NATIONAL CONSERVATION LANDS

Grand Staircase-Escalante National Monument

SCIENCE PLAN

January 2025

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

Our Mission

The Bureau of Land Management's mission is to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations.

NATIONAL CONSERVATION LANDS

Mission

Conserve, protect, and restore nationally significant landscapes that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations.

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ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Full Phrase
ACEC	area of critical environmental concern
AIM	Assessment, Inventory, and Monitoring
BLM	United States Department of the Interior, Bureau of Land Management
dBA	A-weighted decibel
EIS	environmental impact statement
ERWP	Escalante River Watershed Partnership
ESA	Endangered Species Act of 1973
Forest Service	United States Department of Agriculture, Forest Service
Glen Canyon	Glen Canyon National Recreation Area
GSENM	Grand Staircase-Escalante National Monument
NCL	National Conservation Lands
NEPA	National Environmental Policy Act of 1969
PFC	proper functioning condition
RAPTOR	Recreation and Permit Tracking Online Reporting
RMP	resource management plan
RNA	research natural area
SSI	Springs Stewardship Institute
SUU	Southern Utah University
TDS	total dissolved solids
UDWR	Utah Division of Wildlife Resources
UNESCO	United Nations Educational, Scientific, and Cultural Organization
U.S.	United States
USFWS	United States Department of the Interior, Fish and Wildlife Service
USGS	United States Geological Survey
UTDWQ	Utah Division of Water Quality
VOC	volatile organic compound
VRI	visual resource inventory
VRM	visual resource management
WSA	wilderness study area
WSR	wild and scenic river

Section 1. Introduction and the Scientific Mission of Grand Staircase-Escalante National Monument

1.1 Purpose for National Conservation Lands Science Plans

In 1996, Proclamation 6920 by President Bill Clinton created Grand Staircase-Escalante National Monument (GSENM) under the authority of the 1906 Antiquities Act. GSENM originally included 1.7 million acres. Subsequent congressional action increased the size to 1.87 million acres. GSENM is the first national monument to be managed by the Bureau of Land Management (BLM). The 1996 proclamation stated that this "vast and austere landscape embraces a spectacular array of scientific and historic resources." The original proclamation identified over 120 specific objects that make the area magnificent, including diverse geological features, world-class paleontology (mostly Late Cretaceous fossils), outstanding archaeological and historic sites, scarce water resources, and an impressive diversity of plants and animals.

GSENM is part of the United States' National Conservation Lands (NCL) and is legislatively codified in the Omnibus Public Land Management Act of 2009 (Public Law 111-11). This system (previously known as the National Landscape Conservation System) currently includes 905 units spread across approximately 37 million acres of public lands managed by the BLM. The NCL directs the BLM to conserve, protect, and restore the outstanding cultural, ecological, and scientific values of NCL units. Scientific research is an important public land value and an indispensable tool for resource management. This Science Plan is formulated to support and foster scientific research.

GSENM was established with a strong scientific focus, as outlined in Presidential Proclamation 6920 (1996). The proclamation states:

> ". . . this unspoiled natural area remains a frontier, a quality that greatly enhances the monument's value for scientific study. . .. The monument presents exemplary opportunities for geologists, paleontologists, archeologists, historians, and biologists."

The value of GSENM for scientific study was reiterated and strengthened in Presidential Proclamation 10286 (2021), which states:

> "In the 25 years since its designation, Grand Staircase-Escalante has fulfilled the vision of an outdoor laboratory with great potential for diverse and significant scientific discoveries. During this period, hundreds of scientific studies and projects have been conducted within the monument . . .. New scientific discoveries are likely just around the corner . . . Scientists have utilized every corner of the monument in their efforts to better understand our environment, our history, our planet's past, and our place in the universe."

The 1.87 million acres of GSENM contain unique and significant resources for scientific study, assessment, and education. As such, this GSENM Science Plan supports the purpose for which GSENM was designated.

This Science Plan also follows guidance from BLM Manual 6220 on managing NCLs. Manual 6220 forms the outline of this document (as indicated by the section number):

- Identify the scientific mission of the unit (this section).
- Summarize past scientific efforts (Section 2) in the unit and identify the priority needs and management issues within the unit that can be addressed by scientific inquiry (Section 3).
- Define a strategy for accomplishing the scientific goals of the unit (Section 4).
- Develop a science authorization process to ensure scientific inquiry does not negatively impact the long-term sustainability of the unit and its resources (Section 5).
- Create a system to organize scientific reports (Section 6).
- Help and promote the integration of science into management (Section 7).

The BLM has defined science in various documents (such as the National Landscape Conservation System Science Strategy [BLM 2007] and the BLM Science Strategy [BLM 2008a]) to mean the rational, systematic study of natural and social phenomena using repeatable observations or experiments. In the context of land management, scientific data are collected, analyzed, and synthesized to increase knowledge and support decision-making. Within NCL units there is an expectation for "identifying science needed to address management issues, communicating those needs to science providers, and incorporating the results into the decision-making process" (BLM 2007).

This GSENM Science Plan provides direction to:

- Fulfill the vision of GSENM as a premier outdoor laboratory and a place for understanding our environment, our history, our planet's past, and our place in the universe.
- Ensure that best available scientific information is foundational for all management decisions.
- Encourage and support scientific research to avoid degradation and advance the protection of GSENM objects.
- Actively promote basic and applied science on GSENM resources and objects, and disseminate the findings of such research.
- Prioritize research on vulnerable GSENM objects that could be lost over a short time frame (100 years or less).

This GSENM Science Plan will be a living document in the sense that it will be updated as necessary and practical (BLM 2017, Section 4). Scientific needs that emerge in the future should be added to the plan to meet the unit's scientific mission. The prioritization of scientific needs may change over time with new scientific discoveries, data, demands for use, or changes in climate that create new challenges and opportunities.

1.1.1 Scientific Mission

This Science Plan, along with the GSENM Resource Management Plan (RMP; BLM 2025), will be used as the basis for conducting science in GSENM. Scientific efforts within GSENM support the monument's purposes and the conservation, protection, and restoration of the diverse resources, including those identified in Proclamation 10286. As stated in the RMP (BLM 2025), the goals and objectives with regards to science in GSENM are the following:

Goal: Encourage, support, and conduct scientific research within GSENM to fulfill the vision of GSENM as an outdoor laboratory to improve understanding of our environment, our history, our planet's past, and our place in the universe.

Objective: Encourage and advance scientific research in GSENM, consistent with the protection of GSENM objects and resources, to maximize benefits to the management goals of GSENM, to Tribal Nations, to other stakeholders, and to the scientific community.

Objective: Improve knowledge and understanding of the species present and a general understanding of the ecosystem processes, cycles, and anthropogenic influences in GSENM.

Objective: Improve knowledge and understanding of geological, cultural, historical, archaeological, and paleontological resources associated with GSENM.

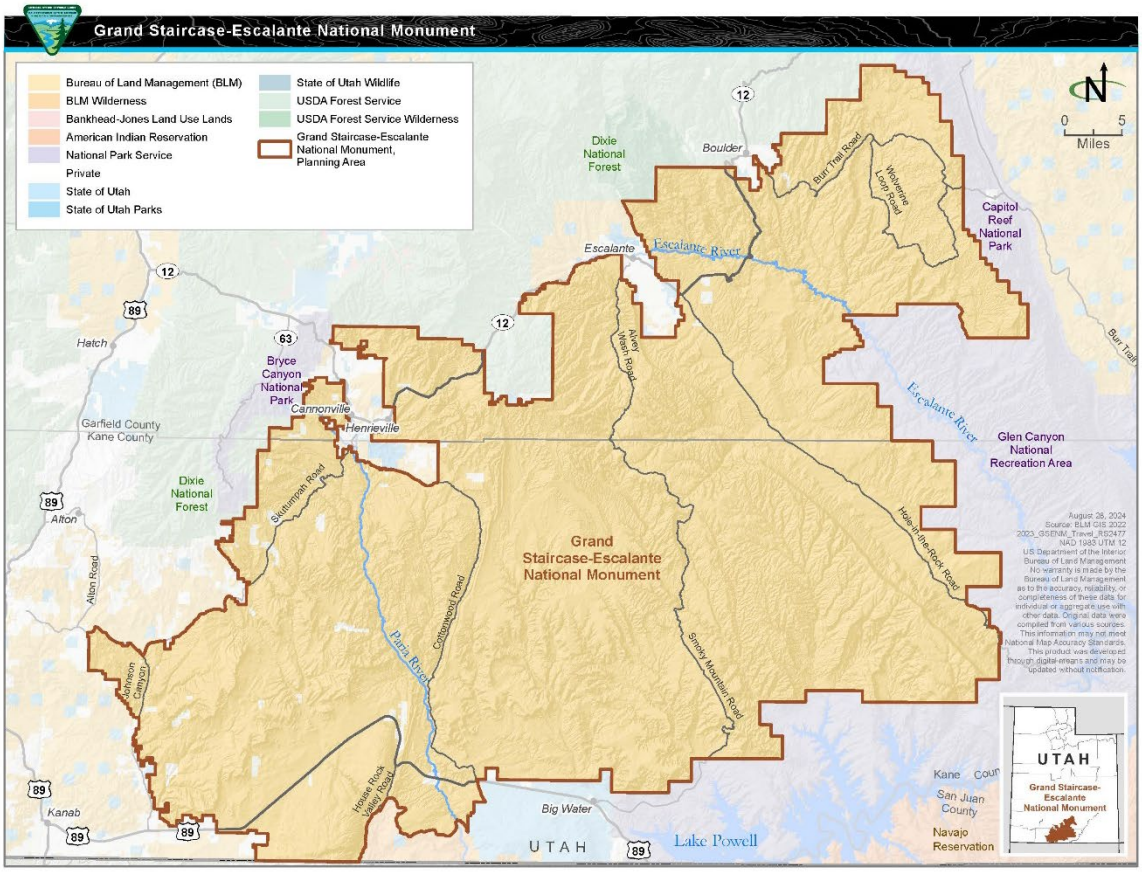
Objective: Improve knowledge and understanding of the social, economic, and recreational benefits associated with GSENM.

1.1.2 GSENM Geography

Figure 1-1: Landscape of GSENM

GSENM is within the Colorado Plateau ecoregion in Kane and Garfield Counties of south-central Utah (**Figure 1-2**). It includes three distinct physiographic provinces: Grand Staircase, Kaiparowits Plateau, and Escalante Canyons. GSENM is primarily surrounded by federal lands managed by the BLM (Kanab Field Office); the U.S. Department of Agriculture, Forest Service (Forest Service) (Dixie National Forest); and the U.S. Department of the Interior, National Park Service (Capitol Reef National Park, Bryce Canyon National Park, and Glen Canyon National Recreation Area [Glen Canyon]). The communities on the periphery of GSENM (in descending order of population) are Kanab, Escalante, Orderville, Tropic, Big Water, Bryce Canyon City, Glendale, Boulder, Henrieville, and Cannonville.

Figure 1-2: Boundary of GSENM



Indigenous people have inhabited the lands of GSENM for millennia and have an ongoing connection to this landscape. The area is rich with archaeological sites that include dwellings; storage structures, such as granaries; and rock writing. Indigenous communities consider this entire landscape as culturally important, including the plants, springs, streams, and canyons.

European and Euro-American explorers entered the area as early as 1776, and more sustained Euro-American settlement included Church of Jesus Christ of Latter-day Saints (Mormon) pioneers in the 1860s to 1900. Some historic Euro-American explorer and settler sites in GSENM include the Old Spanish Trail, Boulder Mail Trail, Cream Cellar Route, Boynton Road, Hole-In-The-Rock Expedition Trail, Dance Hall Rock, and Paria Townsite, among others. The landscape also contains early historic-period sites with

connections to the area's current residents and communities, such as pioneer cabins, fences, stock trails, mining and timber sites, Civilian Conservation Corps camps, and early roads.

