Evaluation of proposed expansion of the Garden Park Fossil Area National Natural Landmark

Fremont County, Colorado

for its Merit in Meeting National Significance Criteria as a
National Natural Landmark

in Representing

Geologic History of the Jurassic Period during the Age of Reptiles

in the Southern Rocky Mountain Province

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EXECUTIVE SUMMARY

Garden Park Fossil Area National Natural Landmark, in Fremont County, Colorado is recommended for expanded designation as a National Natural Landmark in the Southern Rocky Mountain biophysiographic province. The primary features of the site represent the Jurassic Period sub-theme under the Triassic-Cretaceous geologic history theme. The site also has minor representation of the sub-theme of Pinyon-juniper woodland under the dry coniferous forest ecological natural history theme, and supports occurrences of two rare plants endemic to the upper Arkansas Valley. Garden Park Fossil Area is among the most important and diverse Late Jurassic age fossil sites in North America. It was one of the primary areas responsible for generating worldwide interest in dinosaurs during the late 1800s. The proposed expansion would greatly increase the validity of the site by incorporating the majority of the fossil quarries at Garden Park.

INTRODUCTION

Source of Site Proposal

The Garden Park Fossil Area site was originally designated a National Natural Landmark (NNL) in November of 1973. As currently designated, the area does not actually include any of the fossil quarries present in the area. Because land ownership patterns have shifted since the original designation, the Bureau of Land Management (BLM) has proposed to expand the area of the Natural Landmark to include the important fossil sites on federal land, and the associated interpretive trail and signs.

Evaluator(s)

The evaluation presented here was conducted by the Colorado Natural Heritage Program (CNHP).

Scope of Evaluation

Materials researched for this evaluation include literature and data on the geology and paleontology of the Garden Park area, the history of fossil collection in the region, and the history of the Cañon City area. The evaluation relied heavily on material provided by GeoCorps interns Karen Lloyd and Allison Vitkus with the BLM Royal Gorge Field Office. Additional information about the geology of the area was provided by BLM paleontologist Harley Armstrong. The statewide database maintained by CNHP provided information on the biological components of the site. Melissa Smeins (BLM) led the effort to expand the NNL designation, and provided information about the history of BLM involvement at the site and plans for future management.

NNL SITE AND PROPOSED EXPANSION DESCRIPTION

Brief Overview

The Garden Park Fossil Area is located in Fremont County, Colorado, along the Fourmile Creek drainage approximately 8 miles north of Canon City. The original 40-acre designation of 1973 encompasses the SE quarter of the SE quarter of section 28, T17S, R70W, which includes the Colorado Historical Society monument located on the roadside below the Marsh Quarry, but does not cover the quarry itself. The BLM has proposed to add approximately 3168.64 to the designated Landmark (Figure 1) for a total size of 3208.64 acres. There are currently five groups of quarries present in the parcels proposed for expansion of the Landmark:

- Marsh-Felch Quarry
- Cope-Lucas Quarry
- Cleveland Quarry
- DeWeese/Green Acres Quarry
- Small Stegosaurus Quarry

The proposed expansion would greatly increase the validity of the site by incorporating the majority of the fossil quarries at Garden Park. The quarries are currently included in a BLM designated Research Natural Area, which is contained

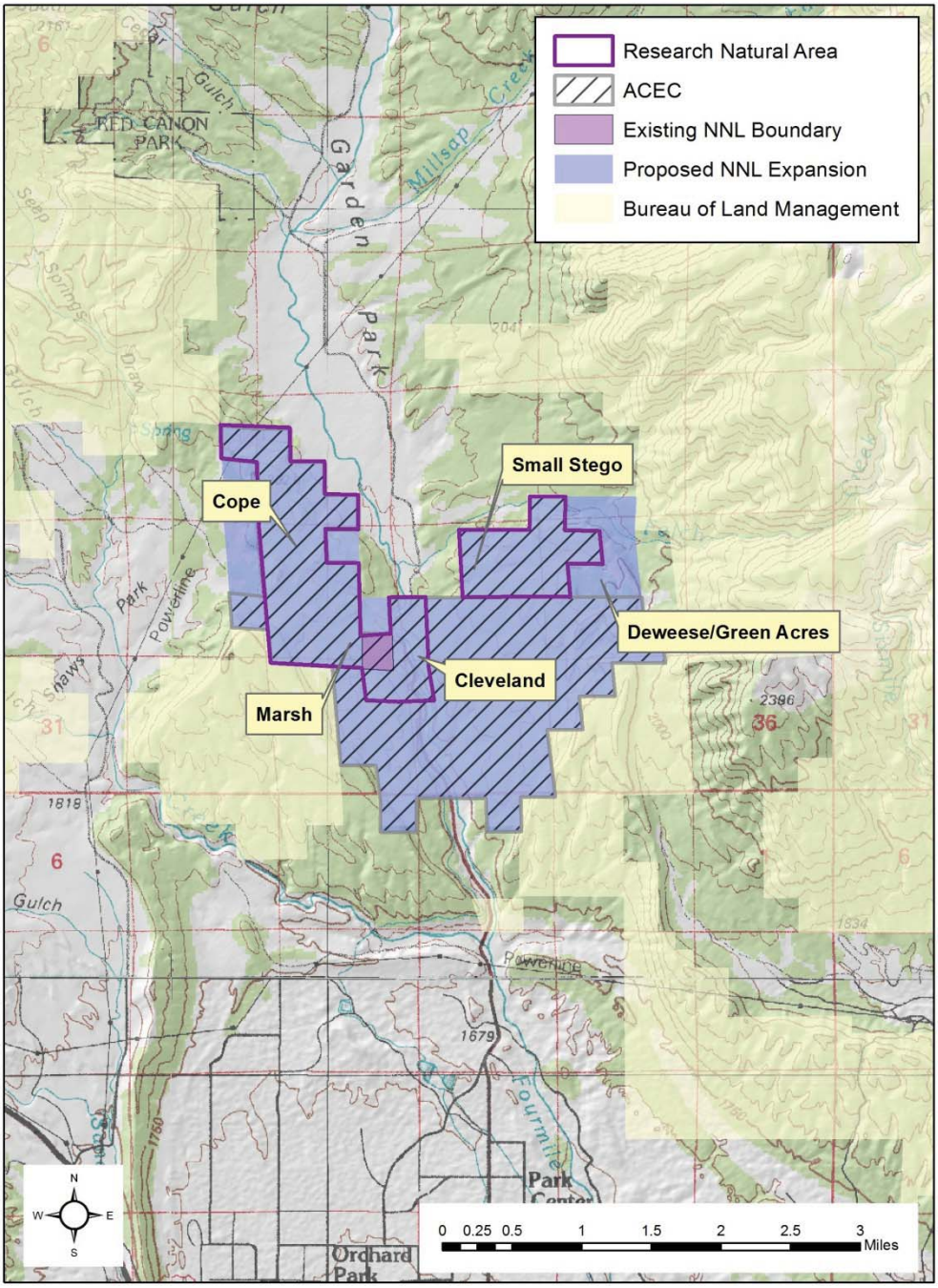

Figure 1. Existing designation and proposed expansion of Garden Park Fossil Area NNL, showing approximate locations of quarries.

within a larger surrounding area designated as an Area of Critical Environmental Concern (ACEC) and Colorado State Natural Area. An ACEC is a designation that highlights areas where special management attention is needed to protect and prevent irreparable damage to important historic, cultural and scenic values; fish, wildlife resources or other natural systems or processes; or to protect human life and safety from natural hazards. BLM establishes special management measures for these areas through land use planning. The designation is a record of significant

values that must be accommodated when BLM considers future management actions and land use proposals.

