                     | Brule Fm.     | 16 Aug 1934, R.V. Witter              |
| MCZ VPM-5225 | <i>Leptauchenia</i> sp.      | Skull                     | Brule Fm.     | 08 Apr 1934, R.V. Witter              |
| MCZ VPM-5226 | <i>Leptauchenia decora</i>   | Maxilla?                  | Brule Fm.     | 08 Apr 1934, R.V. Witter              |
| MCZ VPM-5227 | <i>Leptauchenia decora</i>   | Mandible                  | Brule Fm.     | 28 Mar 1934, R.V. Witter              |
| MCZ VPM-5228 | <i>Leptauchenia</i> sp.      | Mandible                  | Brule Fm.     | 08 Apr 1934, R.V. Witter              |
| MCZ VPM-5229 | <i>Leptauchenia</i> sp.      | Skull                     | Brule Fm.     | 21 Jul 1933, R.V. Witter              |
| MCZ VPM-5230 | <i>Leptauchenia</i> sp.      | Braincase and mandibles   | Brule Fm.     | 21 Jul 1933, R.V. Witter              |
| MCZ VPM-5231 | <i>Leptauchenia</i> sp.      | Mandible                  | Brule Fm.     | 11 Mar 1934, R.V. Witter              |
| MCZ VPM-5232 | <i>Leptauchenia</i> sp.      | Maxilla?                  | Brule Fm.     | 29 Jul 1933, R.V. Witter              |
| MCZ VPM-5233 | <i>Leptauchenia</i> sp.      | Maxilla?                  | Brule Fm.     | 20 Mar 1934, R.V. Witter              |
| MCZ VPM-5234 | <i>Leptauchenia</i> sp.      | Mandible                  | Brule Fm.     | 16 Feb 1934, R.V. Witter              |
| MCZ VPM-5255 | <i>Hyracodon leidyanus</i>   | Maxilla?                  | Brule Fm.     | 28 Mar 1934, R.V. Witter              |
| MCZ VPM-5256 | <i>Hyracodon leidyanus</i>   | Teeth                     | Brule Fm.     | 14 Sep 1933, R.V. Witter              |
| MCZ VPM-5257 | <i>Hyracodon leidyanus</i>   | Lower jaw                 | Brule Fm.     | 11 Mar 1934, R.V. Witter              |
| MCZ VPM-5258 | <i>Hyracodon leidyanus</i>   | Lower jaws                | Brule Fm.     | 11 Mar 1934, R.V. Witter              |
| MCZ VPM-5269 | <i>Daphoenus</i> sp.         | Partial skeleton          | Brule Fm.     | 31 Aug 1933, R.V. Witter and K. Buell |
| MCZ VPM-5270 | <i>Miohippus</i> sp.         | Braincase and upper teeth | Brule Fm.     | 02 Mar 1934, R.V. Witter              |
| MCZ VPM-5276 | <i>Leptauchenia decora</i>   | Skull                     | Brule Fm.     | 11 Mar 1934, R.V. Witter              |
| MCZ VPM-5283 | <i>Merycoidodon bullatus</i> | Mandible                  | Brule Fm.     | 11 Mar 1934, ?                        |
| MCZ VPM-5284 | <i>Merycoidodon bullatus</i> | Skeleton                  | Brule Fm.     | 11 Mar 1934, ?                        |
| MCZ VPM-5285 | <i>Merycoidodon bullatus</i> | Skeleton                  | Brule Fm.     | 08 Apr 1934, ?                        |
| MCZ VPM-5286 | <i>Merycoidodon bullatus</i> | Skeleton                  | Brule Fm.     | 08 Apr 1934, ?                        |

**Table 10 (continued).** Paleontological specimens currently housed at the Museum of Comparative Zoology (MCZ) that may originate from SCBL. Note that many of these specimens are simply documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #     | Taxon                               | Element(s)         | Geologic Unit | Collection History       |
|---------------|-------------------------------------|--------------------|---------------|--------------------------|
| MCZ VPM-5287  | <i>Merycoidodon bullatus</i>        | Skeleton           | Brule Fm.     | 13 Sep 1933, ?           |
| MCZ VPM-5288  | <i>Merycoidodon bullatus</i>        | Skeleton           | Brule Fm.     | 09 Mar 1934, ?           |
| MCZ VPM-5289  | <i>Merycoidodon bullatus</i>        | Skull and mandible | Brule Fm.     | ?                        |
| MCZ VPM-5290  | <i>Merycoidodon bullatus</i>        | Skeleton           | Brule Fm.     | ?                        |
| MCZ VPM-5292  | <i>Merycoidodon bullatus</i>        | Lower jaw          | Brule Fm.     | 29 Apr 1934, R.V. Witter |
| MCZ VPM-5293  | <i>Leptauchenia decora</i>          | Lower jaw          | Brule Fm.     | 14 Sep 1933, R.V. Witter |
| MCZ VPM-5297  | cf. <i>Promerycochoerus</i>         | Lower jaw          | ?             | 1933, R.V. Witter        |
| MCZ VPM-5298  | <i>Merycochoerus magnus</i>         | Skull              | Brule Fm.     | 08 Apr 1934, R.V. Witter |
| MCZ VPM-7170  | <i>Merycoidodon culbertsoni</i>     | Upper incisors     | ?             | 08 Sep 1882, S.W. Garman |
| MCZ VPM-7172  | <i>Miohippus bairdi</i>             | Lower jaw          | ?             | 08 Sep 1882, S.W. Garman |
| MCZ VPM-7173  | <i>Miohippus bairdi</i>             | Lower jaw          | ?             | 08 Sep 1882, S.W. Garman |
| MCZ VPM-7174  | <i>Miohippus bairdi</i>             | Lower jaw          | ?             | 08 Sep 1882, S.W. Garman |
| MCZ VPM-7178  | <i>Miniochoerus gracilis</i>        | Astragalus         | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7179  | <i>Miniochoerus gracilis</i>        | ?                  | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7180  | <i>Subhyracodon occidentalis</i>    | Tooth              | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7181  | <i>Miohippus bairdi</i>             | Lower jaw          | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7182  | <i>Leptomeryx evansi</i>            | Lower jaw          | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7183  | <i>Hyracodon nebraskensis</i>       | Skull              | ?             | 14 Sep 1882, S.W. Garman |
| MCZ VPM-7232  | <i>Archaeotherium mortoni</i>       | Skull              | ?             | Sep 1882, S.W. Garman    |
| MCZ VPM-10927 | <i>Mammuthus</i> cf. <i>columbi</i> | Calcaneum          | ?             | ?                        |
| MCZ VPM-10929 | <i>Mammuthus</i>                    | Foot bone          | ?             | ?                        |
| MCZ VPM-15993 | <i>Miohippus bairdi</i>             | Teeth, tibia end   | ?             | S.W. Garman              |
| MCZ VPM-15994 | <i>Miohippus bairdi</i>             | Teeth              | ?             | S.W. Garman              |
| MCZ VPM-15995 | <i>Miohippus bairdi</i>             | Lower molars       | ?             | S.W. Garman              |

**Table 10 (continued).** Paleontological specimens currently housed at the Museum of Comparative Zoology (MCZ) that may originate from SCBL. Note that many of these specimens are simply documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #     | Taxon                        | Element(s)         | Geologic Unit | Collection History |
|---------------|------------------------------|--------------------|---------------|--------------------|
| MCZ VPM-15996 | <i>Miohippus bairdi</i>      | Lower premolar     | ?             | S.W. Garman        |
| MCZ VPM-15998 | <i>Miohippus bairdi</i>      | Astragalus         | ?             | S.W. Garman        |
| MCZ VPM-16105 | <i>Miniochoerus gracilis</i> | Maxilla            | ?             | 1882, S.W. Garman  |
| MCZ VPM-16106 | <i>Miniochoerus gracilis</i> | Maxillary fragment | ?             | 1882, S.W. Garman  |
| MCZ VPM-16107 | <i>Miniochoerus gracilis</i> | Jaw fragment       | ?             | 1882, S.W. Garman  |
| MCZ VPM-16108 | <i>Miniochoerus gracilis</i> | Jaw fragment       | ?             | 1882, S.W. Garman  |
| MCZ VPM-16109 | <i>Miniochoerus gracilis</i> | Jaw fragment       | ?             | 1882, S.W. Garman  |

