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Bureau of Land Management

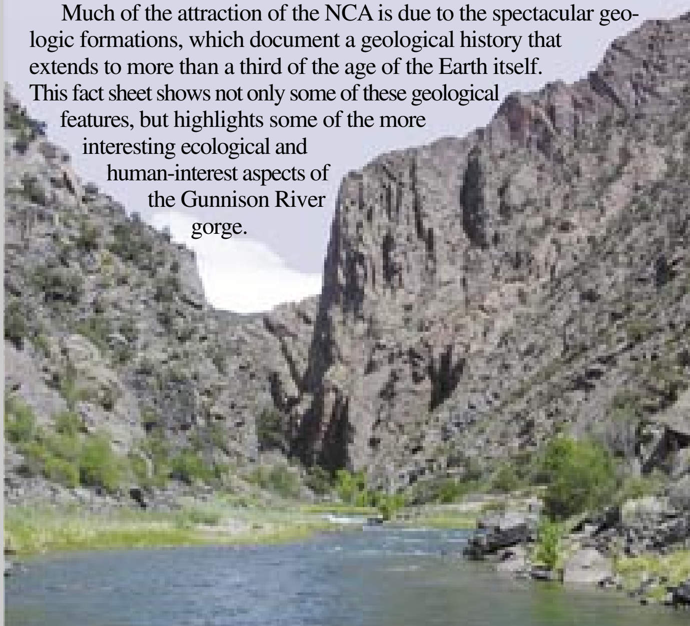
Geology of Gunnison Gorge National Conservation Area, Delta and Montrose Counties, Colorado

Prepared in cooperation with
The U.S. Bureau of Land Management

Introduction

The 57,725-acre Gunnison Gorge National Conservation Area (hereafter referred to as the NCA) was created by Congress in 1999 and is administered by the U.S. Bureau of Land Management (BLM). The NCA is the downstream continuation of Black Canyon of the Gunnison National Park. Unlike the almost inaccessible depths of the Gunnison River canyon within the National Park, several good hiking trails provide access to the canyon within the NCA. It is one of the most beautiful and accessible wild areas to be found in the United States. Every year the gorge attracts over 10,000 visitors, who explore its depths and the surrounding hills by foot, horseback, mountain bike, kayak, and raft. Towering cliffs, quiet riverside glens, cascading rapids, winding trails with spectacular canyon views—these are just a few of the features enjoyed by visitors to the NCA.

Much of the attraction of the NCA is due to the spectacular geologic formations, which document a geological history that extends to more than a third of the age of the Earth itself. This fact sheet shows not only some of these geological features, but highlights some of the more interesting ecological and human-interest aspects of the Gunnison River gorge.



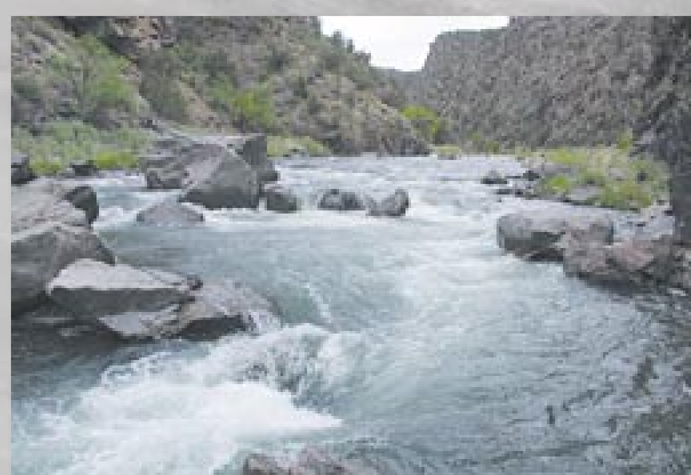
Two lizards sunning themselves on an outcrop of migmatitic biotite gneiss (Xmg) *in the canyon of Smith Fork. The distance between the lizards is about one foot (30 cm).*

Geology

The fascinating geologic story of the Gunnison River gorge is too complicated to describe in detail in this fact sheet. However, this story is told in a separate, companion book, "The Geologic Story of Gunnison Gorge National Conservation Area, Colorado" (Kellogg, in press). For the purposes of this fact sheet, the geology is briefly described here.