Natural History Themes Represented
Primary natural features of the Garden Park Fossil Area site fall under the following themes and subthemes:

- Geological natural history themes, Group 2, Geologic History
  Theme: Triassic-Cretaceous Periods—Age of Reptiles (~245 - 65 mya)
  Sub-theme: Jurassic Period (~208-144 mya)

The Garden Park Fossil Area site also has minor representation of the following themes and subthemes:

- Ecological natural history themes, Group 3, land ecosystems:
  Theme: Dry coniferous forest
  Sub-theme: Pinyon-juniper woodland

Primary Natural Features

Garden Park Fossil Area is one of the most productive and historically important locations in the United States for the study of Late Jurassic dinosaurs. Local residents first found dinosaur bones here in the 1870s. When word of the finds reached the museums of the eastern U.S., two of the most famous paleontologists in American history were soon involved. Edward Drinker Cope and Othniel Charles Marsh were the principal opponents in an intense rivalry that became known as "the Bone Wars." The Marsh-Felch Quarry and the Cope-Lucas Quarries of Garden Park were financed by these two rivals and excavated by Cañon City pioneers. Although paleontology in America was well established by the time of the "dinosaur wars" of Marsh and Cope, the excavations played an important role in the start of the "Great Dinosaur rush" which introduced dinosaurs into the public consciousness and established the field of American vertebrate paleontology. The work also highlighted the western U.S. as *the* place for paleontological fieldwork, adding to the myth of the wild untamed West.

In addition to the Marsh and Cope quarries, three other fossil quarries occur in the proposed expansion of the Garden Park Fossil Area. Fossil dinosaur skeletons from Garden Park can be found in many of the major natural history museums in the U.S. Important discoveries include the three most complete *Stegosaurus* skeletons ever found, as well as the first known remains of dinosaurs like *Camarasaurus*, *Ceratosaurus*, and *Diplodocus*. In addition to dinosaurs, Garden Park has also produced fossils of Late Jurassic mammals, crocodiles, turtles, freshwater mollusks, and trees; finds include 23 type specimens of fossil vertebrates and invertebrates (Table 1). Fossils from Garden Park now reside in museums as far away as New York City and Washington, D.C., and scientists have come to Garden Park from the Carnegie Museum of Natural History in Pittsburgh, the Cleveland Museum of Natural History, and, more recently, the Denver Museum of Nature and Science and the local Dinosaur Depot Museum (Cañon City).

Table 1. Type specimens from the Garden Park area.

Dinosaurs	Theropods	*Allosaurus fragilis*
		Ceratosaurus nasicornis
	Sauropods	*Amphicoelias altus*
		Amphicoelias fragillimus
		Camarasaurus supremus
		Diplodocus longus
		Haplocanthosaurus priscus
		Haplocanthosaurus delfsi
	Ornithischians	*Nanosaurus agilis*
		Stegosaurus stenops
Pterosaurs		*Kepodactylus insperatus*
Turtles		*Glyptops plicatulus*
Crocodyliforms		*Goniopholis lucasii*
		Eutretauranosuchus delfsi
Mammals		*Kepolestes coloradensis*
Mollusks	Bivalves	*Unio felchii*
		Unio toxonotus
		Unio macropisthus
		Unio iridoides
		Unio lapilloides
	Gastropods	*Limnaea ativuncula*
		Limnaea consortis
		Limnaea? a*ccelerata*

Marsh-Felch Quarry

The Marsh-Felch Quarry is the excavation closest to the originally designated National Natural Landmark site. The quarry sits at the edge of a small precipice over a gulch that leads into Four Mile Creek, the main drainage for Garden Park. Fossils were originally discovered here sometime before 1877 by Sarah Felch, daughter of local farmer Marshall P. Felch. Marshall Felch was later employed by Marsh to excavate fossils and ship them to Yale. Over the course of several years, over 270 crates of fossils were sent to Marsh. Felch recognized later that all the fossils came out of a zone of sandstone he called "the old river bed." At the quarry's height of production there were storage sheds for fossils and supplies, a furnace, an outhouse, and a forge. Today, the wall of the quarry is covered with sediments that have slid down its face. This quarry is the source of nearly complete specimens of *Ceratosaurus nasicornis, Stegosaurus stenops,* and *Allosaurus fragilis.* A quarter-mile self-guided interpretive trail provides views of the quarry.

Cope-Lucas Quarries

The Cope-Lucas Quarries were a remarkably productive series of fossil beds in Garden Park, first discovered in 1877 by local school teacher Oramel W. Lucas, and excavated by him and members of his family for Cope. During the course of the Lucas family’s excavations in Garden

Park, fossils were extracted from as many as 17 different quarries, and many shipments of bone were sent from Cañon City to Philadelphia between the summer of 1877 and January, 1884 (McIntosh 1998). Cope used these bones to identify 18 species (16 dinosaurs, one turtle, and one crocodile-like animal), 17 of which were new to science. Only five of these species are considered valid scientific names today, and two of those are debatable.