**Table 11.** Paleontological specimens currently housed at the National Museum of Natural History (USNM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #   | Taxon                           | Element(s)                   | Geologic Unit | Collection History |
|-------------|---------------------------------|------------------------------|---------------|--------------------|
| USNM V 2454 | <i>Hypisodus minimus</i>        | Skull                        | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2455 | <i>Miniochoerus gracilis</i>    | Skeleton                     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2456 | <i>Merycoidodon culbertsoni</i> | Maxilla and partial mandible | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2457 | <i>Merycoidodon</i> sp.         | Partial maxilla              | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2459 | <i>Merycoidodon</i> sp.         | Partial humerus              | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2460 | <i>Merycoidodon</i> sp.         | ?                            | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2469 | <i>Merycoidodon gracilis</i>    | Skull and mandible           | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2470 | <i>Merycoidodon gracilis</i>    | Skull (juvenile)             | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2471 | <i>Merycoidodon gracilis</i>    | Mandible                     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2472 | <i>Merycoidodon gracilis</i>    | Partial skull                | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2474 | <i>Merycoidodon</i> sp.         | Postcrania                   | Brule Fm.     | 1902, C.A. Fisher  |
| USNM V 2475 | <i>Merycoidodon</i> sp.         | Skull                        | Brule Fm.     | 1902, C.A. Fisher  |



**Table 11 (continued).** Paleontological specimens currently housed at the National Museum of Natural History (USNM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #    | Taxon                            | Element(s)                   | Geologic Unit | Collection History       |
|--------------|----------------------------------|------------------------------|---------------|--------------------------|
| USNM V 2476  | <i>Merycoidodon</i> sp.          | Skull                        | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2477  | <i>Daphoenus</i> sp.             | Partial mandible             | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2478  | Camelidae indet.                 | Molar                        | Gering Fm.    | C.A. Fisher              |
| USNM V 2479  | <i>Hyracodon</i> sp.             | Partial maxilla              | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2480  | <i>Hyracodon</i> sp.             | Teeth                        | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2483  | <i>Poebrotherium</i> sp.         | Mandible                     | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2484  | <i>Poebrotherium</i> sp.         | Mandible                     | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2486  | <i>Poebrotherium</i> sp.         | Partial mandible             | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2489  | <i>Leptomeryx</i> sp.            | Partial mandible             | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2490  | <i>Ischyromys</i> sp.            | Mandible                     | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2491  | <i>Palaeolagus haydeni</i>       | Mandible                     | Brule Fm.     | 30 Aug 1897, N.H. Darton |
| USNM V 2492  | <i>Hyaenodon cruentus</i>        | Partial mandible             | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2501  | <i>Merycoidodon gracilis</i>     | Skull fragment               | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2502  | <i>Subhyracodon occidentalis</i> | ?                            | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 2528  | <i>Leptomeryx evansi</i>         | Partial mandible and humerus | Brule Fm.     | 08 Sep 1897, N.H. Darton |
| USNM V 2564  | <i>Hyracodon nebraskensis</i>    | Mandible                     | Brule Fm.     | 1902, C.A. Fisher        |
| USNM V 3944  | <i>Aelurodon</i> sp.             | Mandible                     | Arikaree Gp.  | 02 Sep 1897, N.H. Darton |
| USNM V 3945  | <i>Brachycrus rusticus</i>       | Skull                        | Gering Fm.    | 28 Aug 1897, N.H. Darton |
| USNM V 3947  | <i>Miniochoerus gracilis</i>     | Partial skull and mandible   | Brule Fm.     | 02 Sep 1897, N.H. Darton |
| USNM V 3947  | <i>Miniochoerus gracilis</i>     | Partial skull and mandible   | Arikaree Gp.  | 02 Sep 1897, N.H. Darton |
| USNM V 3948  | <i>Merycoidodon culbertsoni</i>  | Partial mandible             | Brule Fm.     | 02 Sep 1897, N.H. Darton |
| USNM V 4199  | Rhinocerotidae indet.            | Mandible                     | Brule Fm.     | 02 Sep 1897, N.H. Darton |
| USNM V 4499  | Rhinocerotidae indet.            | Partial mandible             | Gering Fm.    | 02 Sep 1897, N.H. Darton |
| USNM V 12340 | <i>Merycoidodon gracilis</i>     | Partial skull                | Brule Fm.     | 1902, C.A. Fisher        |

**Table 11 (continued).** Paleontological specimens currently housed at the National Museum of Natural History (USNM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                           | Element(s)           | Geologic Unit | Collection History |
|-----------------|---------------------------------|----------------------|---------------|--------------------|
| USNM V 12341    | <i>Merycoidodon gracilis</i>    | Partial mandible     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 181486 | <i>Miohippus bairdi</i>         | ?                    | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244240 | <i>Miniochoerus gracilis</i>    | Mandible             | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244241 | <i>Miniochoerus gracilis</i>    | Maxilla              | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244252 | <i>Hyracodon</i> sp.            | Partial maxilla      | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244253 | <i>Hyracodon</i> sp.            | Mandible (juvenile)  | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244254 | <i>Merycoidodon</i> sp.         | Maxilla and mandible | Brule Fm.     | C.A. Fisher        |
| USNM PAL 244255 | <i>Merycoidodon</i> sp.         | Maxilla              | Brule Fm.     | C.A. Fisher        |
| USNM PAL 244256 | <i>Merycoidodon</i> sp.         | Maxilla              | Brule Fm.     | C.A. Fisher        |
| USNM PAL 244257 | <i>Merycoidodon culbertsoni</i> | Mandible             | Brule Fm.     | C.A. Fisher        |
| USNM PAL 244259 | <i>Leptomeryx evansi</i>        | Maxilla              | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244260 | <i>Poebrotherium</i> sp.        | Partial mandible     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244261 | <i>Poebrotherium</i> sp.        | Partial mandible     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244262 | <i>Poebrotherium</i> sp.        | Partial maxilla      | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 244263 | <i>Poebrotherium</i> sp.        | Partial mandible     | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 631642 | Mammalia indet.                 | Femur and tibia      | Brule Fm.     | 1902, C.A. Fisher  |
| USNM PAL 631651 | Mammalia indet.                 | Radius               | Brule Fm.     | 1902, C.A. Fisher  |

**Table 12.** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                        | Element(s)                   | Collection History                           |
|-----------------|------------------------------|------------------------------|----------------------------------------------|
| YPM VP 048001.A | <i>Poebrotherium</i>         | Mandible                     | 1873, A.S. Shelley                           |
| YPM VP 048001.B | <i>Poebrotherium</i>         | Mandible                     | 1873, A.S. Shelley                           |
| YPM VP 048002   | <i>Poebrotherium</i>         | Maxilla                      | 1873, A.S. Shelley                           |
| YPM VP 048003   | <i>Poebrotherium</i>         | Metapodial                   | 1873, A.S. Shelley                           |
| YPM VP 048004   | <i>Poebrotherium</i>         | Molar                        | 1873, A.S. Shelley                           |
| YPM VP 048005   | <i>Poebrotherium</i>         | Molar                        | 1873, A.S. Shelley                           |
| YPM VP 048006   | <i>Poebrotherium</i>         | Mandible                     | 1873, A.S. Shelley                           |
| YPM VP 048007   | <i>Poebrotherium</i>         | Maxilla fragment             | 1873, A.S. Shelley                           |
| YPM VP 048026   | <i>Poebrotherium</i>         | Tooth                        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048027   | <i>Poebrotherium</i>         | Jaw fragment w/ tooth        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048028   | <i>Poebrotherium</i>         | Tooth                        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048029   | <i>Poebrotherium</i>         | Mandible fragment            | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048030   | <i>Poebrotherium</i>         | Maxilla fragment             | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048031   | <i>Poebrotherium</i>         | Mandible fragment            | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048032   | <i>Poebrotherium</i>         | Anterior portion of mandible | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048033   | <i>Poebrotherium</i>         | Postcrania                   | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048034   | <i>Poebrotherium</i>         | Proximal end of femur        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048116   | <i>Poebrotherium</i>         | Maxilla                      | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048117   | <i>Poebrotherium</i>         | Mandible fragment            | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048118   | <i>Poebrotherium</i>         | Mandible fragment            | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048119   | <i>Poebrotherium</i>         | Mandible fragment            | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 010881   | <i>Poebrotherium eximium</i> | Skull                        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 010095   | <i>Poebrotherium wilsoni</i> | Skull                        | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 062706   | Camelidae indet.             | Mandible fragment with teeth | Aug 1870, Yale College Scientific Expedition |
| YPM VP 050583   | Hypertragulidae indet.       | Left mandible                | Aug 1870, Yale College Scientific Expedition |
| YPM VP 050584   | Hypertragulidae indet.       | Right maxilla                | Aug 1870, Yale College Scientific Expedition |
| YPM VP 049019   | <i>Hypertragulus</i>         | Left mandible                | 1874, A.S. Shelley                           |
| YPM VP 049020   | <i>Hypertragulus</i>         | Right mandible               | 1874, A.S. Shelley                           |
| YPM VP 049032   | <i>Hypertragulus</i>         | Right mandible               | Aug 1870, Yale College Scientific Expedition |
| YPM VP 049033   | <i>Hypertragulus</i>         | Right mandible               | Aug 1870, Yale College Scientific Expedition |