Special Designations

The landscape of GSENM features remote canyons, plateaus, and special erosional landscape features (cliffs, canyons, slot canyons, hoodoos, and badlands); many of these are found in special designation areas such as wilderness study areas (WSAs). WSAs provide valuable research opportunities because they have no roads and less visitation than other areas. WSAs in GSENM are briefly described on the following web page: Utah National Conservation Lands. They are also listed below from largest to smallest:

- Fiftymile Mountain (146,143 acres)
- Paria-Hackberry (135,822 acres)
- Wahweap (134,000 acres)
- North Escalante Canyons/The Gulch (119,752 acres)
- Death Ridge (62,870 acres)
- Burning Hills (61,550 acres)
- Carcass Canyon (46,711 acres)
- Phipps-Death Hollow (42,731 acres)
- Mud Spring Canyon (38,075 acres)
- Scorpion (35,884 acres)
- Steep Creek (21,896 acres)
- The Blues (19,030 acres)
- The Cockscomb (10,080 acres)
- Escalante Canyons (1,120 acres)
- Devils Garden (640 acres)

The No Mans Mesa Research Natural Area (RNA) is an area of critical environmental concern (ACEC). This RNA is an isolated and difficult-to-access mesa of 1,500 acres; it provides valuable research opportunities and was established to protect native plant communities and ecosystem processes that have persisted with the absence of roads, livestock grazing, and recreational impacts.

The GSENM RMP (BLM 2025) also includes the designation of Fiftymile Mountain RNA (ACEC), comprised of 54,800 acres featuring significant cultural values, including a cultural crossroads of the Fremont and Ancestral Pueblo cultural groups, with sites spanning multiple time periods. The RNA (ACEC) contains the highest density of cultural sites within GSENM, and many are considered fragile, sensitive, and irreplaceable resources that are threatened and vulnerable to adverse change. A unique cultural melting pot, the area contains diverse scientific research opportunities for archaeological resources. While the RNA (ACEC) is designated in the RMP due to the significance of its cultural resources, Fiftymile Mountain RNA (ACEC) also contains a variety of important ecological resources, including springs, aspen forests, shrublands, sagebrush grasslands, and wildlife habitats.

Water and Wild and Scenic Rivers (WSRs)

Although water shaped much of GSENM's terrain, there are limited sources of surface water under present-day conditions. Surface water in this region flows to the Colorado River (above and below Glen Canyon Dam) and falls within four hydrologic unit code 8 watersheds: Escalante River, Kanab Creek, Lower Lake Powell, and Paria River. Rivers and aquatic ecosystems are a geographically small area but a very important part of the landscape. They provide opportunities for research, particularly rivers listed "suitable" as WSR segments, as included in the RMP (BLM 2025). **Table 1-1** lists these suitable WSR segments.

Table 1-1: Suitable WSR Segments

River System	Segments	Tentative Classification
Escalante River System	Escalante River No. 1	Wild
	Escalante River No. 2	Recreational
	Escalante River No. 3	Wild
	Harris Wash	Wild
	Lower Boulder Creek	Wild
	Slickrock Canyon	Wild
	Lower Deer Creek No. 1	Recreational
	Lower Deer Creek No. 2	Wild
	The Gulch No. 1	Wild
	The Gluch No. 2	Recreational
	The Gluch No. 3	Wild
	Steep Creek	Wild
	Lower Sand Creek	Wild
	Willow Patch Creek	Wild
	Mamie Creek and West Tributary	Wild
	Death Hollow Creek	Wild
	Calf Creek No. 1	Wild
	Calf Creek No. 2	Scenic
	Calf Creek No. 3	Recreational
	Twentyfive Mile Wash	Wild
Paria River System	Upper Paria River No. 1	Wild
	Upper Paria River No. 2	Recreational
	Lower Paria River No. 1	Recreational
	Deer Canyon Creek	Wild
	Snake Creek	Wild
	Hogeye Creek	Wild
	Kitchen Canyon	Wild
	Starlight Canyon	Wild
	Lower Sheep Creek	Wild
	Hackberry Creek	Wild
	Lower Cottonwood Creek	Recreational

Section 2. Scientific Background of GSENM

2.1 Background Information and Scientific Investigations

Proclamation 6920 (1996) states that "The monument presents exemplary opportunities for geologists, paleontologists, archeologists, historians, and biologists" and that the rich human history in GSENM is "worthy of preservation for future study." Proclamation 10286 (2021) describes GSENM as a living, outdoor laboratory and highlights the "focus of a multi-disciplinary study of its large landscape for the benefit of current and future generations." That type of multidisciplinary research must include all biological, physical, cultural, and social sciences. The GSENM RMP (BLM 2025) emphasizes the goal to protect and/or restore GSENM for its value as a unique, largely unspoiled, and natural landscape that is important for natural scientific, recreational, historical, and cultural values.

GSENM's diverse geology, geography, ecosystems, and cultural history provide many opportunities for research, including the ability to use replicates or comparisons of areas across this large landscape. Specific research values are the following:

- A large part of three watersheds are in GSENM, from the forests of the Aquarius Plateau and Boulder Mountain, down to woodlands, and warm-temperate desert grass/shrub communities at lower elevations.
- Elevational and ecological gradients provide opportunities to study the impacts of climatic change, identify ways to alleviate adverse climatic effects, and foster landscape resiliency.
- GSENM contains an extremely high floristic diversity due to the intersection of warm- and cold-desert flora, an abundance of isolated and very old plant communities, and half of Utah's rare flora and 125 species of plants unique (endemic) to the Colorado Plateau.
- There is an outstanding biodiversity of bees (660 known species), including many endemics, due, in part, to the area's substantial elevation gradient, diversity of habitats, and abundance of flowering plants.
- GSENM contains paleontological resources that are world renowned, including globally critical Cretaceous-aged dinosaur resources that are accessible due to the excellent exposures of their host geological formations.
- GSENM contains an outstanding density and diversity of cultural sites, including evidence of the Ancestral Pueblo and Fremont cultures, as well as early Euro-American settlement.

To see summaries of the current conditions of natural, cultural, and social resources as of 2024, see Chapter 3 of the Proposed RMP/Final EIS (BLM 2024a).

2.1.1 Types of Science in GSENM

Basic research is the foundation of science through providing information on the distribution, status, and characteristics of species, populations, physical features, habitats, and sites. After GSENM was designated, much basic research was conducted in GSENM, including inventories of species, biotic communities, geological features, paleontological resources, archaeological resources, and other topics. Over time, applied research and monitoring were conducted to answer questions about land management to complement surveys and other forms of basic research. Research frequency appears to have declined

somewhat since the first decade of GSENM's establishment. However, the BLM hopes this Science Plan will inspire more frequent, engaged, and informative scientific research within GSENM.

Monitoring, which is the regular collection of data over time to evaluate whether objectives are being achieved and to evaluate effectiveness of management (adapted from Toevs et al. 2011), is an important component of improving the scientific understanding of GSENM. Monitoring provides an important information source for science because monitoring generates a regular stream of data on objects, resources, and conditions important to research areas. It further provides the ability to detect unanticipated changes over time, such as climate change-driven events. Pre-project and post-project monitoring are essential to evaluate the success or failure of management efforts. Monitoring provides quantitative data and tools to guide and justify management actions, land uses, and agency decisions. In practice, however, monitoring is not always implemented in a manner that demonstrates whether project goals were met. The GSENM Science Plan seeks to emphasize and encourage monitoring efforts before, during, and after project implementation.

Monitoring efforts are mentioned below and throughout other sections of the GSENM Science Plan. Of particular importance is the BLM's ongoing and widespread Assessment, Inventory, and Monitoring (AIM) program that provides a set of methods and standards for assessing natural resource conditions and trends on BLM-managed lands. The AIM program has three components: (1) lotic (stream), (2) terrestrial (uplands), and (3) riparian and wetlands. AIM data are all publicly available on the websites listed in **Table 2-8**, which includes all three components.

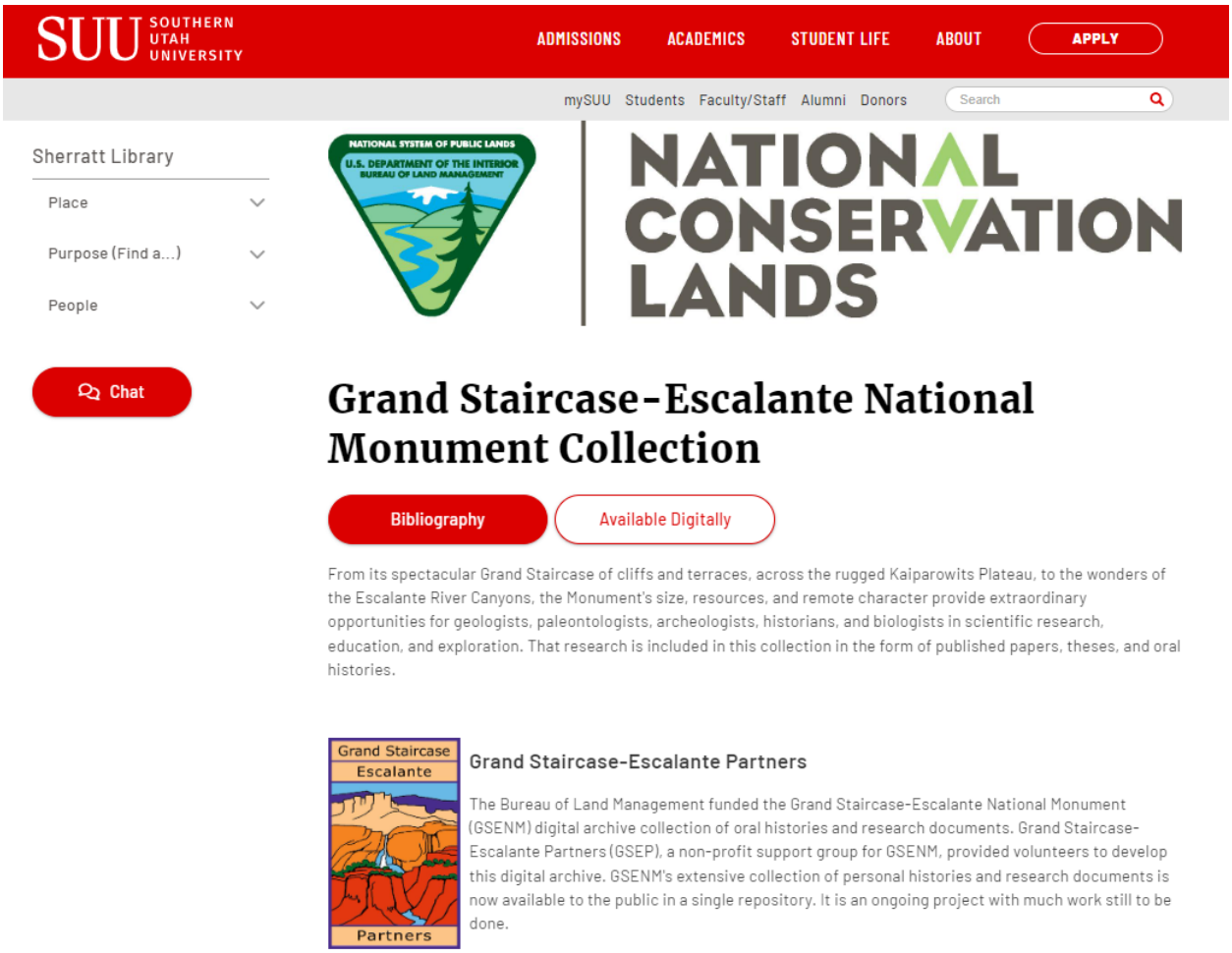
2.1.2 Research in GSENM

There have been hundreds of scientific publications studying GSENM resources, and this Science Plan summarizes notable studies and research efforts below to serve as an entry point for research on each topic. The GSENM Science Plan does not intend to provide a comprehensive list of scientific publications about GSENM; however, information is accessible to the public as discussed below in each resource section. In addition to the publications noted, GSENM's leadership and science program leads recommend the digital library described below, which GSENM staff will continually update with new science publications.