The oldest rocks in the gorge are the ancient basement rocks that make up the mostly steep, dark-colored walls beneath horizontal layers of sedimentary rock. These basement rocks were formed by igneous and metamorphic processes deep in the Earth's crust during the Proterozoic Eon, approximately 1.7–1.4 billion years ago. Examples of metamorphic rocks in the gorge are quartzitic gneiss, mica schist, amphibolite, and migmatite. Within the NCA, coarse-grained Pitts Meadow Granodiorite intruded these ancient metamorphic rocks. In addition, many light-colored dikes and irregular masses of coarse-grained pegmatite form a conspicuous network of igneous intrusions throughout the canyon.

A tremendous period of time—over 1.5 billion years—transpired between the formation of the basement rocks and the deposition of the oldest sedimentary rocks that rest on them. We know that several periods of uplift and erosion took place during this long intervening period. A relatively good geologic record exists for the period of uplift that resulted in the ancestral Uncompahgre uplift, one of several mountainous areas in the Rocky Mountain region that rose about 300 million years ago. Erosion that followed the uplift denuded the region of the 550–300-million-year-old rocks that had been deposited before uplift. The oldest sedimentary rocks that remain on the ancient eroded basement surface are 190 million years old. A younger period of uplift and major mountain building, called the Laramide orogeny, occurred about 70–50 million years ago and formed the pattern of ranges of the present Rocky Mountains.



***(RIGHT)** The Boulder Garden, a class III–IV rapids, contains large blocks of dark Pitts Meadow Granodiorite* (Xpmd).

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The oldest sedimentary rocks in the NCA form the Middle Jurassic Entrada Sandstone, which is composed of pink to yellowish-orange, cross-bedded sandstone that accumulated as ancient sand dunes. Overlying the Entrada are mudstone, sandstone, and gypsum of the Middle Jurassic Wanakah Formation, which were deposited in a closed, shallow inland sea. With time, the land was slowly uplifted and the sea retreated. The sea-floor sediments were then buried by sand and mud deposited in coastal lakes and rivers, and those sediments now form the multicolored sandstone and shale beds of the Upper Jurassic Morrison Formation. The basal part of the Morrison Formation is called the Tidwell Member, which contains some gypsum beds, indicating that shallow, enclosed seas periodically covered the land during deposition of the Tidwell.

Overlying the Tidwell Member is the Salt Wash Member of the Morrison Formation, which contains cross-bedded, red-stained (from the overlying reddish shale), fluvial (deposited in rivers) sandstone beds and interbedded shale. Overlying the Salt Wash Member are colorful red, green, and gray shales and thin sandstone beds of the upper Brushy Basin Member of the Morrison, which are host to some world-famous dinosaur-bone localities outside the NCA.

(ABOVE) *View to the north showing the Ute Indian fault.* Je, *Entrada Sandstone;* Jw, *Wanakah Formation;* Jmt, *Tidwell Member of the Morrison Formation;* Jms, *Salt Wash Member of the Morrison Formation;* Jmb, *Brushy Basin Member of the Morrison Formation;* Kb, *Burro Canyon Formation. Note how the down-to-the-east displacement across the fault dies out to the north, such that the beds of unit Jmt are folded but not broken by the fault. Where formation and member contact lines are dashed, and where the Ute Indian fault is dashed, indicates that these features are approximately located or concealed.*

On the geologic map in this fact sheet, the Wanakah Formation and the Tidwell Member of the Morrison Formation are combined as one map unit (labeled Jmtw), the Salt Wash and Brushy Basin Members of the Morrison Formation are combined as one unit (labeled Jmu*), and the Burro Canyon Formation and Dakota Formation are combined as one unit (labeled* Kdb*). They are combined, because at the scale (size) of the geologic map, these units would be too thin to show separately.*

(BELOW) *Panoramic view downriver toward Ute Park.*

A gap exists in the geologic record following the deposition of the Morrison Formation. This gap was a time when there was either no deposition of sedimentary or volcanic rocks, or possibly such rocks were deposited, but they were eroded away. Such a gap in the geologic record is called an unconformity. The rocks above the unconformity are fluvial deposits of the Lower Cretaceous Burro Canyon Formation, which form thick beds of cliff-forming, light-brown, quartz sandstone with interbedded shale and chert-pebble conglomerate. Above the Burro Canyon Formation, thin beds of quartz sandstone, shale, and coal in the Lower to Upper Cretaceous Dakota Formation record a time when rivers and swamps deposited sand, mud, and decaying plant material along a tropical marine shoreline.