Cleveland-Delfs Quarry

In 1954 a small field expedition from the Cleveland Museum of Natural History, searching for a suitable dinosaur specimen for their museum, spotted dinosaur bones protruding from the base of a cliff next to Fourmile Creek. Acting on a tip from a Louisiana State University geologist, Edwin Delfs, a Yale University zoology undergraduate, and high-school students Wesley Williams, William West and Richard Jones, located the quarry in Garden Park. The eroding east bank of the creek uncovered a layer of mudstone sandwiched between layers of sandstone: a thin layer on top and a massive sandstone layer underneath the mudstone. The dinosaur skeleton was discovered in the mudstone, which, because of its location between the two sandstones, made it difficult to excavate. Despite the difficulties, the fossilized skeleton was removed. Delfs and his crew then made field jackets of burlap sack and plaster of Paris that encased the bones and matrix, providing protection for them on their journey back to the Cleveland Museum. It was not until the jackets were unpacked in the lab that the "distinctive spinal configuration of *Haplocanthosaurus"* was revealed (McIntosh and Williams 1988) The dinosaur skeleton, although on continual public display from 1963, was not scientifically studied and described until 1988 when John S. McIntosh of the Wesleyan University in Middletown, Connecticut and Michael E. Williams, curator of vertebrate paleontology at the Cleveland Museum undertook a systematic study of the skeletal remains. After careful study and comparisons with other specimens of *Haplocanthosaurus*, McIntosh and Williams determined that the Cleveland specimen represented a new species, which they named *Haplocanthosaurus delfsi* in honor of Edwin Delfs, and that the find from the Garden Park Fossil Area represented the largest known specimen of *Haplocanthosaurus. Haplocanthosaurus* is a rare dinosaur and is only found in one other location in Wyoming, so Delfs discovery was an important one for paleontologists and science. In fact Garden Park boasts two species of *Haplocanthosaurus* with Delfs dinosaur, *H. delfsi*, being the larger of the two (Carpenter no date). The skeleton of this huge plant-eating dinosaur is now displayed at the Cleveland (Ohio) Museum of Natural History. In total, the excavation recovered about 60% of the skeleton of *Haplocanthosaurus, Eutretauranosuchus,* (a crocodile), turtle fragments, and carnivorous dinosaur teeth (McIntosh and Williams 1988). The Cleveland Quarry recreation site, adjacent to the quarry and the creek, features interpretive exhibits, a picnic area, and restrooms.

DeWeese Quarry

This quarry is named for prominent local businessman William Dallas DeWeese, known as "Dall", who played a large role in the development of irrigation around Cañon City. An avid hunter and naturalist, DeWeese spent many hours searching for fossils in the Garden Park area. In 1915, while exploring the green and purple badlands east of Four Mile Creek, DeWeese found the neck vertebrae of a *Diplodocus* skeleton. Throughout the following summer and fall, DeWeese worked on excavating the fossilized skeleton, but the project was too big to complete on his own, and so at the beginning of 1916, DeWeese contacted the Denver Museum of Natural

History and inquired whether the museum was interested in the dinosaur bones. DeWeese's quarry produced about two thirds of a *Diplodocus*.

The acquisition of a Colorado *Diplodocus* was an important addition to the Denver museum's paleontology section, which had been established as a section within the Geology Department only a couple years earlier in 1914. Focusing on Colorado's natural history became a major component of the museum's mission, and indeed, paleontology continues to be a major focus of their research and outreach education today. DeWeese's *Diplodocus*, although not complete, the skull and other parts of the skeleton are missing, is considered to be an important paleontological specimen for the museum and for scientific research by paleontologists from around the world. The *Diplodocus* skeleton displays excellent preservation, and the donation of the dinosaur provided the museum with the impetus it needed to expand their collecting efforts and increase their scientific research in paleontology. Prior to DeWeese's donation of the *Diplodocus*, the department relied on donations or purchases of fossils to enhance their paleontological collection, but with DeWeese's donation the department of paleontology split from the Geology and Mineral Department and began active field collecting (Hanington 1938). Since the museum acquired the *Diplodocus*, parts of the fossilized skeleton have been placed on public exhibition, for example in 2005, some of the skeleton was exhibited as part of the museum's tenth anniversary celebrations of their permanent exhibit "Prehistoric Journey," and in 2008, a tail vertebra was exhibited in conjunction with the "Dinosaurs" travelling exhibit.

Small's Quarry

In the summer of 1992, Bryan Small, assistant to Kenneth Carpenter of the Denver Museum of Nature and Science (DMNS), discovered the world's most complete *Stegosaurus* specimen at this location. With the help of an army helicopter from nearby Fort Carson, much of the specimen was airlifted from the quarry in one 6.5 ton piece. Work on the specimen revealed the probable cause of the *Stegosaurus'* death, a very bad infection in a tail spike. The specimen, known as "Spike" has been exhibited at DMNS, and full-size replicas are on display at the Dinosaur Depot Museum in Cañon City and in the preparation laboratory at the DMNS.

Secondary Natural Features

The vegetation of the Garden Park area is a mosaic of high quality pinyon-juniper woodlands, grasslands, and clay barrens. The clay barrens are sparsely vegetated, with scattered clumps of *Oryzopsis hymenoides* (Indian ricegrass), *Frankenia jamesii* (frankenia), and *Atriplex* spp. (saltbush) growing on them (Anderson 2006). Pinyon-juniper woodlands are widely distributed throughout the western United States (West and Young 2000). In the Arkansas River Valley, including the Garden Park area, *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (oneseed juniper) are the dominant overstory species (NatureServe 2010). Here this particular pinyon-juniper community is near the northernmost extent of its range; it is more common in northern New Mexico and West Texas (Peet 2000).

In the intermountain west, many rare plant species are broadly associated with pinyon-juniper woodlands (CNHP and TNC 2008), and this is true of the Garden Park site as well. The site supports populations of three of Colorado's rare plants: *Eriogonum brandegeei* (Brandegee's buckwheat) *Mentzelia chrysantha* (golden blazing star), and *Asclepias uncialis* (dwarf

milkweed). The first two species are endemic to the upper Arkansas Valley. These are plants of barren slopes and outcrops formed in the alkaline and shaley substrates that often characterize pinyon-juniper woodlands.

Physical Setting

The Garden Park Fossil Area is located in central Colorado, north of the Arkansas River where it exits the mountains at the southern foothills of the Front Range. Here the broad valley of the Arkansas River forms an embayment of the Great Plains Province intruding into the Southern Rocky Mountains Province, and vegetation communities partake of elements of both provinces.

The canyon of Fourmile Creek represents the utmost tip of the Cañon City embayment, where it curls around the southwestern edge of the Pikes Peak massif. The upper canyon slopes are capped by cliff-forming outcrops of Lower Cretaceous age Dakota sandstone, lying unconformably atop the Jurassic Morrison Formation sediments (Evanoff 1996). Here the Morrison is upwards of 300 ft. thick, and it forms the primary fossiliferous strata in the site. Further north as the canyon opens out into to the valley of Garden Park, older strata of Fountain Formation sandstones are exposed above the Quaternary deposits on the park floor.