2.1.3 Online Science Bibliography

A list of hundreds of publications about GSENM is available in a digital library hosted by the Gerald R. Sherratt Library at Southern Utah University (SUU) (**Figure 2-1**) at the following website: Grand Staircase-Escalante National Monument Collection. The online library is a joint effort of the BLM and SUU and is further supported by the Grand Staircase-Escalante Partners. The library features a publicly available, searchable online database. It contains articles, historical interviews, films, reports, and other data about GSENM on topics such as ecology, geology, paleontology, archaeology, history, and others. That library database meets the requirement in BLM Manual 6220 (National Monument, National Conservation Areas, and Similar Designations) that the BLM maintain a bibliographic list of completed reports from science on the unit.

Figure 2-1: GSENM Collection Hosted by SUU



The SUU library database includes reports from science symposia that are held circa every 10 years, starting with the 1997 symposium held 1 year after GSENM's establishment. The symposia have included dozens of articles on many topics about GSENM. For example, the 2006 symposium had presentations on ecosystem dynamics and botany, hydrology, geology and paleontology, rangeland ecology, archaeology, social sciences, biology, and wildlife, which were published as articles in a 545-page document available at Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings 2006. Another decadal symposium is anticipated for 2026.

The three decadal symposia each have published proceedings of the presentations at these links:

- 1997: Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings 1997
- 2006: Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings 2006
- 2016: Learning from the Land: Grand Staircase-Escalante National Monument Science Summary 2006-2016

An additional annual symposium began in 2022 for the Grand Staircase-Escalante region, which is sponsored by the Escalante River Watershed Partnership (ERWP), of which GSENM is a partner. That symposium is described in Section 4.

GSENM staff are developing and maintaining an internal database of reports and data for BLM staff purposes. Hosted documents and data include annual research reports and other documents related to GSENM science and the GSENM science program's work.

2.2 RESEARCH TOPICS

2.2.1 Air Quality and Climate

Air quality and climate have not been thoroughly researched or monitored at GSENM to the extent that other resources have been evaluated. Air quality and climate tend to be researched on a broader, regional scale; therefore, there have not been any specific efforts to monitor and study air quality and climate trends in GSENM. Current management direction at GSENM is moving toward additional air quality and climate monitoring; however, there are not discrete research projects at this time.

Air quality affects all living organisms and can be degraded by human actions as well as natural phenomena such as wildfire. Monitoring of this resource is essential to identify sources of pollutants and ways to address them. Air quality data are collected at receptor and meteorological stations. The Utah Division of Air Quality is responsible for monitoring and regulating air quality in Utah. At present, the Utah Division of Air Quality does not have state ambient air quality standards; however, it is responsible for ensuring compliance with the national ambient air quality standards within Utah.

The existing air quality in GSENM, which is good, is typical of undeveloped regions in the western United States. Kane and Garfield Counties are currently designated attainment or unclassifiable for all criteria air pollutants. Ozone and particulate matter are regional concerns that can affect the air quality in GSENM. The most recent Environmental Protection Agency National Emissions Inventory (EPA 2024) estimates that the primary air pollutant in Kane and Garfield Counties is volatile organic compounds (VOCs). VOCs are a precursor to ozone. In 2020, annual emissions of VOCs in Kane and Garfield Counties were 29,737 and 15,630 tons per year, respectively. During the same year, annual particulate matter less than 10 microns in diameter and particulate matter less than 2.5 microns in diameter emissions in Kane County were 4,863 and 841 tons per year, respectively, while in Garfield County they were 1,750 and 235 tons per year, respectively.

Visibility is an air quality concern; regional haze, fugitive dust, and smoke from wildland fire can contribute to local and regional visibility degradation. The visibility trend data from 2011 to 2020 for nearby units (Bryce Canyon and Capitol Reef National Parks and Glen Canyon) are available from the National Park Service (2022). Improvement in visibility on the most impaired days has been documented for all three units since 2011, but visibility on the haziest and clearest days has not changed significantly for Bryce Canyon and Capital Reef National Parks, while Glen Canyon shows improvement for the clearest days.

Air quality and climate data for Utah can be located through the following sources:

- MesoWest
- PurpleAir

- Utah Department of Environmental Quality
- AirNow

Like air quality, climatic conditions at GSENM are also studied on broad scales, but there are more specific results of climate conditions and changes that can be observed in local resources and objects. GSENM is in the Colorado Plateau, which is mostly semiarid and varies in local contexts from north to south and between low to high elevations. In GSENM, there are bimodal annual precipitation maximums occurring both in the winter and in the summer. In the winter, precipitation is driven primarily by cold frontal passages, while in the summer it is due to intermittent, but often intense, monsoonal storms from the south. Spring and fall are generally the driest periods in the area. Annual precipitation is less than 10 inches at the mid- and lower elevations and can be 20 inches at areas above 8,000 feet.

Research on climate in GSENM includes ancient (prehistoric) climatic conditions and relationships to geology, vegetation, and paleontology, such as:

- "Inconsistencies between Pagean reconstructions and basic climate controls" (Rowe et al. 2007)
- "Late quaternary vegetation and climate in the Escalante River Basin on the Central Colorado Plateau" (Withers and Mead 1993)

Current conditions are also evaluated. An example of more recent research that incorporates climate impacts on biotic communities is the paper "Influence of livestock grazing and climate on Pinyon Pine (*Pinus edulis*) Dynamics" by Barger et al. (2009).

Climate change modeling predictions show that the Colorado Plateau ecoregion is expected to undergo general warming over the entire region, with the greatest warming occurring in the ecoregion's southern portion and with average winter temperatures increasing more than average summer temperatures. Climate change modeling predicts an increase of up to 4.4 degrees Fahrenheit (2.4 degrees Celsius) from 2025 to 2049 and 7.7 degrees Fahrenheit (4.3 degrees Celsius) from 2050 to 2074 in average summer temperatures in Garfield and Kane Counties (USGS 2024). Precipitation projections for Utah are less certain. However, projected rising temperatures will increase the likelihood that precipitation will fall as rain instead of snow, particularly at lower elevations. In addition, extreme precipitation is projected to increase, potentially increasing the frequency and intensity of floods (Frankson et al. 2022).

2.2.2 Geology and Paleontology

GSENM's remarkable geological, paleontological, and geomorphic resources are among the most unique it has to offer. They are the primary reason, along with its human history, for GSENM's creation in 1996. Bedrock geology ranges in age from Permian to Late Cretaceous (265 to 73 million years ago), and unconsolidated Neogene deposits probably date back to at least the early Pleistocene. Fossils occur in all bedrock formations and in the Neogene units (Foster et al. 2001) at GSENM (**Figure 2-2**). Permian through Jurassic units have yielded fossil fauna and flora that can largely be viewed over wide areas of the Colorado Plateau. Given its proximity to the western portion of the Cordilleran Foreland Basin, the stratigraphic record is especially complete and thus interesting to researchers studying end-Permian/Mesozoic climate, isotopic records, tectonics, stratigraphy, rock-forming processes, sedimentation patterns, and numerous other topics.

Figure 2-2: Spectacular Hoodoos in the Entrada Formation at Devils Garden (Left), and a Hadrosaur Dinosaur Tibia and Fibula (Right), Kaiparowits Formation, Northern Kaiparowits Plateau Region, GSENM

GSENM partners with many universities; natural history museums, such as the Natural History Museum of Utah and Denver Museum of Nature and Science; researchers; and collaborators from across the world to document thousands of new fossil sites and amass important new invertebrate, vertebrate, and trace fossil specimens from both marine and terrestrial rocks. The need for on-site coordination and scientific expertise is so great that the BLM has employed a full-time GSENM paleontologist since 2000. The paleontology program largely consists of proactive inventory, specimen salvage, overarching management of research activities, and outreach. GSENM has a fully functioning paleontology lab, established in 2003, to support stabilization and repair, preparation, research, and educational exhibits. Tens of thousands of volunteer hours have been donated in the GSENM paleontology lab, resulting in the recovery and preparation of thousands of valuable specimens.

Before GSENM was established, geological mapping-based inventories were produced for coal, petroleum, and other resources (Titus and Loewen 2013). The 1996 proclamation designated GSENM and eliminated any new mining for oil, gas, coal, and other minerals in GSENM.

Monitoring efforts for paleontological and geological resources in GSENM include an ongoing inventory of Late Cretaceous terrestrial units by the Natural History Museum of Utah, the Denver Museum of Nature and Science, and the BLM. Further, the Prehistoric Museum (Price, Utah) and the BLM maintain an ongoing inventory of Late Cretaceous marine vertebrates.

Important geological research in GSENM includes studying Martian iron concretion formation (known as "blueberries"), the living biofilms that inhabit rocks, and the effects of massive submarine volcanic eruptions on the shallow marine ecology/stratigraphy.

Foundational geological publications on GSENM include the following:

- "Geology of the Circle Cliffs Area, Garfield and Kane Counties, Utah" by Davidson (1967)
- "The Geology of Kane County, Utah" by Doelling and Davis (1989)
- "The Geology and Mineral Resources of Garfield County, Utah" by Doelling (1975)
- "Structural geology of the Colorado Plateau region of Southern Utah" by Davis (1999)
- "Geology of Grand Staircase-Escalante National Monument, Utah" by Doelling et al. (2024)

Paleontologically important bedrock formations containing valuable vertebrate fossil content include the Chinle and Morrison Formations and entire Late Cretaceous succession. Of these, the Late Cretaceous succession is unique to GSENM and holds extremely high scientific and public significance (**Figure 2-3**). Dozens of new dinosaur and other large vertebrate taxa (such as giant turtles and giant alligators), as well as hundreds of species of fish, turtles, amphibians, lizards, snakes, birds, and mammals, have been found (Titus et al. 2016). This paleontological record is one of the most complete Late Cretaceous-age terrestrial fossil vertebrate successions in the world.

Figure 2-3: Complete Tyrannosaur Skull Collected from the Kaiparowits Formation, Kaiparowits Plateau Region

The Cretaceous Kaiparowits Formation permits unique and valuable preservation, and resources in this formation include skin, nails, beaks, and other soft tissues. Given the continuity of the fossil record through the Late Cretaceous and the uniqueness of this fossil record to the Kaiparowits Plateau region, the western Kaiparowits Plateau could probably qualify as a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site. Because of the high significance of Cretaceous

and other fossil resources within GSENM, the BLM has actively managed this resource since 2000, including a GSENM in-house paleontology program.

More publications on GSENM's geology and paleontology can be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.3 Soil

Soils in GSENM are mostly semiarid, young, and poorly developed. Physical, chemical, and biological soil development processes, such as rock weathering, plant material decomposition, organic matter accumulation, and nutrient cycling, proceed slowly in this environment. In many areas, natural or geological erosion rates are too fast to develop distinct, deep soil horizons. Although these soils are poorly developed and erosive, they have helped support life from time immemorial.