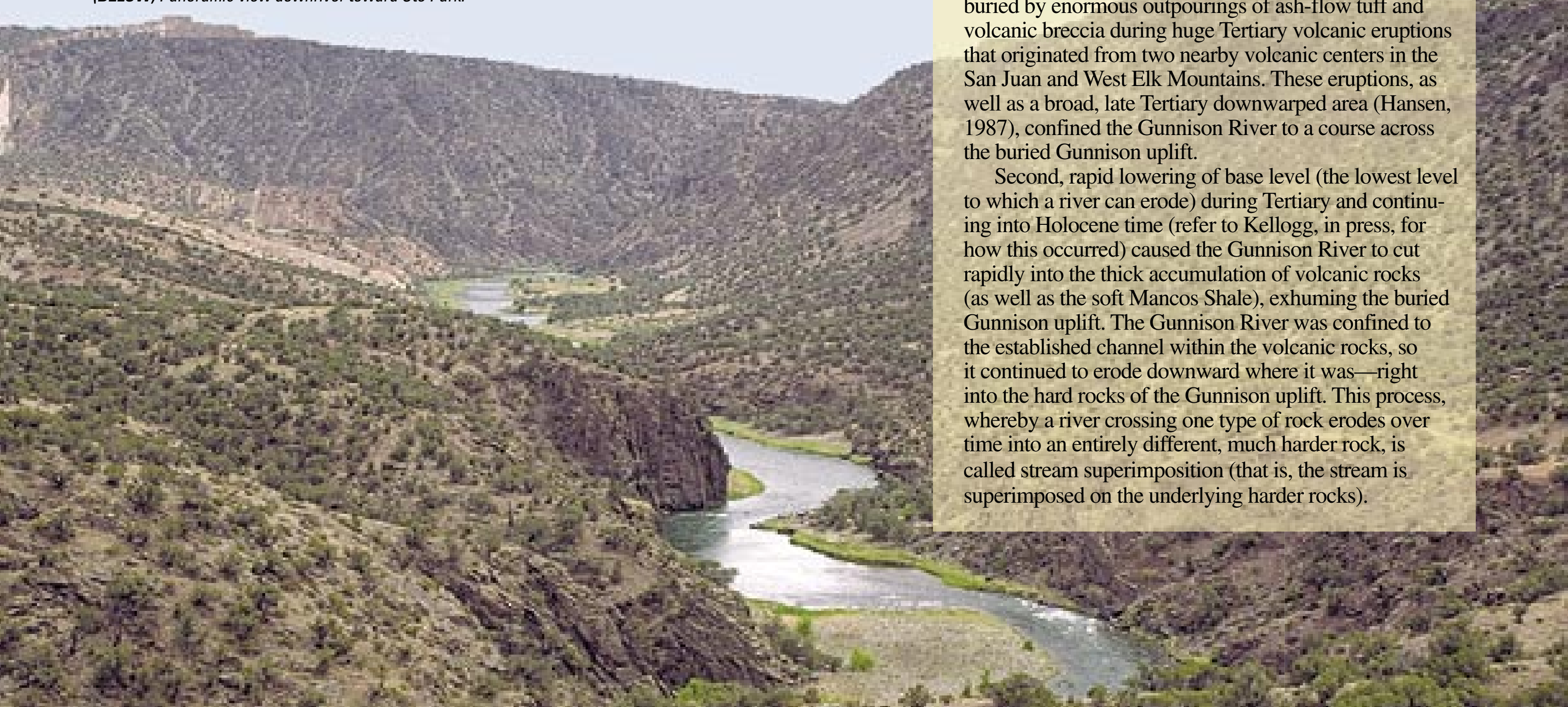
Once again, the sea gradually covered the land, and earlier deposits of sand of the Dakota Formation were buried by thick deposits of marine mud of the Upper Cretaceous Mancos Shale, which now form a gray badlands landscape of weathered shale and mudstone in the southwestern and western parts of the NCA. The Mancos Shale is the youngest consolidated bedrock formation exposed in the NCA. Much younger, mostly uncemented Quaternary surface deposits, such as alluvium, terrace gravels, landslide deposits, and talus, cover large areas of the NCA.