Average annual precipitation for the period of record (March 1893 to present) at Cañon City (elevation 5,340 ft.), south of Garden Park, is 12.55 inches (WRCC 2011). Garden Park is about 600 ft. higher than Cañon City, and probably receives slightly more precipitation. Precipitation is highest during spring and summer months. Temperatures in the area follow a similar elevational pattern, with generally cooler temperatures with increasing elevation. Summer temperatures at the Cañon City station typically range from lows in the upper 50's to highs in the upper 80's, with an extreme high of 107°F recorded in July of 1954. Winters bring highs in the upper 30's and lows generally in the 20's, with a record low of -30°F recorded in 1905 (WRCC 2011). Fourmile Creek has generally moderate perennial flow, but is subject to occasional flood events.

Land Use and Condition

Prior to the arrival of the expedition led by Zebulon Pike in 1806, the area saw frequent use by both Ute bands and various Plain tribes (Campbell 1972). A number of other expeditions followed in Pike's footsteps, including five scientific collecting expeditions led by John Fremont in the 1840s and 1850s. Small agricultural settlements and posts established by trappers, traders, and mountain men formed the early permanent habitations of the Valley until Cañon City was established in 1859 (Rockafellow 1881, Wheeler et al. 1995). As mineral prospecting and mining intensified in the gold and silver camps of the region, the city became an important supply center for the mining districts, and the little valley Garden Park was a successful market farming area. In 1862, the first discovery of oil in the American West was made in the Fourmile Creek area a few miles north of Cañon City (Wheeler et al. 1995). Cattle ranches began operating in the Arkansas Valley in the 1850s and by the late 1880s the cattle industry had become the most profitable business in the area (Wheeler et al. 1995).

At the time of the original NNL designation, the important quarry sites were not under BLM management. With subsequent land exchange and purchases, the majority of the area's paleontological resources have gradually been consolidated in federal ownership. The Fourmile Creek drainage in the vicinity of Garden Park is now a mixture of federal land under the

management of the Bureau of Land Management and privately owned parcels. Although some important fossil quarries are located on private land, the previously designated National Natural Landmark and all areas proposed as additions to this Landmark are now federal BLM-managed lands.

The 1995 Resource Management Plan and 1996 Record of Decision for the Royal Gorge Resource Area provided for the conservation of the most important paleontological resources (2,728 acres at Garden Park Paleo Area) through ACEC designation with the following management stipulations:

- Closed to timber harvesting and wood gathering
- No surface occupancy (A fluid mineral leasing stipulation that prohibits occupancy or disturbance on all or part of the lease surface in order to protect special values or uses. Lessees may develop the oil and gas or geothermal resources under leases restricted by this stipulation through use of directional drilling from sites outside the no surface occupancy area.
- Closed to mineral entry (the land is not available for the location of mining claims or sites)
- Closed to mineral materials disposal, unless disposal will enhance paleo values (mineral materials include but are not limited to, petrified wood and common varieties of sand, stone, gravel, pumice, pumicite, cinders, and clay)
- Retained in public ownership
- Limited livestock grazing
- OHV use limited to designated roads and trails

In the original Record of Decision, the most important paleontological resources were designated as “Class I”. Under the revised classification system in use since 2008, this class is now designated as Paleontological Fossil Yield Classification (PFYC) Class 5.

Threats

The ACEC is heavily visited due to its proximity to Cañon City. Peak use is in the spring and in the fall during hunting season, with approximately 12,500 visitors recorded in FY 2010. Camping is allowed in the area, there is a designated trail system, and some roads are open to all vehicles, while others are open to bicycles and/or hiking. Domestic livestock grazing is permitted in the ACEC.

Although the fossil quarries themselves are generally not open for public visitation, and it is illegal to collect fossils at the site without a special permit from the BLM, the paleontological resources of Garden Park are naturally considered sensitive. The site is not permanently staffed, is patrolled only sporadically, and could be vulnerable to unpermitted collecting, vandalism, or accidental damage from various land uses in the area. Other threats to these resources are the natural erosional processes that expose and degrade fossils, and the potential impacts of land use such as grazing or mineral extraction. In the event of mineral extraction activity, all work would have to be monitored to ensure the recovery of paleontological resources.

Sensitive or Hazardous Resources

Potentially hazardous conditions at the site are limited, arising primarily from the fact that the quarries are located away from developed areas, and are reached by unpaved roads and trails that may become impassable when wet. Under normal conditions, visitors exercising common sense in negotiating the terrain are unlikely to be exposed to hazardous conditions, and access gates are locked when weather is inclement.

COMPARATIVE ASSESSMENT

Regional Site Inventory

Garden Park Fossil Area is currently one of three designated NNL fossil sites within Colorado, all of which are within the Great Plains Province portion of the state. The Intermountain Region of the NNL program has 18 fossil sites (Table 2), of which 15 include fossil-bearing strata of the Triassic-Cretaceous period.

The Morrison Formation sedimentary sequence is about 148 to 155 million years old, outcropping in the western United States and Canada (Figure 2), and containing numerous dinosaur fossils. The formation takes its name from the town of Morrison, Colorado where fossils were discovered by Arthur Lakes in 1877. Quarries in the Morrison Formation have played an important role in the history and evolution of paleontology. In addition to Garden Park, there are three other comparable sites with Jurassic age Morrison Formation paleontological resources within the system of designated NNLs (highlighted in Table 2). Other major non-NNL Morrison formation sites producing fossils of the Jurassic are listed in Table 3 and discussed below.

Table 2: Paleontological NNLs of the Intermountain Region.
Sites with paleontological resources of Jurassic age are shaded.

State	Site	Features
Arkansas	none	---
Arizona	Comb Ridge	Only known location for tritylodont fossils in North America
Colorado	**Garden Park Fossil Area**	Morrison Formation: Fifteen species of dinosaurs, nine of which were new to science. Fish, crocodile, turtle, mammal, invertebrate, and plant fossils have also been recovered, making this site one of the oldest and richest fossil sites in the United States.
	Morrison-Golden Fossil Areas	The site of the first major discovery of giant dinosaur fossil bones in North America. Fossils from nine species of dinosaur were recovered, seven of which were newly discovered species. A new species of crocodile and turtle were also collected. Many tracks and impressions of several different fossils have also been recorded.
	Indian Springs Trace Fossil	The best trace fossil locality in North America for illustrating the markings and movements of ancient Ordovician animal life.
Kansas	Monument Rocks Natural Area	Rich source of fossils of Cretaceous marine animals.
Montana	Bridger Fossil Area	Fossils of *Deinonychus antirrhopus*, a new genus and species of carnivorous dinosaur that was only about three feet tall and eight feet in length.
	Bug Creek Fossil Area	Abundant remains of small, Cretaceous mammals, including the type locality for five species new to science