Biological soils crusts (**Figure 2-4**), which consist of cyanobacteria, fungi, moss, and lichen growing in a symbiotic relationship on the soil surface, are key conservation elements according to the Colorado Plateau Rapid Ecological Assessment (Bryce et al. 2012). Biological soil crusts are common within GSENM and have important functions in the ecosystem.

Soils range in depth from very shallow to very deep at GSENM (NRCS 2022). Deeper soils are formed in recent alluvium. Almost all local soils are derived from sedimentary rock. The dominant topographic features are structural benches, mesas, valley floors, valley plains, alluvial fans, stream terraces, hills, cuestas, and mountainsides. The National Resources Conservation Service has completed soil surveys for the area (NRCS 2022). The National Resources Conservation Service provides foundational ecological site descriptions and critical information for understanding rangeland health. Soil survey data for the entire country can be accessed at the following website: Web Soil Survey.

Figure 2-4: Biological Soil Crust within GSENM

Soils in GSENM are extremely susceptible to impacts, they are difficult to restore or reclaim, and they are considered vulnerable to disturbance. The Colorado Plateau Rapid Ecological Assessment (Bryce et al. 2012) describes sensitive soils in GSENM. To date, approximately 1,291,000 acres of sensitive soils have been mapped in GSENM (Bryce et al. 2012).

The AIM terrestrial program classifies soil pits at their sites, which adds to the knowledge of soils across GSENM. These data are publicly available at BLM National AIM TerrADat Hub.

Soil research at GSENM includes the following publications:

- "Soil carbon storage responses to expanding pinyon–juniper populations in southern Utah" by Neff et al. (2009)
- "Soil characteristics and plant exotic species invasions in the Grand Staircase-Escalante National Monument, Utah, USA" by Bashkin et al. (2003)
- "Untangling the biological contributions to soil stability in semiarid shrublands" by Chaudhary et al. (2009)

Biological soil crust research has been important since the establishment of GSENM, particularly the work of Matt Bowker and Jayne Belnap, who generated data and insights into the distribution, characteristics, and status on biocrusts in the following papers:

- "Spatial modeling of biological soil crusts to support rangeland assessment and monitoring" by Bowker et al. (2006)
- "A simple classification of soil types as habitats of biological soil crusts on the Colorado Plateau, USA" by Bowker and Belnap (2008)
- "Prioritizing conservation effort through the use of biological soil crusts as ecosystem function indicators in an arid region" by Bowker et al. (2008)
- "Revisiting classic water erosion models in drylands: The strong impact of biological soil crusts" by Bowker et al. (2008)

More publications on GSENM's soils can be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.4 Vegetation

Vegetation sustains wildlife, cycles nutrients, stabilizes soil, and provides many other benefits to ecosystems and people (**Figure 2-5**). Vegetation is dynamic due to both natural and human causes; therefore, vegetation is important to study.

Figure 2-5: Vegetation at GSENM: Showy Milkweed, Paintbrush, and Cryptantha (Left to Right)

Indigenous Native American communities were the original botanists of what is now GSENM. They used plants for food, medicine, ceremony, and other means and maintained comprehensive knowledge of plant resources in the area. Tribal members continue to be skilled botanists, and the BLM works to incorporate this Indigenous knowledge of plant resources into planning and resource management at GSENM.

Botanical information gathering by Euro-American explorers was done in the nineteenth century by explorers such as John Wesley Powell and Charles Christopher Parry. Parry studied under John Torrey, one of the most renowned botanists of the United States. From Parry's explorations in Utah and the Southwest, he sent specimens to Torrey, as well as two other notable botanists, George Engelmann and Asa Gray, who cataloged collections and named many new species. In the twentieth century, botanical surveys were conducted in the area by renowned botanists such as Arthur John Cronquist, Rupert Barneby, Noel H. Holmgren, and Patricia K. Holmgren. In addition, Stanley L. Welsh, who coauthored *A Utah Flora* (currently in its fifth edition) with N. Duane Atwood, Sherel Goodrich, and Larry Higgins, conducted many botanical surveys in GSENM and across Utah and named plants new to science. Their

work informs botanical surveys in GSENM and throughout Utah. Other important twentieth century botanists who have provided important botanical efforts for GSENM, especially after GSENM's designation in 1996, include Tom Stohlgren, Walt Fertig, Laura Welp, Leila Shultz, and others. A video presentation (video) by Fertig provides vegetation information about GSENM.

Botanical work has continued up to the present, but perhaps with less intensity and geographic scale in the decades after establishment of GSENM. This Science Plan is part of an effort to bolster botanical research, and all scientific research, at GSENM.

Fertig (2021) describes the following five primary vegetation types correlated with the elevational zones of GSENM, listed from low to high elevation:

1. Desert shrub and grasslands – in low elevation, upland, and clay or sandy soils
2. Sagebrush grassland – in washes and valley bottoms with rich, sandy-loam soils
3. Pinyon and juniper – on rocky sandstone slopes and tablelands
4. Forests of ponderosa pine and Douglas-fir – on the highest mesa tops or shady canyons
5. Riparian and wetlands – along streams and springs; a very small but important vegetation type in this semiarid region

GSENM has a unique floral diversity, with approximately 1,180 species as of 2016, with an estimated 174 having local or regional endemics (Fertig et al. 2002). GSENM contains about 50 percent of the Colorado Plateau's floral diversity and approximately 40 percent of its rare flora (Shultz 1998). The plant diversity comes from the vast geographic, topological, and climatic extent of GSENM. Four major floras exist and overlap within GSENM, including those of Arizona, the Great Basin, the Mojave Desert, and the Great Plains (Belnap and Gillette 1997). New plant species continue to be discovered.

The GSENM vegetation landscape has been highly influenced by previous land uses and land management practices, including both pre- and post-Euro-American settlement, through actions such as fire suppression, tree cutting, hunting, water diversion, and the introduction of livestock. Since the 1850s, sagebrush-steppe communities, which dominated the Intermountain West, have shifted toward woodlands or invasive annual-dominated communities (Tausch et al. 1981; Miller and Wigand 1994). This shift is demonstrated by the level of departure from reference conditions[1] (NRCS 2023), according to data from AIM and the landscape monitoring framework (MacKinnon et al. 2011).

Important upland vegetation monitoring is done by the national AIM terrestrial program across all BLM-managed lands. In GSENM, this quantitative data collection began in 2013 and includes over 400 sites. The random site selection for vegetation monitoring allows for characterization of larger geographic areas, such as allotments, or of GSENM as a whole. The AIM protocol is conducted each year at new, randomly selected sites and at some previously visited sites. Those data are available at the following website: BLM National AIM TerrADat Hub.

AIM field crews receive extensive training in protocol to record data on vegetation and soil (Herrick et al. 2021). For the 2024 Proposed RMP/Final EIS process analysis was done on over 400 monitoring

[1] Reference conditions are those that occur where the biotic integrity, hydrologic function, and soil and site stability are at their potential under the natural disturbance regime (BLM 2016).

plots in GSENM to assess conditions in watersheds and allotments. A subset of the AIM monitoring plots in GSENM also provided data using the Interpreting Indicators of Rangeland Health protocol as a supplement to the AIM core methods. See the GSENM Proposed RMP/Final EIS (BLM 2024a, Appendix B) for AIM data and results.

Vegetation treatments have occurred in GSENM for many decades (at least back to the 1960s), especially through attempts to shift vegetation communities from woody (shrub or tree) dominated to herbaceous-dominated vegetation. Some treatment methods included chaining, mastication, Dixie harrowing, and hand-cutting. Fire has shaped the vegetation landscape. Some studies that have evaluated the impacts of these vegetation alterations include the following:

- "Long-term effects of chaining treatments on vegetation structure in piñon-juniper woodlands of the Colorado Plateau" by Redmond et al. (2013)
- "Vegetation Response to Fire and Postburn Seeding Treatments in Juniper Woodlands of the Grand Staircase-Escalante National Monument, Utah" by Evangelista et al. (2004)

The website and smartphone application iNaturalist is a tool used by citizen scientists and experts to document observations of plants and animals, including photographs, locations, and notes. Researchers have used the data in iNaturalist to study species' distributions, plant flowering times, and other ecological data. In iNaturalist there is a public "project" called Grand Staircase-Escalante National Monument, which shows all the plants that have been reported in GSENM and the date and location where they were observed. As of October 2024, iNaturalist has over 700 plant species observations in GSENM (that number might include observations recorded as genera, varieties, and subspecies).

More publications on GSENM's vegetation can be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.5 Noxious Weeds and Invasive Plants

Noxious weeds and invasive plants can negatively affect native plants, animals, and ecosystems. Controlling populations of these plants and preventing establishment of new populations are crucial in land management. Studying and understanding mechanisms for spread and anticipating which landscapes may be vulnerable to noxious weed establishment are highly important.

There are 95 nonnative species that have been detected in GSENM (Stohlgren et al. 2005; Welsh and Atwood 2002); some of these are invasive (**Figure 2-6**). The BLM places emphasis on species on the Utah Noxious Weed List (Utah Department of Agriculture and Food 2024).

Fifteen noxious weeds (**Table 2-1**) have been documented in GSENM, and active management is done to reduce five species: tamarisk, Russian knapweed, Scotch thistle, Russian olive, and whitetop.

Figure 2-6: Noxious Weeds and Invasive Plants at GSENM – Cheatgrass, Tamarisk, and Russian Thistle (Left to Right)

Table 2-1: Noxious Weeds in GSENM

Name	Weed Class[1]
Russian knapweed (*Acroptilon repens*)	3
Hoary cress or whitetop (*Cardaria draba*)	3
Poison hemlock (*Conium maculatum*)	3
Field bindweed (*Convolvulus arvensis*)	3
Bermudagrass (*Cynodon dactylon*)	3
Quackgrass (*Elymus repens*)	3
Scotch thistle (*Onopordum acanthium*)	3
Johnsongrass (*Sorghum halepense*)	3
Tamarisk or salt cedar (*Tamarix ramosissima*)	3
Leafy spurge (*Euphorbia esula*)	2
Musk thistle (*Carduus nutans*)	3
Spotted knapweed (*Centaurea stoebe*)	2
Squarrose knapweed (*Centaurea virgata*)	2
Dalmatian toadflax (*Linaria dalmatica*)	2
Russian olive (*Elaeagnus angustifolia*)	4

Sources: Utah Weed Control Association 2022; BLM GIS 2022

[1] Noxious Weed Class Descriptions:

2 = Widely distributed in Utah; considered controllable

3 = Widely distributed in Utah; considered beyond control; control expansion

4 = Present in Utah; prevent distribution through retail sales or propagation

Additional weeds on the Utah Noxious Weed List (Utah Weed Control Association 2022) that have been documented in the region and have the potential to spread into GSENM are the following:

- Diffuse knapweed (*Centaurea diffusa*); Class 2
- Yellow starthistle (*Centaurea solstitialis*); Class 2
- Canada thistle (*Cirsium arvense*); Class 3
- Houndstongue (*Cynoglossum officinale*); Class 3
- Dyers woad (*Isatis tinctoria*); Class 2

- Perennial pepperweed or tall whitetop (*Lepidium latifolium*); Class 3
- Purple loosestrife (*Lythrum salicaria*); Class 2

According to rangeland health assessments, tamarisk was documented in riparian areas at 68 percent of sites between 2000 and 2003.

While not listed on Utah's Noxious Weed List (Utah Weed Control Association 2022), cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola tragus*) are widespread and problematic invasive plants across southern Utah. Cheatgrass is a change agent that can alter ecosystem processes, such as fire regimes, and can expand its distribution regardless of human actions and natural disturbances (Bryce et al. 2012). Cheatgrass was in 39 percent (159 out of 405) and Russian thistle was in 11 percent (43 of 405) of AIM and landscape monitoring framework plots in GSENM from 2013 to 2022. Yellow sweetclover (*Melilotus officinalis*) is another introduced plant not on the Utah Noxious Weed List that was documented at 37 percent of riparian sites in GSENM in 2000 to 2003 (BLM 2006a).