Ute Indian fault: a Spectacular Laramide Feature

The Gunnison River gorge contains one of the most spectacularly exposed faults in Colorado—the Ute Indian fault. It is magnificently displayed along part of the gorge. The Ute Indian fault formed during a period of great mountain building called the Laramide orogeny, which began near the end of the Cretaceous Period (about 70 million years ago) and lasted about 20 million years into early Tertiary time. During the Laramide orogeny, the present Rocky Mountains formed, although the mountains have subsequently been greatly modified by erosion, volcanic activity, faulting, and additional uplift. The Gunnison River cuts through the middle of the Gunnison uplift, one of a number of highlands that rose during the Laramide orogeny.

The Ute Indian fault is a north-trending thrust fault that dips (is inclined) about 40º to the west. During the Laramide orogeny, Proterozoic basement rocks were shoved up and to the east along the Ute Indian fault by as much as 1,150 feet (350 meters) vertically above Jurassic sedimentary rocks.

The fault is clearly exposed in Chukar Canyon and generally follows the gorge northward, crossing the Gunnison River at several places. At both its south and north ends, displacement on the fault dies out.



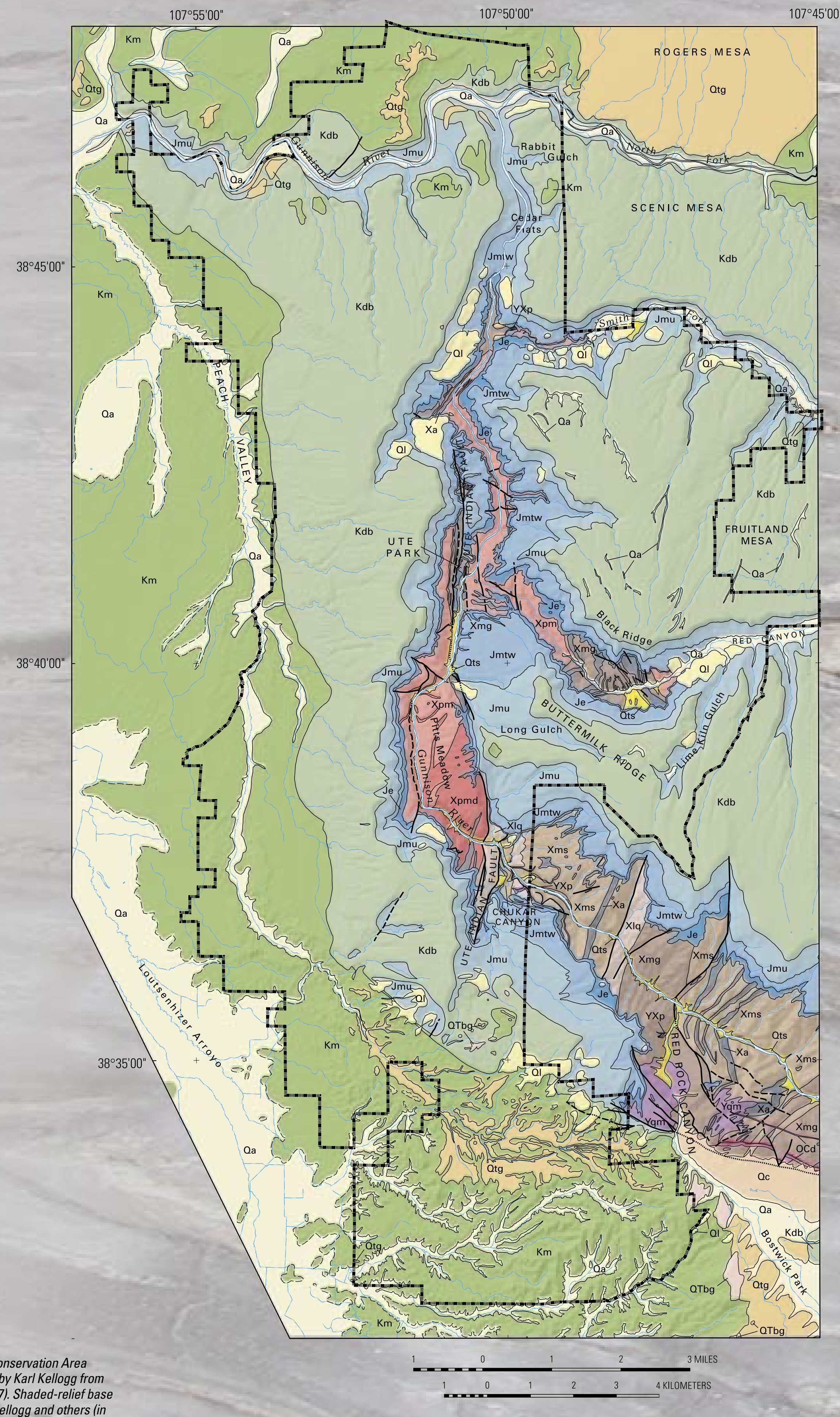
The Gunnison River Paradox

Why does the Gunnison River cut through the center of the Gunnison uplift and not around it? Two interesting geologic relationships have been proposed to explain this paradox. First, the Gunnison uplift was mostly buried by enormous outpourings of ash-flow tuff and volcanic breccia during huge Tertiary volcanic eruptions that originated from two nearby volcanic centers in the San Juan and West Elk Mountains. These eruptions, as well as a broad, late Tertiary downwarped area (Hansen, 1987), confined the Gunnison River to a course across the buried Gunnison uplift.