**Table 12 (continued).** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                           | Element(s)                              | Collection History                           |
|-----------------|---------------------------------|-----------------------------------------|----------------------------------------------|
| YPM VP 049034   | <i>Hypertragulus</i>            | Left mandible                           | Aug 1870, Yale College Scientific Expedition |
| YPM VP 049035   | <i>Hypertragulus</i>            | Left maxilla                            | Aug 1870, Yale College Scientific Expedition |
| YPM VP 049036   | <i>Hypertragulus</i>            | Right mandible                          | 15 Nov 1873, H.C. Clifford                   |
| YPM VP 049037   | <i>Hypertragulus</i>            | Left mandible                           | 15 Nov 1873, H.C. Clifford                   |
| YPM VP 049038   | <i>Hypertragulus</i>            | Left mandible                           | 15 Nov 1873, H.C. Clifford                   |
| YPM VP 010540   | <i>Hypertragulus calcaratus</i> | Right mandible                          | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012554   | <i>Hypisodus</i>                | Skull and jaws                          | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 010035   | <i>Hypisodus alacer</i>         | Skull, mandible, and skeletal fragments | E. Devendorf                                 |
| YPM VP 010035.A | <i>Hypisodus alacer</i>         | 4 maxillaries with molars               | E. Devendorf                                 |
| YPM VP 010035.B | <i>Hypisodus alacer</i>         | Mandibles and skeletal elements         | E. Devendorf                                 |
| YPM VP 048832   | <i>Leptomeryx</i>               | Right maxilla fragment                  | 1874, A.S. Shelley                           |
| YPM VP 048834   | <i>Leptomeryx</i>               | Left mandible                           | 1873, H.C. Clifford and A.S. Shelley         |
| YPM VP 048835   | <i>Leptomeryx</i>               | Left mandible                           | 1873, H.C. Clifford and A.S. Shelley         |
| YPM VP 048836   | <i>Leptomeryx</i>               | Right mandible                          | 1873, H.C. Clifford and A.S. Shelley         |
| YPM VP 048837   | <i>Leptomeryx</i>               | Right maxilla                           | 1873, H.C. Clifford and A.S. Shelley         |
| YPM VP 048953   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048954   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048955   | <i>Leptomeryx</i>               | Teeth                                   | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048956   | <i>Leptomeryx</i>               | Right mandible                          | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048957   | <i>Leptomeryx</i>               | Right maxilla                           | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048958   | <i>Leptomeryx</i>               | Right mandible                          | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048959   | <i>Leptomeryx</i>               | Left mandible                           | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048964   | <i>Leptomeryx</i>               | Right mandible                          | 20 Aug 1874, A.S. Shelley                    |
| YPM VP 048965   | <i>Leptomeryx</i>               | Tooth                                   | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048966   | <i>Leptomeryx</i>               | Tooth and jaw fragment                  | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048967   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048968   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048969   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048970   | <i>Leptomeryx</i>               | Left mandible                           | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 048971   | <i>Leptomeryx</i>               | Maxilla                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 010542   | <i>Leptomeryx evansi</i>        | Partial skull, palate                   | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 010542.A | <i>Leptomeryx evansi</i>        | Left and right mandibles                | 1874, A.S. Shelley and M.H. Clifford         |



**Table 12 (continued).** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                           | Element(s)                        | Collection History                           |
|-----------------|---------------------------------|-----------------------------------|----------------------------------------------|
| YPM VP 010542.B | <i>Leptomeryx evansi</i>        | Partial articulated skull and jaw | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012669.B | <i>Leptauchenia decora</i>      | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012670   | <i>Sespia nitida</i>            | Jaws and teeth                    | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012670.A | <i>Sespia nitida</i>            | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 020526   | <i>Merychys</i>                 | Left mandible                     | 22 Aug 1874, A.S. Shelley and M.H. Clifford  |
| YPM VP 020530   | <i>Merychys</i>                 | Maxillae                          | 14 Nov 1873, H.C. Clifford                   |
| YPM VP 013118   | <i>Merycoidodon bullatus</i>    | Plaster brain cast                | 17 Aug 1874, A.S. Shelley and M.H. Clifford  |
| YPM VP 013119   | <i>Merycoidodon bullatus</i>    | Skeleton                          | 17 Aug 1874, A.S. Shelley and M.H. Clifford  |
| YPM VP 010130   | <i>Merycoidodon culbertsoni</i> | Articulated skull and jaws        | 1873, H.C. Clifford                          |
| YPM VP 012158   | <i>Merycoidodon culbertsoni</i> | Skull, teeth                      | Aug 1870, Yale College Scientific Expedition |
| YPM VP 012235   | <i>Merycoidodon culbertsoni</i> | Skull, ?                          | 1873, H.C. Clifford                          |
| YPM VP 012445   | <i>Merycoidodon culbertsoni</i> | Muzzle, jaws, teeth               | 1873, H.C. Clifford                          |
| YPM VP 012445.A | <i>Merycoidodon culbertsoni</i> | Parts of jaws, scapula            | 1873, H.C. Clifford                          |
| YPM VP 012448   | <i>Merycoidodon culbertsoni</i> | Skull, teeth                      | 1873, H.C. Clifford                          |
| YPM VP 012450.A | <i>Merycoidodon culbertsoni</i> | Rib fragments, radius, carpal     | 1873, H.C. Clifford                          |
| YPM VP 012452   | <i>Merycoidodon culbertsoni</i> | Skull and jaws                    | 1873, H.C. Clifford                          |
| YPM VP 012459   | <i>Merycoidodon culbertsoni</i> | Jaw fragments, teeth              | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012459.A | <i>Merycoidodon culbertsoni</i> | Cranium, skull, jaws, teeth       | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012460   | <i>Merycoidodon culbertsoni</i> | Skull, teeth                      | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012460.A | <i>Merycoidodon culbertsoni</i> | Fragments of skull, jaws, teeth   | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012460.B | <i>Merycoidodon culbertsoni</i> | Jaw fragments, vertebrae          | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469   | <i>Merycoidodon culbertsoni</i> | Mandible, maxillae, teeth         | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469.A | <i>Merycoidodon culbertsoni</i> | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469.B | <i>Merycoidodon culbertsoni</i> | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469.C | <i>Merycoidodon culbertsoni</i> | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469.D | <i>Merycoidodon culbertsoni</i> | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |
| YPM VP 012469.E | <i>Merycoidodon culbertsoni</i> | ?                                 | 1874, A.S. Shelley and M.H. Clifford         |