Information on the abundance and distribution of weeds has come from the AIM terrestrial program, land health assessments, site visits by BLM staff, and county weed managers. Additionally, more targeted weed inventorying has been completed by external groups. The Southwest Exotic Mapping Program, run by the United States Geological Survey (USGS), visited GSENM several years between 1998 and 2005. Data collected from these efforts were ingested into the Southwest Exotic Mapping Program database for use by land managers in the desert Southwest to better understand nonnative plant spread. Utah State University conducted noxious weed inventories in GSENM during the summers of 2010 and 2012. Their efforts were focused on mapping the Henrieville Creek and Alvey Wash watersheds with particular emphasis on tamarisk and Russian olive. Data obtained from this inventory effort helped guide weed treatment efforts in these watersheds in subsequent growing seasons.

Tracking of noxious weed presence and removal has been done by GSENM staff, contracted employees, and volunteer groups. GSENM is a member of the Color Country Cooperative Weed Management Area, which hosts collaborative weed treatment days with weed managers from many land management entities. These combined efforts allow for cross-boundary weed management and are highly effective in treating large infestations.

Publications on weeds in GSENM include the following:

- "Soil characteristics and plant exotic species invasions in the Grand Staircase—Escalante National Monument, Utah, USA" by Bashkin et al. (2003)
- "Evaluating Plant Invasions from both Habitat and Species Perspectives" by Chong et al. (2006)

Observation of the dramatic spread of Russian olive in GSENM and particularly the Escalante River watershed led to major efforts to reduce or eradicate Russian olive. This ongoing effort has been accomplished with $11 million and thousands of hours of crew time to remove hundreds of thousands of Russian olive trees from over 8,000 riparian acres in the watershed. As of 2019, primary treatment was declared completed, and restoration entered the maintenance and monitoring phase, wherein resprouts are cut on a rotating cycle. ERWP developed a rapid monitoring protocol specific to monitoring the success of this massive removal effort. This and other monitoring data inform the effectiveness of the removal effort and direct where the next efforts should be focused.

A citizen science-driven weed inventorying effort began in the summer of 2024 with the "Wild Spotter" application. Members of the public upload a photograph and location (using global positioning system) to document a weedy patch. The photographs are run through a verification process before posting, and these data feed into the nationwide weed reporting system EDDMaps. By utilizing the population visiting GSENM, BLM staff can cover more ground and more quickly identify new infestations. Members of the public can also view weed inventory and treatment data in EDDMaps by visiting the website at EDDMapS.

More publications on GSENM's weeds and nonnative plants may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.6 Water and Aquatic Habitat

Water is particularly important to sustain life in the semiarid region where GSENM is located. Streams, springs, and wetlands in GSENM support plants and animals that need that habitat for part or all of their life cycle (**Figure 2-7**).

Figure 2-7: Springs and Water Features at GSENM

Indigenous people have a long and strong connection to springs and rivers, as described by Stoffle et al. (2004, pp. 76–85). Springs are particularly important to Indigenous people both for the life-sustaining water and also for cultural reasons. Past and present communities established along waterways, specifically the Escalante River, Kanab Creek, Henrieville Creek, Boulder Creek, the Paria River, and others. Stoffle et al. (2004, pp. 76–85) note the Paiute communities' descriptions of springs in GSENM, including the "meaning and power of water" and specific springs in the communities' "cultural landscape."

Four hydrologic unit code 8 watersheds (described at Science in Your Watershed) are largely contained within GSENM: the Kanab, Paria, Lower Lake Powell, and Escalante watersheds. The streams in these watersheds all flow to the Colorado River. The major aquifer system underlying GSENM is the Glen Canyon, which is contained within the Navajo Sandstone (Heilweil and Freethey 1992) and is recharged by precipitation.

Aquatic habitat is discussed here, but aquatic organisms are discussed in the wildlife subsection.

In 2013, the BLM coordinated with the USGS to complete an inventory of wells and springs within GSENM in an effort to document potential locations for establishing a groundwater monitoring program. In total, 262 springs and 1,450 underground wells (active water rights) were identified in or within 10 miles of the

GSENM boundary. Well estimates only included water rights that did not lapse or expire or were not rejected or terminated. In 2019, the USGS performed a water-level synoptic for the Navajo Sandstone across GSENM. Groundwater data for GSENM are in a paper by Wilberg and Stopl (2005) and this presentation to the ERWP.

Inventories of GSENM's springs have been done by the Springs Stewardship Institute (SSI), which surveyed 39 springs (15 percent) of reported GSENM springs from 2019 to 2021 (SSI 2021). The SSI surveys provide detailed data on vegetation, physical characteristics, insects, hydrology, soil, and conditions at those springs. The SSI has records of at least 260 springs in GSENM and hopes to survey more of them in the near future. The SSI's publication is available on the SUU digital library and a related summary in this presentation.

Many perennial streams that flow into and through GSENM have not been instrumented for long-term monitoring needed to effectively track the quantity of water flow. Currently, there are only three long-term gaging stations tracking the surface water flows: (1) Station USGS 09381800 - Paria River near Kanab, (2) Station USGS 09337500 - Escalante River near Escalante, and (3) Station USGS 09337000 - Pine Creek near Escalante.

The streamflow data can be found at the following locations:

- Paria River: Paria River Near Kanab, Utah
- Escalante River: Escalante River Near Escalante, Utah
- Pine Creek: Pine Creek Near Escalante, Utah

The lotic AIM program conducts monitoring of streams each year, including channel morphology, bank conditions, invertebrates, and other descriptors of physical habitat, at randomly selected and targeted sites on all BLM-managed lands, including reaches in GSENM. Those data are available at the following website: BLM National AIM Lotic Indicators Hub.

The riparian and wetland AIM program conducts monitoring each year at randomly selected and targeted riparian and wetland sites on all BLM-managed lands, including reaches in GSENM. Those data are available at the following website: BLM National AIM Riparian and Wetland Indicators Hub.

Every other year, the Utah Department of Environmental Quality, Division of Water Quality (UTDWQ) compiles all available data and conducts analyses to determine whether the water quality is sufficient to meet the beneficial uses assigned to waters in Utah (DEQ 2024; summaries are also available in the GSENM Analysis of the Management Situation [BLM 2022]). For each reporting year, UTDWQ classifies sites as impaired or not impaired based on water quality standards.

Indicators commonly showing impairment in GSENM include total dissolved solids (TDS), temperature, and benthic macroinvertebrate assemblages, all of which are common indicators of impaired uses in the arid West region's streams. There are multiple potential sources of impairment, including natural geological sources and sources driven by land uses such as livestock grazing, agriculture, or development (Brown and Froemke 2012; Agouridis et al. 2007). These uses may contribute to water quality impairment via direct effects, such as those of animal waste on dissolved oxygen or nutrients (nitrogen or phosphorus), or by indirect effects, such as by increasing erosion, which increases sediment loading (turbidity), TDS,

and associated metals. Such effects may also impair benthic macroinvertebrate and fish habitat and result in low observed and expected bioassessment scores.

More publications on GSENM's water and aquatic habitat can be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.7 Special Status Species

GSENM has numerous special status species, as categorized by BLM Manual 6840 (BLM 2008b). That designation is defined as species that occur on BLM-managed lands, for which the BLM has significant management capability to affect their conservation status; they must also meet the following two criteria:

- There is information that a species is known or predicted to undergo a downward trend such that viability of the species or a distinct population segment of the species is at risk across all or a significant portion of its range.
- The species depends on ecological refugia, specialized habitats, or unique habitats, and there is evidence that such areas are threatened with alteration such that the continued viability of the species in that area would be at risk.

Plants

Table 2-2 provides the federally listed and BLM sensitive plant species that have been documented in GSENM.

Table 2-2: Sensitive Plant Species that Occur in GSENM

Species	Common Name	Federal Status
Cycladenia humilis var. *jonesii*	Jones's cycladenia	Threatened
Physaria tumulosa	Kodachrome bladderpod	Endangered
Spiranthes diluvialis	Ute ladies'-tresses	Threatened
Astragalus ampullarius	Gumbo milkvetch	None
Astragalus striatiflorus	Escarpment milkvetch	None
Dalea flavescens var. *epica*	Hole-in-the-Rock prairie-clover	None
Euphorbia nephradenia	Paria spurge	None
Lupinus caudatus var. *cutleri*	Cutler's spurred lupine	None
Oenothera murdockii	Murdock's evening-primrose	None
Pediomelum epipsilum	Kane breadroot	None
Phacelia cronquistiana	Cronquist's phacelia	None
Phacelia pulchella var. *atwoodii*	Atwood's pretty phacelia	None
Salvia columbariae var. *argillacea*	Chinle chia	None
Sphaeralcea grossulariifolia var. *fumariensis*	Smoky Mountain globemallow	None
Thelypodiopsis ambigua var. *erecta*	Kanab thelypody	None

Sources: BLM 2018; USFWS 2022; SEINet 2022; UNHP 2024

Threatened or endangered (listed by the United States Fish and Wildlife Service [USFWS]) species that have the potential to occur in GSENM but have not yet been documented are the following:

- *Asclepias welshii* (Welsh's milkweed)
- *Carex specuicola* (Navajo sedge)

- *Townsendia aprica* (Last Chance townsendia)
- *Pediocactus sileri* (Siler's pincushion cactus)
- *Hesperidanthus barnebyi* (Barneby's reed-mustard)

Sensitive species that have the potential to occur in GSENM but have not yet been documented are *Astragalus welshii* (Loa milkvetch), *Cymopterus beckii* (Pinnate spring-parsley), and *Trifolium variegatum* var. *parunuweapensis* (sand seep clover).

GSENM staff have conducted many inventory efforts of federally listed plant species since GSENM's inception. Substantial efforts of note include 2017 and 2023 surveys completed by the Utah Natural Heritage Program for Kodachrome bladderpod, 2013 and 2014 surveys for Jones' cycladenia by Utah Conservation Corps crews and private contractors, and a 1999 inventory for Ute ladies'-tresses orchid.

Regular monitoring of federally listed species has occurred on a semiregular basis at GSENM. Little monitoring has been documented for BLM sensitive species, though the following efforts are listed below by species.

Kodachrome bladderpod:

- Two demographic monitoring sites were established in 1997 and monitored through 2001. Individual plants received were tagged, and the diameter and reproductive outputs were measured.
- Ten monitoring plots were established in 2006 and revisited yearly through 2016. Individuals within the plots were counted, and reproductive outputs were measured.

Jones' cycladenia:

- Sporadic monitoring of known populations occurred prior to 2008.
- Regular monitoring was completed from 2008 to 2014 of at least three established sites.
- Monitoring is typically done by counting stems (ramets) and percent flower/fruit from binoculars or on-site, if possible, given the challenge of the terrain.
- Research on Jones' cycladenia includes the paper "Clonal Structure and Patterns of Allozyme Diversity in the Rare Endemic *Cycladenia humilis* var. *jonesii* (Apocynaceae)" by Sipes and Wolf (1997).

Ute ladies'-tresses:

- A total census with global positioning system location collection of plants was completed from 2002 to 2013.

The Utah Natural Heritage Program, housed at Utah State University, conducts rare plant surveys across the state. Their inventorying trips often included GSENM, and their target species included federally listed threatened and endangered species, BLM sensitive species, and other rare and endemic species in Utah. The Utah Natural Heritage Program hosts a centralized rare plant database for authorized partners to upload survey data and use to plan survey efforts in support of understanding and protecting these rare plants.