Second, rapid lowering of base level (the lowest level to which a river can erode) during Tertiary and continuing into Holocene time (refer to Kellogg, in press, for how this occurred) caused the Gunnison River to cut rapidly into the thick accumulation of volcanic rocks (as well as the soft Mancos Shale), exhuming the buried Gunnison uplift. The Gunnison River was confined to the established channel within the volcanic rocks, so it continued to erode downward where it was—right into the hard rocks of the Gunnison uplift. This process, whereby a river crossing one type of rock erodes over time into an entirely different, much harder rock, is called stream superimposition (that is, the stream is superimposed on the underlying harder rocks).

Geologic Time

Geologic Eon, Period, or Epoch	Estimated age	
	Today	
Holocene		
	10,000 years	
Pleistocene		
	1.8	Million years
Tertiary		
	65	
Cretaceous		
	144	
Jurassic		
	206	
Triassic		
	248	
Permian		
	290	
Pennsylvanian		
	323	
Mississippian		
	354	
Devonian		
	417	
Silurian		
	443	
Ordovician		
	490	
Cambrian		
	543	
Proterozoic	1.0	Billion years
	2.5	
Age of the Earth	4.5	



Geologic map of Gunnison Gorge National Conservation Area and vicinity. Geology compiled and modified by Karl Kellogg from Hansen (1968, 1971) and Ellis and others (1987). Shaded-relief base created by D. Paco VanSistine in 2003. See Kellogg and others (in press) for a large, detailed version of this map.

List of Geologic Map Units

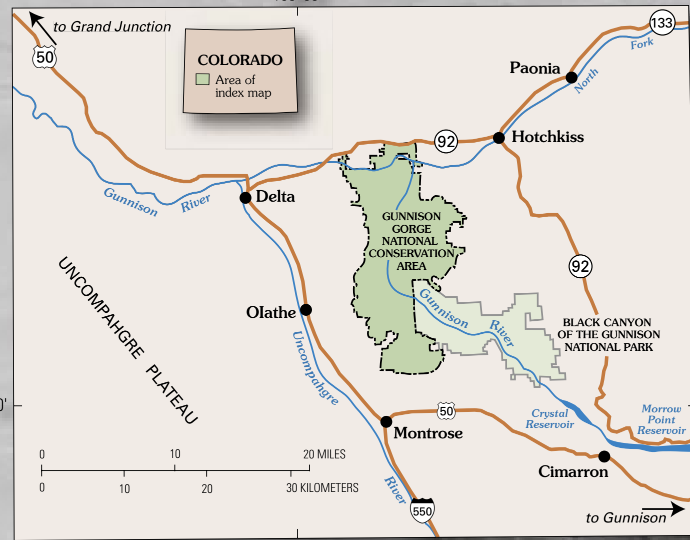
Name of geologic map unit and geologic age of unit are shown