**Table 12 (continued).** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                           | Element(s)                                                                       | Collection History                                          |
|-----------------|---------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------|
| YPM VP 012476   | <i>Merycoidodon culbertsoni</i> | Brain cast                                                                       | Aug 1870, Yale College Scientific Expedition (E. Whitney)   |
| YPM VP 012477.A | <i>Merycoidodon culbertsoni</i> | Astragali?                                                                       | Aug 1870, Yale College Scientific Expedition (H.B. Sargent) |
| YPM VP 012611   | <i>Merycoidodon culbertsoni</i> | Skull, jaws, teeth                                                               | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 048451   | <i>Merycoidodon culbertsoni</i> | Mandible w/ symphysis                                                            | 1873, A.S. Shelley                                          |
| YPM VP 012477   | <i>Merycoidodon culbertsoni</i> | Partial mandible                                                                 | Aug 1870, Yale College Scientific Expedition (H.B. Sargent) |
| YPM VP 012261   | <i>Merycoidodon major</i>       | Teeth and parts of maxilla(e)                                                    | 1873, H.C. Clifford                                         |
| YPM VP 012261.A | <i>Merycoidodon major</i>       | Teeth and parts of maxilla(e)                                                    | 1873, H.C. Clifford                                         |
| YPM VP 050585   | Merycoidodontidae               | Right maxilla                                                                    | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 012446   | <i>Mesoreodon chelonys</i>      | Skull                                                                            | 1873, H.C. Clifford                                         |
| YPM VP 010141   | <i>Miniochoerus affinis</i>     | Skull, mandible, hind foot, etc.                                                 | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012449   | <i>Miniochoerus affinis</i>     | Skull, jaw                                                                       | 1873, H.C. Clifford                                         |
| YPM VP 012464   | <i>Miniochoerus affinis</i>     | Skulls, jaws, teeth, femur                                                       | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012464.A | <i>Miniochoerus affinis</i>     | ?                                                                                | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012464.C | <i>Miniochoerus affinis</i>     | ?                                                                                | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012464.D | <i>Miniochoerus affinis</i>     | ?                                                                                | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012475   | <i>Miniochoerus affinis</i>     | Fragments of skull and jaws                                                      | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 012748   | <i>Miniochoerus affinis</i>     | Skull                                                                            | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012752   | <i>Miniochoerus affinis</i>     | Skull, partial rami, 2 cervical vertebrae, 3 dorsal vertebrae, distal end radius | 1874, M.H. Clifford                                         |
| YPM VP 012266   | <i>Miniochoerus gracilis</i>    | Jaws, teeth                                                                      | 1873, H.C. Clifford                                         |
| YPM VP 012463   | <i>Miniochoerus gracilis</i>    | Skull, jaws                                                                      | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012463.B | <i>Miniochoerus gracilis</i>    | Mandible, teeth                                                                  | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 012467.B | <i>Miniochoerus gracilis</i>    | ?                                                                                | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 020532   | <i>Ticholeptus</i>              | Left mandible                                                                    | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 011762   | <i>Hesperocyon gregarius</i>    | Partial mandible                                                                 | Aug 1870, Yale College Scientific Expedition (O.C. Marsh)   |
| YPM VP 011816   | <i>Hesperocyon gregarius</i>    | Partial mandibles                                                                | Aug 1870, Yale College Scientific Expedition                |

**Table 12 (continued).** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #       | Taxon                             | Element(s)                                                                                                                                 | Collection History                                           |
|-----------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| YPM VP 011816.A | <i>Hesperocyon gregarius</i>      | Partial mandible                                                                                                                           | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 011844   | <i>Hesperocyon gregarius</i>      | Partial maxilla and mandible fragment                                                                                                      | 08 Aug 1870, Yale College Scientific Expedition (C.M. Reeve) |
| YPM VP 012678   | <i>Hesperocyon gregarius</i>      | Articulated skull and jaws                                                                                                                 | 1870, Yale College Scientific Expedition (H.B. Sargent)      |
| YPM VP 012682   | <i>Hesperocyon gregarius</i>      | Partial mandibles                                                                                                                          | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 012683   | <i>Hesperocyon gregarius</i>      | Partial mandible                                                                                                                           | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 012683.A | <i>Hesperocyon gregarius</i>      | Partial mandible                                                                                                                           | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 012683.B | <i>Hesperocyon gregarius</i>      | Partial mandible                                                                                                                           | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 012686   | <i>Hesperocyon gregarius</i>      | Partial mandible                                                                                                                           | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 012775   | <i>Hesperocyon gregarius</i>      | Partial maxilla                                                                                                                            | 1874, A.S. Shelley and M.H. Clifford                         |
| YPM VP 056104   | Canidae indet.                    | 2 isolated premolars                                                                                                                       | 15 Aug 1874, M.H. Clifford                                   |
| YPM VP 012756   | <i>Hoplophoneus occidentalis</i>  | Partial mandible                                                                                                                           | 1874, A.S. Shelley and M.H. Clifford                         |
| YPM VP 010950   | <i>Hoplophoneus primaevus</i>     | Fragments of skull, sacrum, axis, vertebrae, partial pelvis, proximal and distal ends of femur, patella, partial metapodials and phalanges | 1874, A.S. Shelley and M.H. Clifford                         |
| YPM VP 000909   | <i>Archaeophasianus mioceanus</i> | Right humerus                                                                                                                              | 16 Aug 1874, M.H. Clifford                                   |
| YPM VP 011312   | <i>Miohippus</i>                  | Pes, manus                                                                                                                                 | Aug 1870, Yale College Scientific Expedition (O.C. Marsh)    |
| YPM VP 011601   | <i>Miohippus</i>                  | Jaw fragments                                                                                                                              | 1873, H.C. Clifford                                          |
| YPM VP 045984   | <i>Miohippus</i>                  | Vertebrae, metapodials, proximal radius                                                                                                    | –                                                            |
| YPM VP 011579   | <i>Miohippus bairdi</i>           | Skull                                                                                                                                      | 29 Sep 1874, A.S. Shelley and M.H. Clifford                  |
| YPM VP 045983   | Equidae indet.                    | Teeth                                                                                                                                      | Aug 1870, Yale College Scientific Expedition                 |
| YPM VP 046003   | Equidae indet.                    | 2 maxilla fragments                                                                                                                        | Aug 1870, Yale College Scientific Expedition                 |

**Table 12 (continued).** Paleontological specimens currently housed at the Yale Peabody Museum (YPM) that may originate from SCBL. Note that many of these specimens are documented as originating from Scotts Bluff County and therefore may originate from outside of SCBL boundaries.

| Catalog #     | Taxon                         | Element(s)                                                          | Collection History                                          |
|---------------|-------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------|
| YPM VP 012503 | <i>Hyracodon</i>              | Mandible, vertebrae, limb bones                                     | 1873, H.C. Clifford                                         |
| YPM VP 047365 | <i>Hyracodon</i>              | Skull and jaws                                                      | 20 Aug 1870, Yale College Scientific Expedition (G. Stokes) |
| YPM VP 012501 | <i>Hyracodon leidymanus</i>   | Mandibles                                                           | H.C. Clifford                                               |
| YPM VP 011166 | <i>Hyracodon nebraskensis</i> | Jaws                                                                | Aug 1870, Yale College Scientific Expedition (J.M. Russell) |
| YPM VP 011175 | <i>Hyracodon nebraskensis</i> | Skull, jaws, foot bones                                             | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 014673 | <i>Eumys elegans</i>          | 2 jaw fragments, 6 elements of right pes, anterior portion of skull | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 020275 | <i>Eumys elegans</i>          | ?                                                                   | 17 Aug 1874, A.S. Shelley and M.H. Clifford                 |
| YPM VP 012514 | <i>Ischyromys typus</i>       | Jaws, teeth                                                         | 1874, A.S. Shelley and M.H. Clifford                        |
| YPM VP 009776 | cf. Testudinidae              | Shell                                                               | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 009777 | cf. Testudinidae              | Shell                                                               | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 009778 | cf. Testudinidae              | Shell                                                               | Aug 1870, Yale College Scientific Expedition                |
| YPM VP 009779 | cf. Testudinidae              | Shell                                                               | Aug 1870, Yale College Scientific Expedition                |

**Table 13.** SCBL paleontological specimens currently listed in MCMS as being on loan for preparation.

| Catalog #  | Taxon                 | Element(s)      | Geologic Unit           |
|------------|-----------------------|-----------------|-------------------------|
| SCBL 2243  | cf. Merycoidodontidae | Possible skull  | –                       |
| SCBL 11417 | –                     | Jacketed fossil | Brule Fm. (Orella Mbr.) |
| SCBL 11418 | –                     | Jacketed skull  | Brule Fm. (Orella Mbr.) |



## Appendix C: Repository Contact Information

Contact information for institutions known to house collections likely from SCBL is included below. Addresses, links, and email addresses to departments are included as available. This information is subject to change, particularly hyperlinks.