Animals

Table 2-3 presents a list of federally threatened, endangered, and candidate fish and wildlife species that occur in GSENM (USFWS 2022). GSENM includes designated critical habitat for the Mexican spotted owl and the southwestern willow flycatcher.

Table 2-3: Federally Listed and Candidate Species that Occur in GSENM

Species	Scientific Name	Federal Status
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered
California condor	*Gymnogyps californianus*	Experimental population
Mexican spotted owl	*Strix occidentalis lucida*	Threatened
Monarch butterfly	*Danaus plexippus*	Candidate

Source: USFWS 2022

The following threatened or endangered fish were historically in the Colorado River and may have been in the Escalante River before Glen Canyon Dam, but they are not currently known to be in GSENM: humpback chub (*Gila cypha*), bonytail chub (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*).

Due to a lack of occurrence records, it was determined that the Utah prairie dog (*Cynomys parvidens*) does not have the potential to occur in GSENM. Suitable habitat for western yellow-billed cuckoo (*Coccyzus americanus*) is not present in GSENM. Although this species has been observed in dense riverside tamarisk thickets at several locations on the Colorado and San Juan Rivers, the primary element of the species' critical habitat—vast riparian woodlands with mixed willow-cottonwood vegetation in contiguous patches greater than 325 feet in width and 200 acres or more in extent (USFWS 2014)—is not present in GSENM. There are no known occurrence records for the western yellow-billed cuckoo in GSENM.[2]

Table 2-4 presents the BLM sensitive animal species that occur in GSENM.

Table 2-4: BLM Sensitive Species Documented in GSENM (Not Including the Threatened or Endangered Species Listed Above)

Species	Scientific Name	BLM Status	State Status	Occurrence in GSENM
Birds				
Northern goshawk	*Accipiter gentilis*	Conservation agreement species[3]	Conservation agreement species	One confirmed territory in Mud Springs Canyon and one additional territory in Rock Creek/Mudholes; occasionally observed in winter in pinyon-juniper habitat
Golden eagle	*Aquila chrysaetos*	Sensitive species	Species of concern	Permanent resident; commonly observed

[2]Cameron McQuivey, BLM GSENM wildlife biologist, personal communication on July 6, 2022, regarding federally listed species in GSENM.

[3] Conservation agreements species are those special status species with a formal, written agreement between the USFWS and other interested parties such as Federal or State Agencies, local governments, or private sector to achieve conservation of the species through voluntary cooperation.

Species	Scientific Name	BLM Status	State Status	Occurrence in GSENM
Burrowing owl	*Athene cunicularia*	Sensitive species	Species of concern	Documented in the Hole-in-the-Rock area and near Church Wells
Short-eared owl	*Asio flammeus*	Sensitive species	Species of concern	Uncommon permanent resident
Ferruginous hawk	*Buteo regalis*	Sensitive species	Species of concern	Commonly observed during winter raptor surveys; two historically unoccupied nests on West Clark Bench
Bald eagle	*Haliaeetus leucocephalus*	Sensitive species	Species of concern	Winter resident; commonly seen during winter raptor surveys
Lewis's woodpecker	*Melanerpes lewis*	Sensitive species	Species of concern	Uncommonly observed in pinyon-juniper and oak habitats
Greater sage-grouse	*Centrocercus urophasianus*	Sensitive species	Species of concern	Known to occur
Mammals				
Townsend's big-eared bat	*Corynorhinus townsendii*	Sensitive species	Species of concern	Known to occur
Spotted bat	*Euderma maculatum*	Sensitive species	Species of concern	Known to occur
Allen's big-eared bat	*Idionycteris phyllotis*	Sensitive species	Species of concern	Known to occur
Fringed myotis	*Myotis thysanodes*	Sensitive species	Species of concern	Known to occur
Big free-tailed bat	*Nyctinomops macrotis*	Sensitive species	Species of concern	Confirmed through mist net capture (BLM 2008b)
Insects				
Western bumble bee	*Bombus occidentalis*	Sensitive species	Species of concern	Known to occur
Amphibians				
Arizona toad	*Bufo microscaphus*	Sensitive species	Species of concern	Previously recorded by Oliver (2003) but not found in recent surveys by Heyborne and Gardner (2021)
Reptiles				
Common chuckwalla	*Sauromalus ater*	Sensitive species	Species of concern	Previously recorded by Oliver (2003) but not found in recent surveys by Heyborne and Gardner (2021)
Desert night lizard	*Xantusia vigilis*	Sensitive species	Species of concern	Previously recorded by Oliver (2003) but not found in recent surveys by Heyborne and Gardner (2021)
Fish				
Bluehead sucker	*Catostomus discobolus*	Conservation agreement species	Conservation agreement species	Present in the Escalante River drainage (Holden and Irvine 1975; McAda 1977; UDWR 2015)
Colorado River cutthroat trout	*Oncorhynchus virginalis pleuriticus*	Conservation agreement species	Conservation agreement species	Present in the Escalante River drainage (McAda 1977)

Species	Scientific Name	BLM Status	State Status	Occurrence in GSENM
Roundtail chub	*Gila robusta*	Conservation agreement species	Conservation agreement species	Present in the Escalante River drainage (Holden and Irvine 1975; McAda 1977; UDWR 2015)
Flannelmouth sucker	*Catostomus latipinnis*	Conservation agreement species	Conservation agreement species	Present in the Escalante River drainage (Holden and Irvine 1975; McAda 1977; UDWR 2015)

Sources: BLM 2024a, 2024b

There is potential habitat in GSENM for the western red bat (*Lasiurus blossevillii*), but these bats have not been documented to date.

Examples of studies about Mexican spotted owl, a special status species in GSENM, include the following:

- "Exploring relationships among recreation, habitat type, and Mexican spotted owls on the Colorado Plateau in Southern Utah" by Chad Hockenbary (2011)
- "Diet of Mexican Spotted Owls in Utah and Arizona" by David Willey (2013)
- "Mexican Spotted Owl Site Occupancy Trends and Small Mammal Abundance in the Canyonlands of Utah" by John Thornburg et al. (2016)
- "Effects of seasonal precipitation and habitat associations on the demographics of Mexican spotted owl prey in the canyonlands region of southern Utah" by John Thornburg (2018)

More publications on GSENM's special status species may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.8 Wildlife

Wildlife have long been important to the inhabitants of the Grand Staircase-Escalante region, as indicated by evidence of wildlife remains (burned bone, hide, etc.) in archaeological sites (Geib et al. 2001) as well as depictions of deer, bighorn sheep, turkey, and other animals on pictographs and petroglyphs on rock walls in GSENM that are hundreds, if not thousands, of years old.

The 1996 GSENM proclamation highlights the diversity of the wildlife species due to the elevation gradient and variable climatic zones (**Figure 2-8**). Large, roaming mammals such as mountain lion and bear inhabit the upper elevations while mule deer herds are widespread throughout GSENM.

Desert bighorn sheep, wild turkey, American pronghorn, and river otter have been reestablished or augmented within GSENM. Several species have been extirpated from GSENM, including the grizzly bear and gray wolf. Riparian corridors host neotropical birds, slot canyons have bat roosts, migratory butterflies visit the cooler climes of GSENM, and bees number at least 660 species (Carril et al. 2018); these are described in this presentation. Inventories for all taxa have been conducted; however, some inventories are incomplete, such as those for invertebrates (**Table 2-5**).

Figure 2-8: Wildlife at GSENM (Bighorn Sheep, Snake, Lizard)

Table 2-5: Wildlife Species Counts and Inventories Recorded in GSENM

Taxa	Number of Species Identified	Date of Inventory and Last Updates
Mammals	60	2003, 2004, and 2017
Birds	254	2017
Reptiles and amphibians	28	2003 and 2017
Invertebrates	1,112	2012
Fish	23	2017

Fish and Aquatic Species

Early research by Holden and Irvine (1975) and McAda (1977) were the first publications on the aquatic community in the Escalante River. The Utah Division of Wildlife Resources (UDWR) has completed various fish surveys in the Escalante River (including UDWR 2015). From 2017 to 2024, surveys were done for nearly the entire length of the Escalante River in GSENM, from just upstream of Sand Creek to Glen Canyon. UDWR hopes to publish the data in the future.

Surveys of fish species' richness in the Escalante River in nearby Glen Canyon found five native species, including the four sensitive species listed in **Table 2-4**, and 11 introduced fish species (Mueller et al. 1999). The introduced species, which are probably also in GSENM, were brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), fathead minnow (*Pimephales promelas*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), red shiner (*Cyprinella lutrensis*), yellow bullhead (*Ameiurus natalis*), striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and green sunfish (*Lepomis cyanellus*).

Macroinvertebrate sampling has been done to assess stream health, as described in "Aquatic Invertebrates of the Grand Staircase-Escalante National Monument, Utah" by Vinson and Dinger (2008).

Wildlife (Terrestrial Generally)

Herpetology surveys have documented over 30 species of amphibians and reptiles in GSENM (**Table 2-6**).

Table 2-6: Amphibians and Reptiles that Have Been Documented in GSENM

Species	Common Name	Studies
	Amphibians	
Ambystoma mavortium nebulosum	Arizona tiger salamander	Oliver (2003) called it *Ambystoma tigrinum*; Heyborne and Gardner (2021)
Anaxyrus punctatus (syn. *Bufo punctatus*)	Red-spotted toad	Oliver (2003); Heyborne and Gardner (2021)
Anaxyrus woodhousii (syn. *Bufo woodhousii*)	Woodhouse's toad	Oliver (2003); Heyborne and Gardner (2021)
Bufo microscaphus	Arizona toad (or southwestern toad)	Oliver (2003)
Hyla arenicolor	Canyon tree frog	Heyborne and Gardner (2021)
Lithobates blairi	Plains leopard frog	Heyborne and Gardner (2021)
Spea intermontane	Great Basin spadefoot	Oliver (2003); Heyborne and Gardner (2021)
	Lizards	
Aspidoscelis tigris	Western whiptail	Oliver (2003); Heyborne and Gardner (2021)
Aspidoscelis velox	Plateau striped whiptail	Oliver (2003) called it *Aspidoscelis innotata*; Heyborne and Gardner (2021)
Crotaphytus bicinctores	Great Basin collared lizard	Oliver (2003); Heyborne and Gardner (2021)
Crotaphytus collaris	Eastern collared lizard	Heyborne and Gardner (2021)
Gambelia wislizenii	Long-nosed leopard lizard	Oliver (2003); Heyborne and Gardner (2021)
Phrynosoma hernandesi	Greater short-horned lizard	Oliver (2003); Heyborne and Gardner (2021)
Phrynosoma platyrhinos	Desert-horned lizard	Oliver (2003)
Sauromalus ater	Common chuckwalla	Oliver (2003)
Sceloporus graciosus	Northern sagebrush lizard	Oliver (2003); Heyborne and Gardner (2021)
Sceloporus magister	Desert spiny lizard	Oliver (2003); Heyborne and Gardner (2021); Tanner (1955)
Sceloporus undulatus elongatus	Eastern plateau fence lizard	Oliver (2003) called it *Sceloporus tristichus*; Heyborne and Gardner (2021)
Urosaurus ornatus	Ornate tree lizard	Oliver (2003); Heyborne and Gardner (2021)
Uta stansburiana	Common side-blotched lizard	Oliver (2003); Heyborne and Gardner (2021)
Xantusia vigilis	Desert night lizard	Oliver (2003)
	Snakes	
Arizona elegans	Glossy snake	Oliver (2003)
Coluber taeniatus	Striped whipsnake	Oliver (2003) called it *Masticophis taeniatus*; Heyborne and Gardner (2021)
Crotalus oreganus lutosus	Great Basin rattlesnake	Oliver (2003); Heyborne and Gardner (2021)
Crotalus viridis	Prairie rattlesnake	Oliver (2003)

Species	Common Name	Studies
Hypsiglena chlorophaea deserticola	Desert night snake	Oliver (2003) called it *Hypsiglena torquata*; Heyborne and Gardner (2021)
Lampropeltis getula	Common kingsnake	Oliver (2003); Heyborne and Gardner (2021)
Pituophis catenifer deserticola	Great Basin gopher snake	Oliver (2003); Heyborne and Gardner (2021)
Rhinocheilus lecontei	Long-nosed snake	Oliver (2003)
Salvadora hexalepis	Western patch-nosed snake	Oliver (2003)
Sonora semiannulata	Ground snake	Oliver (2003)
Thamnophis elegans vagrans	Western terrestrial garter snake	Oliver (2003); Heyborne and Gardner (2021)

Over 200 species of birds are in GSENM. Some are year-round residents, while most are present seasonally and are considered migratory. Common raptor species include bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), California condor (*Gymnogyps californianus*), and peregrine falcon (*Falco peregrinus*). Many neotropical (migratory) birds concentrate around the Paria and Escalante Rivers and other riparian corridors in GSENM, while others require upland habitat such as sagebrush or pinyon-juniper communities.