Qa	**Valley alluvium (Holocene)**
Qts	**Talus (Holocene)**
Ql	**Landslide deposit (Holocene)**
Qc	**Colluvium (Holocene and Pleistocene)**
Qtg	**Terrace gravel (Holocene and Pleistocene)**
QTbg	**Boulder gravel (Pleistocene and (or) Pliocene)**
Km	**Mancos Shale (Upper Cretaceous)**
Kdb	**Dakota Formation and Burro Canyon Formation (Upper and Lower Cretaceous)**
Jmu	**Morrison Formation, upper part (Upper Jurassic)**
Jmtw	**Tidwell Member of Morrison Formation and Wanakah Formation (Upper and Middle Jurassic)**
Je	**Entrada Sandstone (Middle Jurassic)**
O€d	**Diabase dike (Ordovician or Cambrian)**
YXp	**Pegmatite (Middle or Early Proterozoic)**
Yqm	**Vernal Mesa Quartz Monzonite (and similar rocks) (Middle Proterozoic)**
Xpm	**Pitts Meadow Granodiorite (Early Proterozoic)**
Xpmd	**Pitts Meadow Granodiorite, dark-colored variant**
Xa	**Amphibolite (Early Proterozoic)**
Xlq	**Layered quartzitic gneiss (Early Proterozoic)**
Xms	**Mica schist (Early Proterozoic)**
Xmg	**Migmatite (Early Proterozoic)**

Contact between geologic map units—Dashed where approximately located

Fault—Dashed where approximately located, dotted where concealed by surficial deposits

Approximate boundary of Gunnison Gorge National Conservation Area



Index map showing location of the Gunnison Gorge National Conservation Area and Black Canyon of the Gunnison National Park. Major roads are shown in brown.

Humans and the Canyon

The earliest known inhabitants or visitors to the canyon were prehistoric Native Americans who camped and hunted in the area. Petroglyphs and rock structures that were constructed without mortar are scattered throughout the canyon. Clovis and Folsom spear points have been found in the Uncompahgre River valley, indicating that the region has been inhabited for at least 10,000–11,000 years. More recently, until historic times, mountain-dwelling Utes traversed the canyon's depths.

The Gunnison River is named after John William Gunnison, who led an expedition through the region in 1854 to survey a railroad route from the Mississippi River to the Pacific Ocean. The Black Canyon of the Gunnison understandably caused the expedition to make a large detour and led Gunnison to conclude that a railroad could be constructed through the region only "at an enormous expense."

Few people have lived permanently in the canyon. During the Depression years, John Howell from Olathe built several cabins and eked out a living prospecting for gold and mining mica from pegmatite deposits in the Ute Park area. The Duncan brothers also prospected in the canyon at about the same time; the ruins of their stone cabin and a prospect tunnel are at the base of the Duncan Trail.

"Howell Village," the remains of John Howell's cabins built during the 1930s just north of Ute Park. Howell was a prospector who lived in the canyon during the Great Depression.