### AMERICAN MUSEUM OF NATURAL HISTORY (AMNH)

200 Central Park West

New York, NY 10024-5102

(212) 769-5100

<https://www.amnh.org/>

### BADLANDS NATIONAL PARK (BADL)

25216 Ben Reifel Road

Interior, SD 57750

(605) 433-5361

<https://www.nps.gov/badl/index.htm>

### EASTERN OREGON UNIVERSITY (EOU)

One University Boulevard

La Grande, OR 97850

(541) 962-3672

<https://www.eou.edu/>

### INDEPENDENCE MULTI-PARK FACILITY (IMPF)

Harry S Truman National Historic Site

223 North Main Street

Independence, MO 64050

(816) 254-9929

<https://www.nps.gov/hstr/index.htm>

### MIDWEST ARCHEOLOGICAL CENTER (MWAC)

100 Centennial Mall North, Room 474

Lincoln, NE 68508

(402) 437-5392

<https://www.nps.gov/orgs/1740/index.htm>

MUSEUM OF COMPARATIVE ZOOLOGY (MCZ)

Harvard University

26 Oxford Street

Cambridge, MA 02138

(617) 495-2460

[mcz\\_collections\\_operations@oeb.harvard.edu](mailto:mcz_collections_operations@oeb.harvard.edu)

<https://www.mcz.harvard.edu/>

NATIONAL MUSEUM OF NATURAL HISTORY (USNM)

Smithsonian Institution

PO Box 37012

Washington, D.C. 20013-7012

[naturalexperience@si.edu](mailto:naturalexperience@si.edu)

<https://naturalhistory.si.edu/>

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY (SDSMT)

501 East Saint Joseph Street

Rapid City, SD 57701

(605) 394-2511

<https://www.sdsmt.edu/index.html/>

UNIVERSITY OF NEBRASKA STATE MUSEUM (UNSM)

Morrill Hall

645 North 14<sup>th</sup> Street

Lincoln, NE 68588-0338

(402) 472-2637

<https://museum.unl.edu/>

YALE PEABODY MUSEUM (YPM)

Yale University

170 Whitney Avenue

New Haven, CT 06520

(203) 432-3752

[ypm.collections@yale.edu](mailto:ypm.collections@yale.edu)

<https://peabody.yale.edu/>

## Appendix D: Paleontological Resource Law and Policy

The following material is reproduced in large part from Henkel et al. (2015); see also Kottkamp et al. (2020).

In March 2009, the Paleontological Resources Preservation Act (PRPA) (16 USC 460aaa) was signed into law (Public Law 111–11). This act defines paleontological resources as

*...any fossilized remains, traces, or imprints of organisms, preserved in or on the [E]arth's crust, that are of paleontological interest and that provide information about the history of life on [E]arth.*

The law stipulates that the Secretary of the Interior should manage and protect paleontological resources using scientific principles. The Secretary should also develop plans for

*...inventory, monitoring, and deriving the scientific and educational use of paleontological resources.*

Paleontological resources are considered park resources and values that are subject to the “no impairment” standard in the National Park Service Organic Act (1916). In addition to the Organic Act, PRPA will serve as a primary authority for the management, protection, and interpretation of paleontological resources. The proper management and preservation of these non-renewable resources should be considered by park resource managers whether or not fossil resources are specifically identified in the park’s enabling legislation.

The Paleontological Resources Management section of NPS Reference Manual 77 provides guidance on the implementation and continuation of paleontological resource management programs. Administrative options include those listed below and a park management program will probably incorporate multiple options depending on specific circumstances:

- **No action**—no action would be taken to collect the fossils as they erode from the strata. The fossils would be left to erode naturally and over time crumble away, or possibly be vandalized by visitors, either intentionally or unintentionally. This is the least preferable plan of action of those listed here.
- **Surveys**—will be set up to document potential fossil localities. All sites will be documented with the use of GPS and will be entered into the park GIS database. Associated stratigraphic and depositional environment information will be collected for each locality. A preliminary fossil list will be developed. Any evidence of poaching activity will be recorded. Rates of erosion will be estimated for the site, and a monitoring schedule will be developed based upon this information. An NPS Paleontological Locality Database Form will also be completed for each locality. A standard version of this form will be provided by the Paleontology Program of the Geologic Resources Division upon request and can be modified to account for local conditions and needs.

- **Monitoring**—fossil-rich areas would be examined periodically to determine if conditions have changed to such an extent that additional management actions are warranted. Photographic records should be kept so that changes can be more easily ascertained.
- **Cyclic prospecting**—areas of high erosion which also have a high potential for producing significant specimens would be examined periodically for new sites. The periodicity of such cyclic prospecting will depend on locality-specific characteristics such as rates of sediment erosion, abundance or rarity of fossils, and proximity to visitor use areas.
- **Stabilization and reburial**—significant specimens which cannot be immediately collected may be stabilized using appropriate consolidants and reburied. Reburial slows down but does not stop the destruction of a fossil by erosion. Therefore, this method would be used only as an interim and temporary stop-gap measure. In some situations, stabilization of a locality may require the consideration of vegetation. For example, roots can destroy in situ fossils, but can also protect against slope erosion, while plant growth can effectively obscure localities, which can be positive or negative depending on how park staff want to manage a locality.
- **Shelter construction**—it may be appropriate to exhibit certain fossil sites or specimens in situ, which would require the construction of protective shelters to protect them from the natural forces of weathering and erosion. The use of shelters draws attention to the fossils and increases the risk of vandalism or theft but also provides opportunities for interpretation and education.
- **Excavation**—partial or complete removal of any or all fossils present on the surface and potentially the removal of specimens still beneath the surface which have not been exposed by erosion.
- **Closure**—the area containing fossils may be temporarily or permanently closed to the public to protect the fossil resources. Fossil-rich areas may be closed to the public unless accompanied by an interpretive ranger on a guided hike.
- **Patrols**—may be increased in areas of known fossil resources. Patrols can prevent and/or reduce theft and vandalism. The scientific community and the public expect the NPS to protect its paleontological resources from vandalism and theft. In some situations, a volunteer site stewardship program may be appropriate (for example the “Paleo Protectors” at Chesapeake & Ohio Canal National Historical Park).
- **Alarm systems/electronic surveillance**—seismic monitoring systems can be installed to alert rangers of disturbances to sensitive paleontological sites. Once the alarm is engaged, a ranger can be dispatched to investigate. Motion-activated cameras may also be mounted to visually document human activity in areas of vulnerable paleontological sites.

National Park Service Management Policies (NPS 2006; Section 4.8.2.1) also require that paleontological resources, including both organic and mineralized remains in body or trace form, will be protected, preserved, and managed for public education, interpretation, and scientific research. In 2010, the National Park Service established [National Fossil Day](#) as a celebration and partnership



organized to promote public awareness and stewardship of fossils, as well as to foster a greater appreciation of their scientific and educational value. National Fossil Day occurs annually on Wednesday of the second full week in each October in conjunction with Earth Science Week.

## **Related Laws, Legislation, and Management Guidelines**

### **National Park Service Organic Act**

The NPS Organic Act directs the NPS to manage units

*...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner as will leave them unimpaired for the enjoyment of future generations. (16 U.S.C. § 1).*

Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that the NPS must conduct its actions in a manner that will ensure no

*...derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress. (16 U.S.C. § 1 a-1).*

The Organic Act prohibits actions that permanently impair park resources unless a law directly and specifically allows for the acts. An action constitutes an impairment when its impacts

*...harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources and values. (Management Policies 2006 1.4.3).*

### **Paleontological Resources Preservation Act (P.L. 111-011, Omnibus Public Land Management Act of 2009, Subtitle D)**

Section 6302 states

*The Secretary (of the Interior) shall manage and protect paleontological resources on Federal land using scientific principles and expertise. The Secretary shall develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources, in accordance with applicable agency laws, regulations, and policies. These plans shall emphasize interagency coordination and collaborative efforts where possible with non-Federal partners, the scientific community, and the general public.*

### **Federal Cave Resources Protection Act of 1988 (16 USC 4301)**

This law provides a legal authority for the protection of all cave resources on NPS and other federal lands. The definition for “Cave Resource” in Section 4302 states

*Cave resources include any material or substance occurring naturally in caves on Federal lands, such as animal life, plant life, paleontological deposits, sediments, minerals, speleogens, and speleothems.*