State	Site	Features
	Cloverly Formation Site	Early Cretaceous vertebrate fossils.
	Hell Creek Fossil Area	Type locality for *Tyrannosaurus rex*, *Ankylosaurus magniventris,* and *Brachychampsa fontana,* the oldest known true alligator. The Hell Creek Fossil Area has also produced several specimen of *Triceratops prorsus* and is the source of over 95% of *T. rex* museum specimens.
North Dakota	none	---
Nebraska	Ashfall Fossil Beds	One of the only locations where large numbers of fossil mammals have been found as whole, three-dimensionally preserved skeletons. The thick bed of volcanic ash at the site contains hundreds of extraordinarily complete skeletons of extinct rhinos, camels, three-toed horses and other vertebrates still lying in their death poses.
New Mexico	Ghost Ranch	An abundance of well-preserved *Coelophysis* skeletons within exposures of the Upper Triassic Chinle Formation. This reptile, one of the oldest and most primitive carnivorous dinosaurs, was known only from scanty fossil evidence until the 1947 discovery and excavation at this site. This discovery is considered by some paleontologists as one of the most important single fossil finds in the American Triassic.
Oklahoma	none	---
South Dakota	Mammoth Site of Hot Springs	One of the largest concentrations of mammoth remains in the United States. The site also contains bones of other vertebrates including peccary, bear, coyote, camel, and rodents.
	The Castles	Cretaceous and Tertiary beds contain a variety of flora and fauna fossils.
Texas	Dinosaur Valley	Only known source of distinct and full-grown sauropod footprints.
	Greenwood Canyon	Rich source of Early Cretaceous mammalian fossils.
Wyoming	**Como Bluff**	One of the most significant Mesozoic vertebrate localities in the world. The first and best examples of Jurassic mammals, including the discovery of 80 new vertebrate species, were found at this site
	Crooked Creek Natural Area	Fossils of Early Cretaceous land vertebrates and is one of only three known areas representing this period of life on the North American continent. It has produced eight new species and three new genera of dinosaurs.
Utah	**Cleveland-Lloyd Dinosaur Quarry**	More than 10,000 fossil bones from at least seven different genera of the Jurassic Period, representing more than 60 individual animals. The unique predator trap is unduplicated in any other classic dinosaur beds known anywhere in the world.

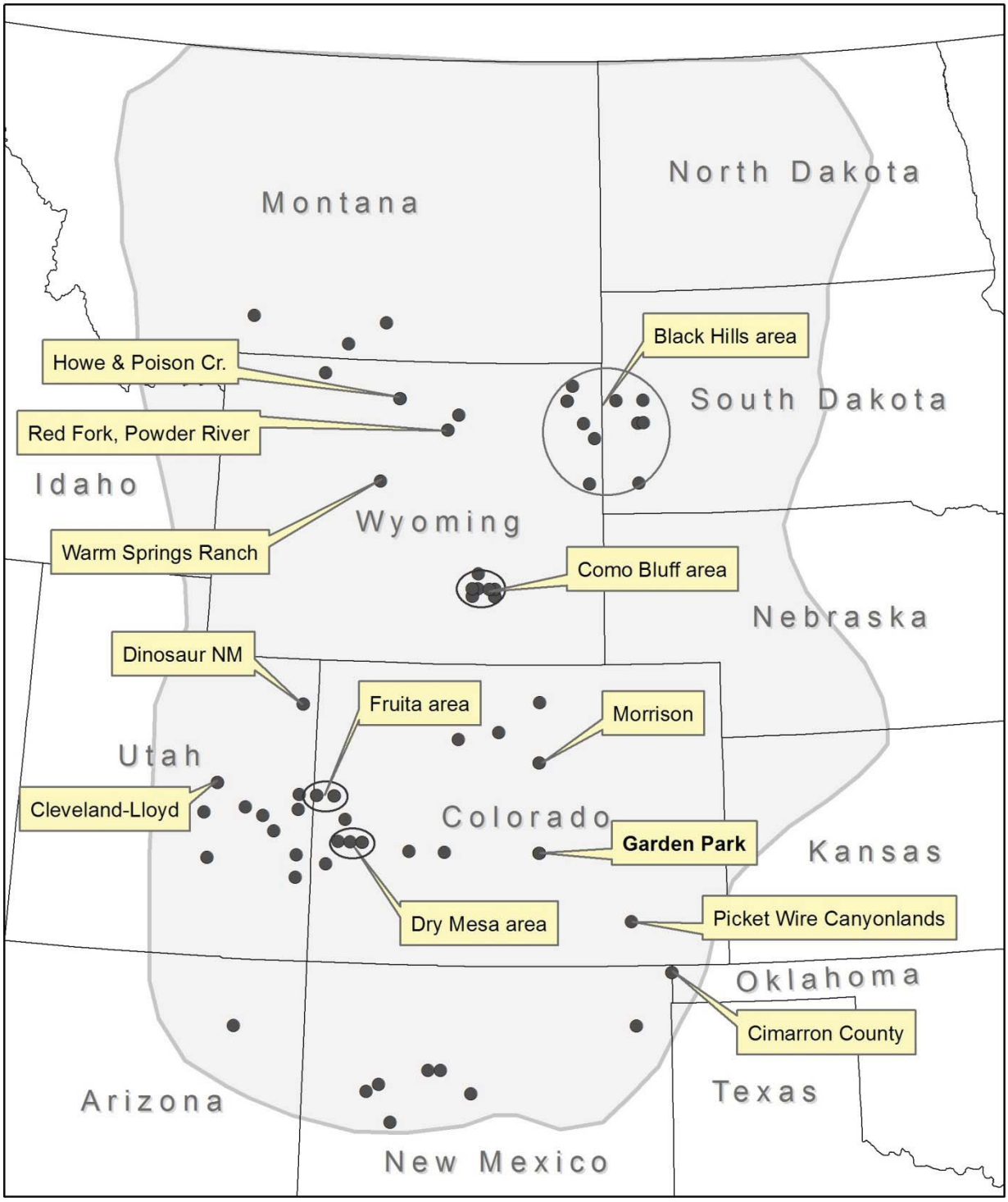

Figure 2. Approximate extent of the Morrison Formation in the western United States (adapted from Dodson et al. 1980), and locations of vertebrate fossil quarries (Paleobiology Database 2011).

Table 3. Comparison of significant Morrison Formation vertebrate fossil areas.
Designated NNL sites are shaded.