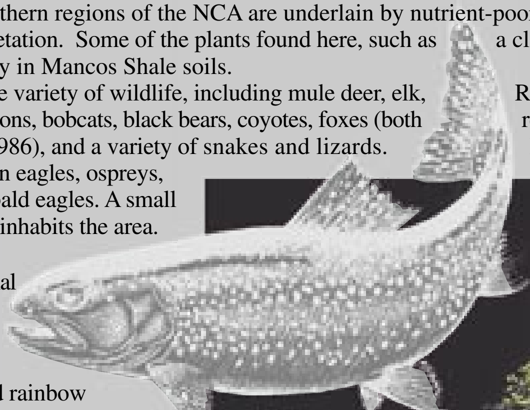
Ecology of the Canyon

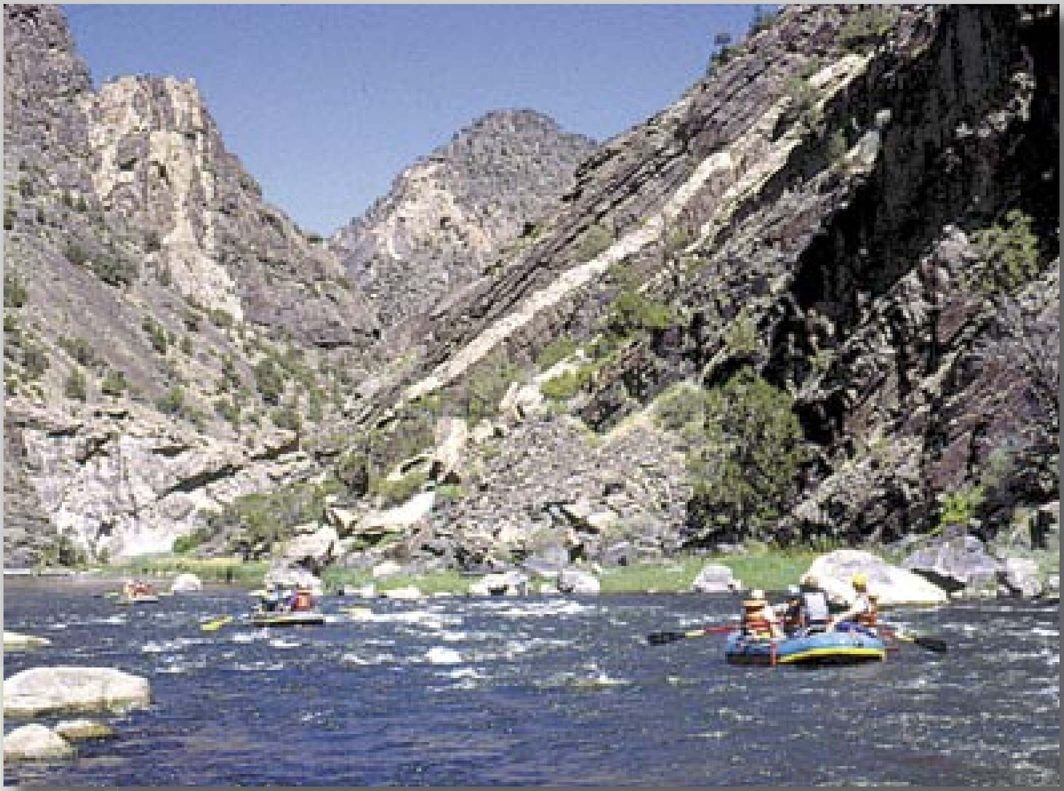
The canyon has a variety of ecological environments. Riparian habitats along the river corridor are host to cottonwoods, box elder, willows, patches of poison ivy, and other water-loving plants. In addition to these native plants, tamarisk (salt cedar), an introduced water-loving species, is making inroads along the riverbank. The BLM has launched an aggressive tamarisk-control program to rid the NCA of this threat to native plant communities.

Rocky Mountain bighorn sheep.

Farther back from the river is a semi-arid environment containing juniper, scrub oak, mountain mahogany, grasses, Mormon tea, occasional cactus, and other plants. Pinon-juniper forests and open sagebrush parks mark the higher regions of the NCA. The western and southern regions of the NCA are underlain by nutrient-poor Mancos Shale, which forms a barren landscape with sparse vegetation. Some of the plants found here, such as a clay-loving species of buckwheat, are endangered and are found only in Mancos Shale soils.

The NCA is the home of a wide variety of wildlife, including mule deer, elk, Rocky Mountain bighorn sheep (reintroduced in 1986), mountain lions, bobcats, black bears, coyotes, foxes (both red fox and the diminutive kit fox), river otters (also reintroduced in 1986), and a variety of snakes and lizards. Birds of prey include peregrine and prairie falcons, kestrels, golden eagles, ospreys, red-tailed hawks, and occasional bald eagles. A small population of turkey vultures also inhabits the area. Many other bird species are either residents of the canyon or are seasonal visitors. The Gunnison River is considered a "gold-medal" trout stream and contains introduced eastern brook, German brown, and rainbow trout, as well as northern pike. Certain native warm-water species, such as the humpback chubb, and pikeminnow, no longer inhabit the canyon. Native fish have had to compete with the non-native fish for food and habitat, and they have had to exist in water that is considerably colder than it was before the early 1960s, when three upstream dams (Crystal, Morrow Point, and Blue Mesa) were built. Water from these dams is released from the deepest and coldest parts of these reservoirs and provides ideal habitat for the canyon's excellent trout fishery, but has proved deadly for most native warm-water species.





Running the river, just below the Chukar Canyon launch site. The light-colored rocks are dikes of coarse-grained pegmatite (YXp) *cutting layered quartzitic gneiss* (Xlq). *View is toward the northwest.*

Acknowledgments

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Prickly pear cactus (Opuntia phaeacantha).