### **NPS Management Policies 2006**

NPS Management Policies 2006 include direction for preserving and protecting cultural resources, natural resources, processes, systems, and values (NPS 2006). It is the goal of the NPS to avoid or minimize potential impacts to resources to the greatest extent practicable consistent with the management policies. The following is taken from section 4.8.2.1 of the NPS Management Policies 2006, “Paleontological Resources and their contexts”:

*Paleontological resources, including both organic and mineralized remains in body or trace form, will be protected, preserved, and managed for public education, interpretation, and scientific research. The Service will study and manage paleontological resources in their paleoecological context (that is, in terms of the geologic data associated with a particular fossil that provides information about the ancient environment).*

*Superintendents will establish programs to inventory paleontological resources and systematically monitor for newly exposed fossils, especially in areas of rapid erosion. Scientifically significant resources will be protected by collection or by on-site protection and stabilization. The Service will encourage and help the academic community to conduct paleontological field research in accordance with the terms of a scientific research and collecting permit. Fossil localities and associated geologic data will be adequately documented when specimens are collected. Paleontological resources found in an archeological context are also subject to the policies for archeological resources. Paleontological specimens that are to be retained permanently are subject to the policies for museum objects.*

*The Service will take appropriate action to prevent damage to and unauthorized collection of fossils. To protect paleontological resources from harm, theft, or destruction, the Service will ensure, where necessary, that information about the nature and specific location of these resources remains confidential, in accordance with the National Parks Omnibus Management Act of 1998.*

*Parks will exchange fossil specimens only with other museums and public institutions that are dedicated to the preservation and interpretation of natural heritage and qualified to manage museum collections. Fossils to be deaccessioned in an exchange must fall outside the park’s scope of collection statement. Systematically collected fossils in an NPS museum collection in compliance with 36 CFR 2.5 cannot be outside the scope of the collection statement. Exchanges must follow deaccession procedures in the Museum Handbook, Part II, chapter 6.*

*The sale of original paleontological specimens is prohibited in parks.*

*The Service generally will avoid purchasing fossil specimens. Casts or replicas should be acquired instead. A park may purchase fossil specimens for the park museum collection only after making a written determination that*

- *The specimens are scientifically significant and accompanied by detailed locality data and pertinent contextual data;*
- *The specimens were legally removed from their site of origin, and all transfers of ownership have been legal;*
- *The preparation of the specimens meets professional standards;*
- *The alternatives for making these specimens available to science and the public are unlikely;*
- *Acquisition is consistent with the park's enabling legislation and scope of collection statement, and acquisition will ensure the specimens' availability in perpetuity for public education and scientific research.*

*All NPS construction projects in areas with potential paleontological resources must be preceded by a preconstruction surface assessment prior to disturbance. For any occurrences noted, or when the site may yield paleontological resources, the site will be avoided or the resources will, if necessary, be collected and properly cared for before construction begins. Areas with potential paleontological resources must also be monitored during construction projects.*

(See Natural Resource Information 4.1.2; Studies and Collections 4.2; Independent Research 5.1.2; and Artifacts and Specimens 10.2.4.6 in National Park Service 2006, available [here](#). Also see [36 CFR 2.5](#).)

### ***NPS Director's Order-77, Paleontological Resources Management***

DO-77 describes fossils as non-renewable resources and identifies the two major types, body fossils and trace fossils. It describes the need for managers to identify potential paleontological resources using literature and collection surveys, identify areas with potential for significant paleontological resources, and conduct paleontological surveys (inventory). It also describes appropriate actions for managing paleontological resources including: no action, monitoring, cyclic prospecting, stabilization and reburial, construction of protective structures, excavation, area closures, patrols, and the need to maintain confidentiality of sensitive location information.

### ***Excerpt from Clites and Santucci (2012):***

#### **Monitoring**

An important aspect of paleontological resource management is establishing a long-term paleontological resource monitoring program. National Park Service paleontological resource monitoring strategies were developed by Santucci et al. (2009). The park's monitoring program should incorporate the measurement and evaluation of the factors stated below.

#### ***Climatological Data Assessments***

These assessments include measurements of factors such as annual and storm precipitation, freeze/thaw index (number of 24-hour periods per year where temperature fluctuates above and below 32 degrees Fahrenheit), relative humidity, and peak hourly wind speeds.

#### *Rates of Erosion Studies*

These studies require evaluation of lithology, slope degree, percent vegetation cover, and rates of denudation around established benchmarks. If a park does not have this information, there may be opportunities to set up joint projects, because erosion affects more than just paleontological resources.

#### *Assessment of Human Activities, Behaviors, and Other Variables*

These assessments involve determining access/proximity of paleontological resources to visitor use areas, annual visitor use, documented cases of theft/vandalism, commercial market value of the fossils, and amount of published material on the fossils.

#### *Condition Assessment and Cyclic Prospecting*

These monitoring methods entail visits to the locality to observe physical changes in the rocks and fossils, including the number of specimens lost and gained at the surface exposure. Paleontological prospecting would be especially beneficial during construction projects or road repair.

#### *Periodic Photographic Monitoring*

Maintaining photographic archives and continuing to photo-document fossil localities from established photo-points enables visual comparison of long-term changes in site variables.



## Appendix E: Paleontological Locality Data

During the 2025 inventory, 51 paleontological localities were documented for SCBL, 30 of these newly recorded during the 2025 field survey. The following tables contain basic information on the localities, including UTM coordinates, stratigraphy, and the fossils and taxa observed. A number of sites comprise multiple fossil occurrences in close proximity, with individual UTM coordinates recorded and reported below. To enhance readability, the list of localities has been divided into two chronological tables (Tables 14 and 15), for localities reported prior to and during the 2025 field inventory, respectively. Detailed information is available to qualified researchers upon request.

**Table 14.** SCBL paleontological locality data, for localities documented/discovered prior to the 2025 field inventory.

| Locality #        | Lithostratigraphy        | Paleontological Resource(s) | Taxon(s)                                          | Collection | Remarks      |
|-------------------|--------------------------|-----------------------------|---------------------------------------------------|------------|--------------|
| SCBL-PAL-2012-001 | Brule Fm., Orella Mbr.   | Fragmentary skeleton        | cf. Equidae                                       | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Burrow w/ shell near end    | cf. Testudinidae                                  | –          | –            |
| SCBL-PAL-2013-001 | Brule Fm., Whitney Mbr.  | Bone fragments              | Indet.                                            | –          | –            |
| SCBL-PAL-2013-002 | Brule Fm., Whitney Mbr.  | Multiple shells             | cf. Testudinidae                                  | –          | –            |
| SCBL-PAL-2013-003 | Brule Fm., Whitney Mbr.  | Bone fragments              | cf. Testudinidae, Mammalia indet.                 | –          | –            |
| SCBL-PAL-2013-004 | Brule Fm., Whitney Mbr.  | –                           | <i>Palaeolagus</i> , cf. Testudinidae, Gastropoda | –          | –            |
| SCBL-PAL-2013-005 | Brule Fm., Whitney Mbr.  | –                           | <i>Merycoidodon</i> , cf. Testudinidae            | –          | Also anthill |
| SCBL-PAL-2013-006 | Brule Fm., Whitney Mbr.  | Mandibles                   | “Insectivora”                                     | –          | Anthill      |
| SCBL-PAL-2013-007 | Brule Fm., Orella Mbr.   | Mandible                    | <i>Poebrotherium</i>                              | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Shell                       | cf. Testudinidae                                  | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Mandible                    | <i>Miniochoerus</i>                               | –          | –            |
|                   | Brule Fm., Orella Mbr.   | –                           | <i>Poebrotherium</i>                              | –          | –            |
| SCBL-PAL-2014-001 | Brule Fm., Whitney Mbr.  | Bone fragments              | cf. Testudinidae                                  | –          | –            |
| SCBL-PAL-2014-002 | Gering Fm.               | Footprints                  | Artiodactyla indet.                               | –          | –            |
| SCBL-PAL-2015-001 | Brule Fm., Orella Mbr.   | Shell                       | cf. Testudinidae                                  | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Mandible                    | cf. <i>Poebrotherium</i>                          | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Mandible                    | <i>Leptomeryx evansi</i>                          | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Bone fragments, teeth       | Indet.; Leporidae indet.; Ischyromyidae indet.    | –          | Anthill      |
| SCBL-PAL-2015-002 | Brule Fm., Orella Mbr.   | Skull; foot                 | Nimravidae indet.                                 | –          | Poor         |
| SCBL-PAL-2015-003 | Brule Fm., Orella Mbr.   | Mandible                    | <i>Hypertragulus</i>                              | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Mandible                    | <i>Leptomeryx</i>                                 | –          | –            |
|                   | Brule Fm., Orella Mbr.   | Partial skeleton            | <i>Palaeolagus</i>                                | –          | –            |
| SCBL-PAL-2015-004 | Arikaree Gp. (undivided) | Skull                       | <i>Promylagaulus</i>                              | YES (2015) | –            |
| SCBL-PAL-2015-005 | Brule Fm., Orella Mbr.   | Shell                       | cf. Testudinidae                                  | –          | Small        |
|                   | Brule Fm., Orella Mbr.   | Shell                       | cf. Testudinidae                                  | –          | Very small   |