Locality	*Haplocanthosaurus*	*Brachiosaurus*	*Camarasaurus*	*Apatosaurus*	*Diplodocus*	*Barosaurus*	*Allosaurus*	*Ceratosaurus*	*Stegosaurus*	*Camptosaurus*	*Dryosaurus*	croc-turtle
Garden Park Fossil Area, CO	X	X	X	X	X		X	X	X	X	X	X
Morrison-Golden, CO			X	X	X		X		X			
Fruita area quarries, CO		X	X	X	X	X	X	X	X	X	X	X
Dry Mesa area quarries, CO		X	X	X	X	X	X	X	X	X	X	X
Picket Wire Canyonlands, CO			X	X	X		X		X			
Cimarron County, OK		X	X	X	X	X	X	X	X	X		
Black Hills vicinity, SD		X	X	X	X	X	X		X	X		X
Cleveland-Lloyd Quarry, UT			X	X	X		X	X	X	X		
Dinosaur NM, UT			X	X	X	X	X	X	X	X	X	X
Como Bluff Area, WY	X	X	X	X	X	X	X	X	X	X	X	X
Howe & Poison Creek, WY	X		X	X	X	X	X		X	X	X	
Warm Springs Ranch, WY			X	X	X	X	X		X	X		
Red Fork, Powder River WY	X		X	X	X		X					

Site Descriptions

Morrison-Golden Fossil Area

This newly expanded NNL near Golden, Colorado is the site that gave the Morrison Formation its name. At about the same time that fossils were being excavated at the Garden Park and Como Bluff sites, a local schoolteacher named Arthur Lakes discovered sauropod bones, and eventually worked the area on behalf of O.C. Marsh (Foster 2007). This area is known internationally for being the only place in the world to have produced a number of unique fossil footprint types representing Cretaceous reptiles, birds and mammals. The sites are well-documented scientifically, well-managed and most areas are used as an educational resource with supporting guidebooks and two interpretative trails available to students and the general public.

Fruita vicinity:

After some years of work in the Wyoming quarries of the Como Bluff region, Elmer Riggs arrived in Colorado's Grand Valley in 1900 to develop quarries in the Morrison Formation there. Riggs' quarries produced a number of important specimens, including the first *Brachiosaurus* ever found (Foster 2007). Over the years, numerous quarries in the vicinity of Fruita, Colorado have made this area famous for Jurassic fossils. One of most productive and interesting sites is the Mygatt-Moore quarry in Rabbit Valley, which has yielded more than 5,000 bones of seven dinosaur species such as *Allosaurus, Camarasaurus*, *Apatosaurus*, and *Diplodocus.* The first North American Jurassic ankylosaurian dinosaur *(Mymoorapelta)* came from this quarry (BLM

2011a), and specimens of preserved dinosaur skin from the site have recently been described (Foster and Hunt-Foster 2011). Quarries near Fruita have yielded a large collection of microinvertebrates, including the unusual Late Jurassic mammal *Fruitafossor* (Foster 2007). The BLM designated the Fruita Paleontological Area in the 1970s in recognition of important finds in the area (Armstrong no date).

Dry Mesa Quarry and vicinity

Southwest of Delta Colorado, the Dry Mesa Quarry overlooks the canyons of the Uncompahgre Plateau. The site was discovered by Daniel E. and Vivian Jones in the 1940s, and later worked by James Jenson and Ken Stadtman of Brigham Young University. The quarry represents an exceptionally diverse paleofauna and has produced several type specimens, including the pterodactyloid pterosaur *Mesadactylus*, the large theropod dinosaur *Tovosaurus*, and the large diplodocid sauropod dinosaur *Supersaurus* (Foster 2007). Other sites in the Uncompahgre Plateau area worked by Jenson include the Potter Creek and Cactus Park quarries.

Picket Wire Canyonlands

In southeastern Colorado, the canyon of the Purgatoire River exposes Morrison Formation strata where three explored quarries have revealed more than 50 dinosaur bone occurrences, including partial skeletons of *Allosaurus, Apatosaurus, Camarasaurus*, and a juvenile *Diplodocus* (Schumacher 2008). An eight foot long shoulder blade of the *Apatosaurus* is on display as the Forest Service office in La Junta, while the other fossil materials are prepared and housed in partnership with the Denver Museum of Nature and Science. The site is a Forest Service Special Interest Area and is most notable for containing the largest assemblage of Jurassic dinosaur trackways in North America, with over 1300 individual prints representing perhaps as many as 100 individual dinosaur trails.

Cimarron County, Oklahoma

In 1931 a road grading crew hit a rich bone bed in the Morrison Formation in the northwest corner of Cimarron County, Oklahoma. J.Willis Stovall of the University of Oklahoma subsequently carried out extensive quarry operations at the site of the first discovery, collecting more than 3,500 individual bones, most of them from a single genus, *Apatosaurus* (then called *Brontosaurus*) and also identified specimens of *Ceratosaurus, Camptosaurus*, and *Stegosaurus* (Stovall 1938). Stovall eventually excavated 17 sites in Cimarron County, recovering about 6,000 bones. The Oklahoma state fossil *Saurophaganax maximus* was later described from his collections(Oklahoma Geological Survey 2000).

Black Hills

In northeast Wyoming and western South Dakota the Morrison Formation forms outcrops around the outer rim of the Black Hills. The type specimen of *Barosaurus lentus*, first recognized by O.C. Marsh in 1890 was based on a partial skeleton from Piedmont, South Dakota. Specimens found in the various Morrison Formation quarries of the region include *Allosaurus fragilis*, *Camarasaurus*, and *Apatosaurus,* as well as carnivorous dinosaurs, and theropod footprints (Bjork and Tallman 1995).

Cleveland-Lloyd

Located in Emery County, Utah, the Cleveland-Lloyd Dinosaur Quarry is noted for having an unusual concentration of fossils of carnivorous dinosaurs. The deposit is the largest collection of the large meat-eating dinosaur (*Allosaurus fragilis*) ever found, but is also one of the most diverse Morrison localities (Foster 2007). Since the 1920s, paleontologists have collected more than 12,000 fossil bones, belonging to at least 74 individual dinosaurs. One commonly presented explanation for the concentration of carnivorous dinosaurs is that the site represents a "predator trap," wherein predators were lured to the site by mired prey species (Foster 2007). Display skeletons from this quarry are on exhibit in more than 65 museums throughout the world. Visitors can also view part of the quarry that has been enclosed for specimen protection (BLM 2001b).

Dinosaur National Monument

The quarry site at Dinosaur National Monument was discovered in 1909 by Carnegie Museum paleontologist Earl Douglass (Hayden 1994). Douglass spent the remainder of his career working the site, known as the Carnegie Quarry. This quarry is the most prolific of the Morrison Formation quarries, yielding specimens of the plant-eating sauropods *Apatosaurus, Diplodocus, Barosaurus,* and *Camarasaurus;* the meat-eating theropods *Allosaurus, Ceratosaurus*, and *Torvosaurus;* and the plant-eating ornithischians *Camptosaurus*, *Dryosaurus*, and *Stegosaurus*, as well as examples of the turtle *Glyptops* and the crocodilian *Goniopholis* (Hayden 1994, Foster 2007). Douglass' finds included several nearly complete skeletons. The juvenile *Camarasaurus* is the most complete sauropod ever found (Hayden 1994). The quarry site and surrounding land was established as a National Monument in 1915.