A literature and museum survey of GSENM mammals lists 82 confirmed contemporary species, including the ungulates discussed below. As many as 24 rodent species are thought to occur in GSENM (Flinders et al. 2002). Rodents are the most represented group, and common rodents represented in the region include woodrats (*Neotoma* spp.), which are known for their storage and waste structures, called middens; pocket mice (*Perognathus* spp.); kangaroo rats (*Dipodomys* spp.); chipmunks (*Tamias* spp.); pocket gophers (*Thomomys* spp.); and mice (*Peromyscus* spp.) (Willey and Willey 2006). David Willey of Montana State University recorded 12 distinct rodent species while conducting a Mexican spotted owl prey study in GSENM (Willey and Willey 2006).

Carnivorous mammals include black bear (*Ursus americanus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and mountain lion (*Puma concolor*). Black-tailed jackrabbit (*Lepus californicus*) and desert cottontail (*Sylvilagus audubonii*) are the only rabbit species in GSENM.

Sixteen bat species have been observed in GSENM (Flinders et al. 2002 and recent capture data[4]), including pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), little brown myotis (*Myotis lucifugus*), fringed myotis (*Myotis thysanodes*), western pipistrelle (*Parastrellus larkia*), and Brazilian free-tailed bat (*Tadarida brasiliensis*). Bats in GSENM include both year-round residents and migrants.

Desert bighorn sheep have two populations in GSENM, the Kaiparowits East/West and Kaiparowits Escalante. In 2018, the estimate for these combined populations was 954 sheep, which is about a third of Utah's total population of 2,900 desert bighorn sheep (UDWR 2018). Those include bighorn sheep that have been reintroduced by the UDWR. Year-long crucial habitat for desert bighorn sheep is approximately 546,800 acres in GSENM.

[4]Cameron McQuivey, BLM GSENM wildlife biologist, personal communication on July 6, 2022, regarding bat species in GSENM.

Pronghorn are evident in the archaeological record in portions of south-central Utah, but they were extirpated by the early 1900s. In the 1970s, the UDWR began a reintroduction program that was unsuccessful. Poaching led to the herd being extirpated for the second time by the 1980s. With the establishment of GSENM, reintroductions were once again initiated in 1999 and continued until 2005. Approximately 400 individuals were released, mostly to the Kaiparowits population. In 2017, the Kaiparowits population was estimated at only 60 individuals in GSENM (UDWR 2017). The Paunsaugunt population was only 40 individuals.[5] Year-long crucial habitat for pronghorn is approximately 82,900 acres in GSENM.

Mule deer numbers include an estimated 6,500 mule deer that migrate from higher elevations of the Paunsaugunt Plateau and travel up to 30 miles to winter habitats at lower elevations in areas such as Buckskin Mountain, Nephi Pasture, and Fivemile Mountain. Mule deer habitat is approximately 1,239,100 acres in GSENM, including winter, year-long, and summer habitat.

Elk habitat includes approximately 165,600 acres in GSENM, including winter, year-long, and summer habitat, at mid- to high elevations (UDWR 2020). There are also established year-round residents in the Circle Cliffs and Skutumpah Terrace.

There are 660 known bee species, across 55 genera, in GSENM. Most bee populations in GSENM are highly localized, only occurring in a few locations and typically in low abundance. Only a few species are widespread and highly abundant. GSENM represents one of the richest bee faunas in the U.S., likely due to the substantial elevational gradient, large number of flowering plants, and the diverse habitats GSENM contains (Carril et al. 2018).

Citizen science research on wildlife at GSENM includes the Christmas bird count, which is an effort to engage the public in counting birds in the area, and iNaturalist, a crowdsourced online database that houses observations of wildlife, including a project for GSENM that has records of 55 arachnid species, 5 fish species, 7 amphibian species, 20 reptile species, 88 bird species, and 35 mammal species as of October 2024.

More publications on GSENM's wildlife may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.9 Rangeland Health and Livestock Grazing

Livestock grazing has been part of the GSENM landscape for over a century and continues to be an important part of the heritage and tradition to many within the GSENM communities (**Figure 2-9**). In the RMP (BLM 2025) 1,737,300 acres of GSENM land is available (open) for livestock grazing and 105,300 acres are unavailable (**Table 2-7**). Approximately 101 permittees have permits to graze on 76 active allotments in GSENM and adjacent areas administered by GSENM staff.

[5]Cameron McQuivey, BLM GSENM wildlife biologist, personal communication on July 27, 2022, regarding pronghorn populations.

Table 2-7: Livestock Grazing Acres Available in GSENM

Status	Acres
Available	1,737,300
Unavailable/closed	105,300

Source: BLM 2025

Figure 2-9: Livestock Grazing at GSENM

The BLM has been monitoring and assessing rangeland conditions through a variety of landscape-scale and site-specific data, such as actual use monitoring, utilization, the landscape monitoring framework, AIM data, and the Landscape Fire and Resource Management Planning Tools (LANDFIRE) vegetation condition class.

Rangeland trend data have been collected in GSENM since the late 1960s to assess grazing effects. Data are collected in microplots or along transects using line-point intercept and nested frequency methods. Trend data have been collected at approximately 280 sites across GSENM, with varying regularity and data collection methods. Data are collected at established key areas throughout the grazing allotments. Key areas are generally in the most important and representative major ecological sites of an area, pasture, or allotment. Currently, about 30 to 45 sites are sampled each year.

BLM Utah Rangeland Health Standards are assessed according to BLM Handbook H-4180-1, Rangeland Health Standards (BLM 2001). In the early 2000s, the BLM began a comprehensive effort to complete rangeland health standards across GSENM; this effort was summarized in the 2006 Rangeland Health Evaluation and Determinations (BLM 2006b). Since that time only a few additional assessments have been completed at GSENM.

Riparian areas in GSENM were characterized with the proper functioning condition (PFC) protocol starting in 1999, but PFC assessments have not been done in recent years. The PFC assessment was done at approximately 100 sites across GSENM. PFC data for GSENM are available on paper or scanned forms. It should be noted that the PFC protocol is designed to give a qualitative assessment of riparian conditions. PFC is an assessment and is not intended to be a monitoring tool, because it generally lacks the sensitivity to detect incremental changes in riparian-wetland conditions (BLM 2020).

The terrestrial AIM program collects data at randomly selected points (over 400 to date) in GSENM. The BLM uses the data to assess site conditions, which can be helpful in livestock management.

Mark E. Miller (2008) conducted a broadscale assessment of rangeland health in GSENM; the resulting paper included seven chapters on vegetation and soils data.

Previous research on rangeland health includes the following:

- "Broad-scale Assessment of Rangeland Health Grand Staircase-Escalante National Monument USA" by Mark E. Miller (2008)
- "Grazing Efficiency of Forage by Cattle on the Grand Staircase-Escalante National Monument" by Carter et al. (2019)

More publications on GSENM's rangelands may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.10 Recreation

GSENM is a popular destination for visitors. Well-known types of recreation include hiking, camping, backpacking, bikepacking, all-terrain vehicle and utility-task vehicle riding, automobile touring, equestrian activities, canyoneering, rock climbing, wildlife viewing, photography, and hunting. Recreation affects the vegetation, soil, water, and other aspects of GSENM. Therefore, recreation's impacts need to be studied so that managers can identify where changes could benefit resource protection.

Recreation is monitored and analyzed by staff and other researchers. The BLM reports recreation visitation estimates using the Recreation Management Information System, which is an internal database. The Recreation Management Information System estimates participation in 65 types of recreational activities recorded at BLM sites and areas, based on registrations, permit records, observations, and professional judgment. Visitation is estimated by the number of visitors and visitor days. Visitors are the actual number of people who take part in a recreational activity. A visitor day is a common recreation unit of measure used among federal agencies that represents an aggregate of 12 visitor hours at a single site or area. Visitor numbers at GSENM increased from approximately 743,000 in 2010 to 1,371,000 in 2021, and then decreased slightly to 1,111,000 in 2022 (BLM 2022, 2023; BLM GIS 2022). These visitor numbers are only an estimate of the actual level of recreational use.

GSENM's Backcountry Database system (2006 to present) has been an internal system of record to report front-country and backcountry impacts in GSENM. These data have been made available to study issues and trends within WSAs. The data could be made available, upon request, to support future research in GSENM.

Visitor impacts have been monitored at GSENM since 1998 by academic researchers and BLM staff. Examples of studies about recreation's impacts include the following:

- "Recreationist Responses to Livestock Grazing in a New National Monument" by Brunson and Gilbert (2003)
- "A Front Country Visitor Study for Grand Staircase – Escalante National Monument" by Burr et al. (2006)

- "Recreation Experience Baseline Study Report: Grand Staircase-Escalante National Monument" by Casey (2018)
- "Grand Staircase – Escalante National Monument: A Summary of Economic Performance, in the Surrounding Communities" by Headwaters Economics (2017)
- "Recreation Site Inventory & Evaluation: 2016-2018" by Pennsylvania State University, Applied Trails Research, and Virginia Tech University (2020)
- "Examining Opportunities for Solitude or Unconfined Recreation in a Colorado Plateau Wilderness Setting: A Case Study from the Canyons of the Escalante" by Meyer et al. (2024)

Research efforts have been conducted using visitor surveys and focus group discussions to understand the public's interest in GSENM. Other surveys have focused on visitor demographics, visitor expectations and satisfaction, visitor use, how visitors obtained information, and local community services. Studies have also focused on impacts from specific user groups, such as wilderness therapy programs, outfitters and guides, front-country visitors, and backcountry visitors.

More publications on recreation at GSENM may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.11 Night Skies

Dark skies are an important and noteworthy attribute of the GSENM landscape (**Figure 2-10**) and are described in Proclamation 10286 in this way:

> The Grand Staircase-Escalante's large, isolated, and, at times, impenetrable landscape is one of the most naturally dark outdoor spaces left in America, providing views of the cosmos that are nearly unrivaled in the contiguous United States, and an opportunity for visitors to encounter a landscape at night, undisturbed by electric lights, in the same way people have experienced the West for most of America's history.

Dark night skies are important resources to people, wildlife, and ecosystems and increasingly becoming more popular as a tourism asset in the local community. Indigenous people have long looked to the night skies as part of their culture and beliefs. "The ancients were accomplished cosmologists, part of a tradition of indigenous knowledge that intertwined with spirituality and survival. They had to be, at the minimum, in order to know what to plant, and when" (Minard 2018).