**Table 14 (continued).** SCBL paleontological locality data, for localities documented/discovered prior to the 2025 field inventory.

| Locality #        | Lithostratigraphy        | Paleontological Resource(s) | Taxon(s)                            | Collection | Remarks      |
|-------------------|--------------------------|-----------------------------|-------------------------------------|------------|--------------|
| SCBL-PAL-2015-006 | Arikaree Gp. (undivided) | Teeth, bones                | Artiodactyla indet.                 | –          | “Deer?”      |
| SCBL-PAL-2015-007 | Arikaree Gp. (undivided) | Bones, ?skull               | cf. Ferae                           | –          | “Carnivore?” |
| SCBL-PAL-2021-001 | Brule Fm., Orella Mbr.   | Ulnare                      | cf. Bathornithidae                  | YES (2021) | –            |
| SCBL-PAL-2024-001 | Brule Fm., Whitney Mbr.  | Bone fragments              | <i>Hyracodon</i> , cf. Testudinidae | –          | –            |
| SCBL-PAL-2024-002 | Brule Fm., Whitney Mbr.  | Bone fragments              | Mammalia indet., cf. Testudinidae   | –          | –            |
| SCBL-PAL-2024-003 | Brule Fm., Whitney Mbr.  | Skull                       | <i>Hyracodon</i>                    | YES (2024) | –            |
|                   | Brule Fm., Whitney Mbr.  | Shell                       | cf. Testudinidae                    | –          | Green        |
|                   | Brule Fm., Whitney Mbr.  | Shell                       | cf. Testudinidae                    | –          | –            |

**Table 15.** SCBL paleontological locality data, for localities newly documented during the 2025 field inventory.

| Locality #        | Lithostratigraphy       | Paleontological Resource(s)  | Taxon(s)                             | Collection | Remarks              |
|-------------------|-------------------------|------------------------------|--------------------------------------|------------|----------------------|
| SCBL-PAL-2025-001 | Brule Fm., Whitney Mbr. | Partial skull and jaw        | cf. Equidae                          | –          | –                    |
| SCBL-PAL-2025-002 | Brule Fm., Whitney Mbr. | Ulna                         | Artiodactyla indet.                  | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Mandible                     | <i>Hyracodon</i>                     | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Mandible                     | cf. <i>Miniochoerus</i>              | –          | –                    |
| SCBL-PAL-2025-003 | Brule Fm., Whitney Mbr. | Tooth; mandible              | Leporidae indet.; <i>Hyracodon</i>   | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Vertebral column and limb    | –                                    | –          | Articulated, in situ |
| SCBL-PAL-2025-004 | Brule Fm., Whitney Mbr. | Mandible                     | cf. <i>Eumys brachyodus</i>          | –          | Likely reworked      |
| SCBL-PAL-2025-005 | Brule Fm., Whitney Mbr. | Calcaneum                    | cf. <i>Hyracodon</i>                 | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Skull                        | <i>Leptauchenia</i>                  | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Mandible                     | <i>Hyracodon</i>                     | –          | –                    |
| SCBL-PAL-2025-006 | Brule Fm., Whitney Mbr. | Skull                        | cf. <i>Miniochoerus</i>              | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Skull                        | <i>Leptauchenia</i> cf. <i>major</i> | –          | –                    |
|                   | Brule Fm., Whitney Mbr. | Shell; acetabulum; fragments | Turtle, Mammalia, indet.             | –          | –                    |

**Table 15 (continued).** SCBL paleontological locality data, for localities newly documented during the 2025 field inventory.

| Locality #        | Lithostratigraphy      | Paleontological Resource(s)         | Taxon(s)                                          | Collection        | Remarks               |
|-------------------|------------------------|-------------------------------------|---------------------------------------------------|-------------------|-----------------------|
| SCBL-PAL-2025-007 | Brule Fm., Orella Mbr. | Partial skeleton                    | <i>Pseudoprotoceras</i> sp.                       | YES (24 Jun 2025) | –                     |
|                   | Brule Fm., Orella Mbr. | Shell and bones                     | cf. Testudinidae                                  | –                 | –                     |
| SCBL-PAL-2025-008 | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | –                     |
|                   | Brule Fm., Orella Mbr. | Microfossils                        | Aves indet.; Rodentia indet.                      | –                 | –                     |
| SCBL-PAL-2025-009 | Brule Fm., Orella Mbr. | Mandible                            | Leporidae indet.                                  | –                 | In channel deposit    |
|                   | Brule Fm., Orella Mbr. | Mandible                            | cf. Equidae                                       | –                 | –                     |
| SCBL-PAL-2025-010 | Brule Fm., Orella Mbr. | Limb bone; bone fragments; mandible | cf. Aves; Indet.; <i>Eumys</i> cf. <i>elegans</i> | –                 | –                     |
| SCBL-PAL-2025-011 | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | Green                 |
|                   | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | Green                 |
|                   | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | Green                 |
| SCBL-PAL-2025-012 | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | Green                 |
|                   | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | Green                 |
|                   | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | –                     |
| SCBL-PAL-2025-013 | Brule Fm., Orella Mbr. | Skull                               | cf. Merycoidodon                                  | –                 | –                     |
|                   | Brule Fm., Orella Mbr. | Large partial humerus               | Artiodactyla indet.                               | –                 | Rhino?<br>Entelodont? |
|                   | Brule Fm., Orella Mbr. | Mandible                            | <i>Leptomeryx</i> cf. <i>evansi</i>               | –                 | –                     |
| SCBL-PAL-2025-014 | Brule Fm., Orella Mbr. | Bone fragments                      | Indet.                                            | –                 | –                     |
| SCBL-PAL-2025-015 | Brule Fm., Orella Mbr. | Mandible                            | Merycoidodontidae indet.                          | –                 | –                     |
|                   | Brule Fm., Orella Mbr. | Shell                               | cf. Testudinidae                                  | –                 | White                 |
|                   | Brule Fm., Orella Mbr. | Partial skull                       | <i>Miniochoerus gracilis</i>                      | YES (24 Jun 2025) | –                     |
|                   | Brule Fm., Orella Mbr. | Skeleton                            | Merycoidodontidae indet.                          | –                 | –                     |
|                   | Brule Fm., Orella Mbr. | Skull                               | <i>Miniochoerus</i> cf. <i>affinis</i>            | –                 | –                     |



**Table 15 (continued).** SCBL paleontological locality data, for localities newly documented during the 2025 field inventory.