Como Bluff Region

The Como Bluff NNL is located in Albany and Carbon counties, Wyoming. This region is one of the most significant Mesozoic vertebrate localities in the world, and, together with Garden Park and Morrison, was one of the first major locales of the Morrison Formation. Cope and Marsh both had workers in the area, and the finds here contributed to the rivalry (Foster 2007). Eighty new vertebrate species were found at this site, including the first and best examples of Jurassic mammals (NPS 2011). The many highly productive and diverse quarries of the region, including the Bone Cabin Quarry, Reed's Quarry 13 and Quarry 9, AMNH Stegosaur 1899 Quarry, Ninemile Crossing Quarry, and the Carnegie Sheep Creek and N & O Quarries in the Freezeout Mountains clearly make this the premiere Jurassic site in North America one of the most important fossil sites in North America (Dodson et al. 1980). Reed's Quarry 10 produced the specimen originally known as *Brontosaurus excelsus*, the famous sauropod now called *Apatosaurus* (Foster 2007). The Little Houston Quarry north of Como Bluff has also produced an exceptionally diverse paleofauna (Foster 2007).

Howe & Poison Creek Quarries

One of the densest fossil sites of the Morrison Formation is the Howe Quarry near Shell, Wyoming. The site was first excavated in 1934 by the paleontologist Barnum Brown, of the American Museum of Natural History in New York, who was able to excavate more than 4000 bones of nearly 20 individual dinosaurs during that dig, primarily those of diplodocid sauropod

dinosaurs (Foster 2007). The expedition was funded by the Sinclair Oil Company and it was documented in major news outlets and scientific publications. This site has also produced skin impressions of sauropods, both during the original excavations, and at later digs during the 1990s (Foster 2007). Nearby, the Poison Creek Quarry produced an articulated subadult *Allosaurus* specimen (known as "Big Al") in 1991. Important specimens from this site include a partial *Haplocanthosaurus*, and a large *Camptosaurus*, as well as specimens of other common dinosaurs.

Red Fork Powder River

Quarries at this site on the eastern edge of the Bighorn Mountains in Wyoming were first worked by William Utterback in 1903. In addition to the usual assortment of Morrison Formation dinosaurs, a unique specimen later named *Diplodocus hayi* was uncovered at this site (Foster 2007).

Warm Springs Ranch

The Warm Springs Ranch, near Thermopolis, Wyoming, has one of the largest excavations ever dug in the Morrison Formation. Beginning in 1993, Burkhard Pohl and the Wyoming Dinosaur Center created a massive open-pit quarry containing nearly 40 individual excavation sites (Foster 2007). Material from this site includes specimens of *Diplodocus, Camarasaurus, Apatosaurus, Allosaurus, Stegosaurus,* and *Camptosaurus*.

Comparative Analysis & Discussion

Although the Garden Park Fossil Area is not the largest or most diverse fossil site providing Jurassic age specimens from the Morrison Formation, it unquestionably played a significant historic role during a defining period in American paleontology, bringing dinosaur fossils to the national and international stage. The Garden Park Area, particularly the Marsh Felch Quarry, provided several complete articulated skeletons enabling scientists to piece together what was initially a puzzle. Each of the major quarries provides a piece of the puzzle in the reconstruction of past life on our planet. The importance of Garden Park was recognized with the original designation. Expansion of the NNL designation would enhance the value and meaning of the original designation by including quarries producing many important discoveries, including those for which site was originally established.

Illustrative Character

The expansion proposed for the Garden Park Fossil Area adds significantly to the illustrative character of the NNL. As currently designated, the area includes the Colorado Historical Society monument on the roadside below the Marsh Quarry, but does not actually include any of the fossil quarries present in the area. The proposed expansion would include the important fossil sites on federal land, as well as the associated interpretive trail and signs. The quarries and unworked deposits at Garden Park provide an exceptional record of Jurassic age specimens from the Morrison Formation, and the history of the site illustrates the development of American paleontology in a fashion unmatched at other comparable paleontological sites (Evanoff and Kuntz 1987).

Present Condition

Garden Park Fossil Area is largely an intact natural landscape, with only moderate alteration by human activities. Within the mosaic of high quality pinyon-juniper woodlands, grasslands, and clay barrens, there are a few developed roads and minimal recreational facilities. The paleontological resources are well managed and preserved under the ACEC designation, even though the area receives a fair amount of visitation. The intact ecosystems provide habitat for several of Colorado's endemic rare plant species.

Diversity

The Garden Park Fossil Area is among the most diverse Morrison Formation sites, perhaps second only to the Como Bluff area in Wyoming. Most of the characteristic large invertebrates of the period are represented at Garden Park, along with fossil remains of many other groups. The area has provided nearly two dozen type specimens.

Rarity

It is rare to find *Stegosaurus* specimens as complete as those found at Garden Park, and the *Haplocanthosaurus* specimens from Garden Park are the ones found outside Wyoming. The site also supports two rare endemic plant species.

Value for Science and Education.

The history of discoveries made at Garden Park Fossil Area is well documented, providing important insight into the ideals and aspirations of American paleontology as well as a revealing portrait of the personalities involved. High quality specimens from this site have been sent to institutions across the country, where they continue to provide basic scientific evidence for the evolution of Jurassic life forms, and serve as educational material. It is likely that significant amounts of fossil evidence remain undiscovered in this area, providing a reservoir of future scientific data for the ongoing research by paleontologists into this period. Interpretive signage at the site also provides educational opportunities for visitors.

EVALUATION RECOMMENDATIONS

The Garden Park Fossil Area site qualifies for expansion of its designation as a National Natural Landmark.

Summary Significance Statement

Garden Park Fossil Area remains one of the most important excavation sites for fossils of the Jurassic Period sub-theme under the Triassic-Cretaceous geologic history theme, and has unique historical significance in the story of American paleontology.

Proposed Landmark Boundary and Ownership Maps

The proposed landmark boundary was provided by the Colorado Bureau of Land Management Royal Gorge Field Office, with the following legal description and acreage:

Table 4. Legal description of proposed expanded designation.

LEGAL DESCRIPTION: 6th PM	***Approximate*** equivalent quarter-quarter description	Acreage
T 18 S., R70W:		
Section 3, Lot 2	NW¼ of NE¼	40.74
Section 4, Lot 1	NE¼ of NE¼	40.56
T 17 S., R 70W:		
Section 20, E½SE, SENE	E½ of SE¼, SE¼ of NE¼	120
Section 21, Lots 1-5, SWSE	SW¼, SW¼ of SE¼, SW1¼ of NW¼	226.35
Section 23, SWSE, SESE, SWSW	S½ of SW¼, SW¼ of SE¼	120
Section 26, W½, W½E½, W½SESE	W½, W½ of E½, W½ of SE¼ of SE¼	500
Section 27, Lots 1-4, E½	E½, SW¼	492.4
Section 28, Lots 1-12, NWSE, NWNE	W½, SE¼, E½ of NE¼	506.23
Section 29, E½NE, NESE	E½ of NE¼, NE¼ of SE¼	120
Section 33, Lots 1, 2, 7-11	NE¼, N½ of SE¼, SE¼ of SE¼	247.02
Section 34, Lots 1, 2, E½, NW, E½ SE, SWSE	Entire section	675.34
Section 35, NWNW, SWNW, NENW	W½ of NW¼, SW¼ NW¼	120

This area encompasses approximately 3208.64 acres, and are all federal lands under BLM management. The boundary and master title plot are shown in Figure 3.

LANDMARK BRIEF

Name: Garden Park Fossil Area

Location: Fremont County, Colorado

Description:
The Garden Park Fossil Area is located in Fremont County, Colorado, along the Fourmile Creek drainage approximately 8 miles north of Cañon City. The site was originally designated in 1973 in recognition of the historical and paleontological significance of the Jurassic age dinosaur discoveries excavated from outcrops of the Morrison Formation in the area. An additional 3168.64 acres are proposed for expansion of the original 40-acre NNL site, bringing the total designation to 3208.64 acres. Quarries in the Garden Park area played an important role in the "Bone Wars" of the early period of American paleontology, and activities at this site were responsible for generating wide-spread interest in dinosaurs beginning in the late 1870s. Important discoveries include the three most complete *Stegosaurus* skeletons ever found, as well as the first known remains of dinosaurs like *Camarasaurus, Ceratosaurus,* and *Diplodocus*. In addition to dinosaurs, Garden Park has also produced fossils of Late Jurassic mammals, trees, and turtles, among other things, and finds include 23 type specimens.

The site also includes a high quality example of pinyon-juniper woodlands that support populations of two plants endemic to the upper Arkansas valley.

Significance:
Garden Park Fossil Area is among the most important and diverse Late Jurassic age fossil sites in North America. It was one of the primary areas responsible for generating worldwide interest in dinosaurs during the late 1800s. The proposed expansion would greatly increase the validity of the site by incorporating the majority of the fossil quarries at Garden Park.

Ownership: Federal

Designation: November 1973; Boundary expanded 2012

Evaluation: Dr. Paul O. McGrew and Michael W. Hager, University of Wyoming, 1972; Karin Decker, Colorado Natural Heritage Program, 2012.

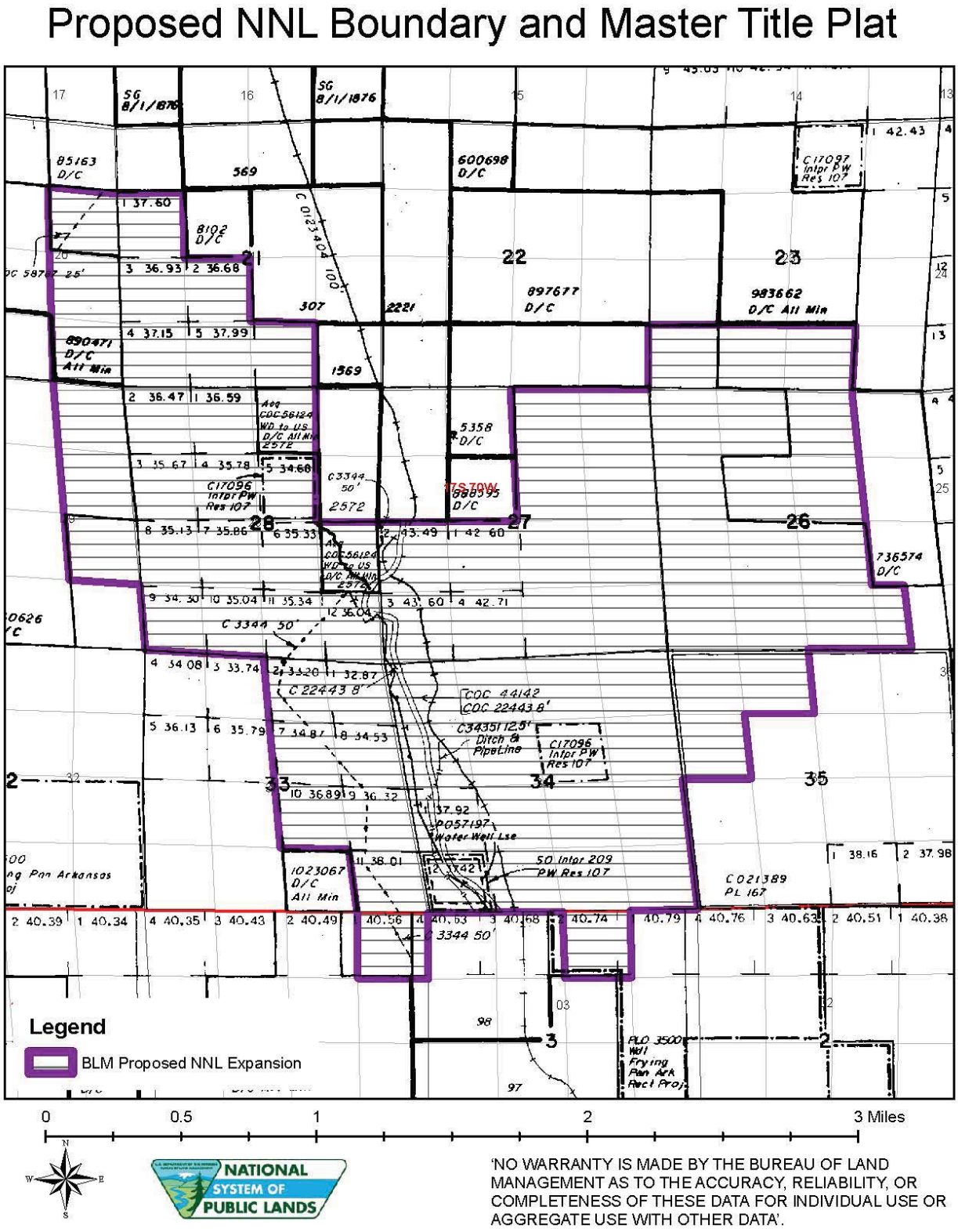

Figure 3. Proposed boundary and master title plat for Garden Park Fossil Area.

Figure 4. Location of Garden Park Fossil Area in Colorado.

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