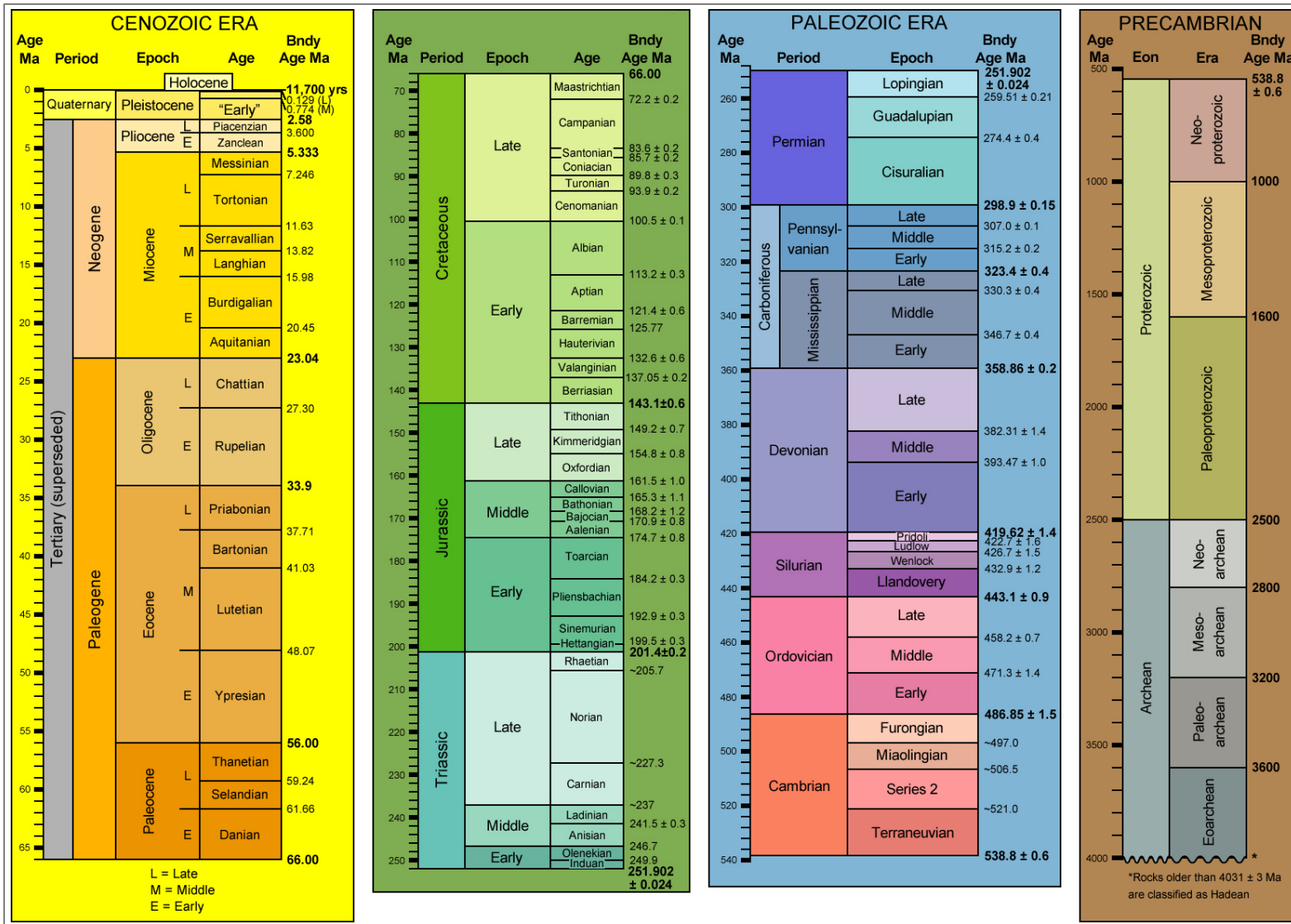
| Locality #        | Lithostratigraphy       | Paleontological Resource(s)              | Taxon(s)                                                                                            | Collection        | Remarks      |
|-------------------|-------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------|--------------|
| SCBL-PAL-2025-016 | Brule Fm., Orella Mbr.  | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
|                   | Brule Fm., Orella Mbr.  | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
| SCBL-PAL-2025-017 | Brule Fm., Orella Mbr.  | Mandible                                 | cf. Camelidae                                                                                       | –                 | –            |
| SCBL-PAL-2025-018 | Brule Fm., Whitney Mbr. | Mandibles                                | Ungulate                                                                                            | –                 | –            |
|                   | Brule Fm., Whitney Mbr. | Microfossils                             | <i>Eumys brachyodus</i> , cf. <i>Leptictis</i> ,<br><i>Herpetotherium</i> cf. <i>fugax</i> , Indet. | YES (26 Jun 2025) | –            |
|                   | Brule Fm., Whitney Mbr. | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
|                   | Brule Fm., Whitney Mbr. | Mandible                                 | Leporidae                                                                                           | –                 | –            |
| SCBL-PAL-2025-019 | Brule Fm., Whitney Mbr. | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
|                   | Brule Fm., Whitney Mbr. | Shell and fragments                      | cf. Testudinidae                                                                                    | –                 | –            |
|                   | Brule Fm., Whitney Mbr. | Assorted fragments                       | turtle, ?oreodont                                                                                   | –                 | –            |
| SCBL-PAL-2025-020 | Brule Fm., Orella Mbr.  | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
|                   | Brule Fm., Orella Mbr.  | Mandible                                 | –                                                                                                   | –                 | –            |
|                   | Brule Fm., Orella Mbr.  | Shell                                    | cf. Testudinidae                                                                                    | –                 | –            |
| SCBL-PAL-2025-021 | Brule Fm., Orella Mbr.  | Femoral head                             | –                                                                                                   | –                 | –            |
| SCBL-PAL-2025-022 | Brule Fm., Orella Mbr.  | Vertebra and limb end                    | –                                                                                                   | –                 | –            |
|                   | Brule Fm., Orella Mbr.  | Skull                                    | –                                                                                                   | –                 | –            |
|                   | Brule Fm., Orella Mbr.  | Tooth                                    | Equidae indet.                                                                                      | –                 | –            |
| SCBL-PAL-2025-023 | Brule Fm., Orella Mbr.  | Astragalus                               | <i>Hyracodon</i>                                                                                    | –                 | –            |
| SCBL-PAL-2025-024 | Brule Fm., Orella Mbr.  | Well-preserved skeleton fragments        | –                                                                                                   | –                 | –            |
| SCBL-PAL-2025-025 | Brule Fm., Orella Mbr.  | Skull and mandibular fragment            | Nimravidae indet.                                                                                   | –                 | –            |
| SCBL-PAL-2025-026 | Brule Fm., Orella Mbr.  | Shell                                    | cf. Testudinidae                                                                                    | –                 | "Explodemys" |
|                   | Brule Fm., Orella Mbr.  | Maxillary tooth row; mandibular fragment | ? <i>Santuccimeryx</i>                                                                              | –                 | In situ      |

**Table 15 (continued).** SCBL paleontological locality data, for localities newly documented during the 2025 field inventory.

| Locality #                   | Lithostratigraphy      | Paleontological Resource(s) | Taxon(s)              | Collection | Remarks              |
|------------------------------|------------------------|-----------------------------|-----------------------|------------|----------------------|
| SCBL-PAL-2025-026<br>(cont.) | Brule Fm., Orella Mbr. | Shell                       | cf. Testudinidae      | –          | Small white nice     |
|                              | Brule Fm., Orella Mbr. | Large femoral head          | –                     | –          | –                    |
| SCBL-PAL-2025-027            | Quaternary sediments   | Bone fragments              | Mammalia indet.       | –          | –                    |
| SCBL-PAL-2025-028            | Brule Fm., Orella Mbr. | Right dentary               | Leptomerycidae indet. | –          | –                    |
|                              | Brule Fm., Orella Mbr. | Mandible                    | ?Ungulate             | –          | Large, blue, in situ |
| SCBL-PAL-2025-029            | Brule Fm., Orella Mbr. | Shell                       | cf. Testudinidae      | –          | –                    |
|                              | Brule Fm., Orella Mbr. | Shells                      | cf. Testudinidae      | –          | Multiple turtles     |
|                              | Brule Fm., Orella Mbr. | Shell                       | cf. Testudinidae      | –          | Big                  |
|                              | Brule Fm., Orella Mbr. | Shell                       | cf. Testudinidae      | –          | In burrow?!          |
|                              | Brule Fm., Orella Mbr. | Atlas                       | cf. Rhinoceroidea     | –          | –                    |
| SCBL-PAL-2025-030            | Gering Fm.             | Footprints                  | Artiodactyla indet.   | –          | –                    |

## **Appendix F: Geologic Time Scale**

A geologic time scale (Figure 45) is provided below for reference.



**Figure 45.** Geologic time scale. Ma = Millions of years old. Bndy Age = Boundary Age. Layout after [1999 Geological Society of America Time Scale](#). Dates after International Commission on Stratigraphy version 2024/12.

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