In 2016, an inventory conducted by a Weber State University and the International Dark-Sky Association team working under a GSENM science permit (UT-16-035-05-S) using satellite imagery and on-ground readings revealed that GSENM is one of the most naturally dark outdoor spaces left in the lower 48 United States. Measurements from the Visible Infrared Imaging Radiometer Suite instrument aboard the Suomi National Polar-orbiting Partnership satellite suggest, based on light escaping upward and not a direct measure of sky brightness, that the night skies in over 90 percent of GSENM qualify under the descriptive term "pristine." In such conditions, only natural sources of light, such as starlight, airglow, and aurora and zodiacal light, are visible to the human eye. Ground measurements of zenith (directly above observers) and sky luminance (brightness) in GSENM supported that conclusion. Excluding measurements around populated places around the edges of GSENM, the mean zenith luminance was 21.8±0.06 magnitudes per square arcsecond, which is comparable to the lower limit of 21.9 to 22.0 magnitudes per square arcsecond established by natural night sky phenomena (IDA 2016).

Figure 2-10: Night Skies at GSENM

Only 30.4 percent of the land area of the U.S. experiences this degree of natural darkness on a regular basis; much of that is in Alaska (Falchi et al. 2016). The routinely seen "pristine" night skies in GSENM are a testament to the rarity of these conditions.

A 2016 inventory of fixed artificial light sources on developed structures within the GSENM boundary revealed that fewer than 30 total lights exist in three locations (Citation Oil facility, which has 18 lights [6 poles with 3 lights per pole]; Calf Creek Campground, which has 2 lights under the porches of the restrooms and 2 lights inside each restroom; and 7 lights on the Paria Contact Station buildings). This inventory did not include lighting on private property inholdings.

Publications on GSENM's night skies can be found in the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.12 Soundscapes

GSENM's natural soundscape is noted in Proclamation 10286 and described this way: "The Grand Staircase-Escalante area also provides a remarkable natural soundscape with infrequent human-caused sounds."

Protection of ambient soundscapes has received growing attention over the past four decades, with legislation dating back to the Noise Control Act of 1972. Subsequent nationwide legislation has described the importance of the acoustical environment for resource protection and the visitor experience in protected natural areas. Because of the abundant noise found in urban and suburban areas, the majority

of visitors to protected natural areas seek respite from ambient stressors such as noise. Natural quiet is important for visitors, ecosystem health, and the welfare of non-human species who reside in protected natural areas.

From 2014 to 2017, an acoustic baseline was documented using sound level meters and digital audio recorders located in various locations across GSENM based on acoustic, biological, and geographic zones; visitor use areas; and WSAs (Mace et al. 2020). The highest percentages of human-caused noise in GSENM are created by high-altitude jets and visitors at popular recreation sites. Several monitored sites were found to be within the range of the quietest locations monitored in the lower 48 United States, based on exceedingly low decibel levels. Recorded decibel levels were approaching the noise floor at several monitored locations, which required extremely sensitive acoustic equipment to accurately document the sound level. One such location was at the Dry Fork site.

As a comparison, the natural quiet in GSENM was recorded at 5.7 A-weighted decibels (dBA), whereas two very quiet national parks, Great Sand Dunes National Park (8.7 dBA) and Haleakala National Park (10 dBA), had higher decibel readings. Additionally, the National Park Service has developed data depicting existing soundscapes for the lower 48 United States; these data also show GSENM is in one of the quietest areas of the country.

2.2.13 Visual Resources

The visual (or scenic) resources of GSENM, as noted in Proclamation 10286, encompass the entire landscape; specific areas and routes are also highlighted. The proclamation describes the visual landscape as follows: "High, rugged, and remote, the vast and austere Grand Staircase-Escalante landscape is characterized by bold plateaus and multihued cliffs that run for distances that defy human perspective."

GSENM's visual resources are highly scenic, highly valued by the public, exceedingly undeveloped, and intact. Many areas within GSENM have a high level of sensitivity to change. GSENM contains internationally recognized scenic destinations and draws an increasing number of visitors who come to the area to recreate and sightsee. "Scenic quality" was selected more than any other quality (61 percent) by focus group participants when asked, "What are the qualities of the place that make it special?" (Casey 2018). Additionally, the "wild, unspoiled and natural" (58.6 percent) and "remote and rugged" (42.5 percent) characteristics were also highly valued. In general, high scenic quality within GSENM is a result of the area's diverse vistas; extraordinary topography; dramatic, colorful, and unusual geology; abundance of canyons and waterways; varieties of vegetation; cultural history features; and lack of development.

The visual resource inventory (VRI) for GSENM was completed in 2018 (BLM 2019). Almost 50 percent of GSENM inventoried as high scenic quality and less than 1 percent inventoried as low scenic quality. The highest-rated scenic quality rating unit inventoried on Utah BLM-managed lands is the Upper Escalante Unit (score of 28), which includes the upper reaches of the Escalante River, Calf Creek, and the lower reaches of Death Hollow. Almost 60 percent of GSENM inventoried as the public being highly sensitive to change in its landscape character. Only 2 percent of the area inventoried as having low public sensitivity to change in the landscape character. About half of the area inventoried as being in the front country or middle country distance zone (visible areas up to 5 miles from common viewing platforms, such as primary travel routes, communities, and viewpoints). About half of the area inventoried as being in seldom seen locations due to landform screening or the distance from viewing platforms (beyond 15 miles).

Almost 50 percent of the lands in GSENM are in WSAs and are classified as VRI Class I. Without the automatic VRI Class I classification of WSAs, more than 60 percent of the lands within GSENM inventoried as VRI Class II, the highest classification that results from combining scenic quality, public sensitivity, and proximity to viewing platforms like commonly used roads. Slightly more than 20 percent inventoried as VRI Class III. Less than 20 percent inventoried as VRI Class IV.

To underscore the undeveloped nature of GSENM, one of the scenic quality scoring factors is cultural modifications, which can be assigned both positive and negative values to rate whether modifications add favorably to the visual environment or create levels of strong disharmony with the natural characteristic landscape. There are 48 scenic quality rating units in the inventory area. Ten of the 48 scenic quality ratings units have slight negative cultural modification scores of -1.0 or -0.5 of a possible -4.0 score. These ten units comprise less than 10 percent of the inventory area.

2.2.14 Cultural Resources

Preservation of tribal and non-tribal cultural resources was one of the key reasons for GSENM's designation under the Antiquities Act (Presidential Proclamation 6920). The proclamation lists occupation by the Ancestral Puebloan and Fremont cultures, as well as by modern tribal communities. Tribal cultural resources in the GSENM represent important records of events and cultures that are invaluable to contemporary tribal communities today. Anglo-European cultural resources are also evident in the form of old trails, cabins, mining activity, and more. These structures and records are meaningful to contemporary people, particularly the descendants of the Mormon pioneers, and others.

GSENM contains an incredibly rich archaeological record that dates back over 10,000 years (**Figure 2-11** and **Figure 2-12**). Material evidence from the Ancestral Puebloan and Fremont peoples has been found across GSENM. Previous occupation by "preceramic" hunters and gatherers and early farmers is also evident in the material and sites present in GSENM (Spangler and Zweifel 2021). Inventorying archaeological sites allows more learning about the Indigenous peoples and the first Anglo-European settlers in this region.

Figure 2-11: Examples of Cultural Resources within GSENM, including a Cliffside Structure (Left) and Rock Imagery (Right)

Figure 2-12: Paria Townsite Historic Structure

Monitoring archaeological sites is an integral part of protecting the important cultural resources in GSENM. Site stewards, BLM staff, and interns monitor approximately 90 sites per year with more sites being added to be monitored each year. Monitoring is done by looking for changes to the sites, including increased visitation, human-made damages, and natural degradation. Damage can occur through a variety of processes. Natural erosion and aging of structures cause most damages. However, damage can also occur through ground-disturbing activities associated with construction projects, human visitation, and livestock grazing. Looting and vandalism, though infrequent, continue to occur. Damage to these cultural resources is why it is important for them to be inventoried and then be continually monitored in an appropriate manner that will not further the degradation of the resources.

GSENM staff partner with the Utah State Historic Preservation Office as part of the statewide monitoring program called Utah Cultural Site Stewardship. This program was mandated to "protect cultural sites located in the state" and "increase public awareness of the significance and value of cultural sites and the damage done to cultural sites by vandalism" (Utah State Legislature 2020). This program involves trained volunteers who regularly monitor sensitive and threatened archaeology.

GSENM staff also partner with the Grand Staircase-Escalante Partners on some site monitoring, graffiti removal from sites, and general cleanup. Grand Staircase-Escalante Partners' mission is to "[Honor] the past and [safeguard] the future of Grand Staircase-Escalante National Monument through science, conservation, and education."

Many different research studies have been conducted in GSENM since its inception. Current efforts focus on identifying, stabilizing, and preventing damage to cultural resources. Cultural resource site surveys are conducted for compliance with Section 106 of the National Historic Preservation Act of 1966 before any ground-disturbing project, and under Section 110 of the National Historic Preservation Act for background and research information. Since it was set aside as a monument with protection and research goals, GSENM has hosted many archaeological researchers, field schools, and graduate students.

Staff at the GSENM have produced several significant archaeological studies and documents, with GSENM staff being the main contributors to the Utah BLM Cultural Resource publication series for the past 20 years. In addition, the BLM has sponsored additional research that has contributed many important documents to the realm of cultural research (see oral history project below). A significant amount of recent cultural resource research can be found in the Learning from the Land GSENM Science Symposium Proceedings (BLM 1997, 2006a, 2016).

An example of a significant archaeological study and publication completed by GSENM staff is the "Excavations at the Arroyo Site, 42KA3976: A Pueblo II/III Virgin Anasazi Farmstead" by Douglas A. McFadden (2012). An exhibit from this excavation is on display at the Kanab Visitors Center. The publication can be accessed on the SUU digital library at Excavations at the Arroyo Site, 42KA3976: A Pueblo II/III Virgin Anasazi Farmstead.

There are a few past and currently ongoing studies that are monitoring the impacts of livestock and humans on cultural resources. One such study by Matt Zweifel, the GSENM archaeologist from 1998 to 2019, was conducted on monitoring site conditions in grazing allotments (Zweifel 2016).

Work done by Lisbeth Louderback and Bruce Pavlik, who are outside researchers from the University of Utah, has shown that cultural materials, specifically stone-grinding tools, have yielded Four Corners potato starch granules. These starch granules have been dated to be over 10,000 years old (Louderback and Pavlik 2017), giving evidence of the long history of cultural use of this landscape and the plants of the region.

While much research has been focused on tribal cultural resources, there is also much research on non-tribal cultural resources. Explorers, such as John Wesley Powell, spent time in and around GSENM in association with trips down the Colorado River for expeditions in 1872. While there is little, if any, physical evidence of the explorers' time in GSENM, there are written accounts and a few early photographs.

A portion of the Old Spanish Trail passes through GSENM. The BLM completed the Grand Staircase-Escalante National Monument Old Spanish National Historical Trail Inventory, Assessment, and Monitoring Report in the fall 2023. This study identified trail segments and conducted inventory and assessment within units based on a viewshed analysis. The inventory focused on historic, cultural, scenic, recreational, biological, geological, and scientific landscape elements.

Starting in 1998 and continuing to the present, historical information about the small communities around GSENM has been compiled by the Southern Utah Oral History Project funded by the BLM. These researchers have conducted over 200 interviews of residents from communities surrounding GSENM. Through this project, substantial efforts have been invested in collaborating with local communities, organizations, Native American tribal members, and others to document and showcase the region's history and people. Most of those interviews are available as typed transcripts on the SUU Special Collections page under "Southern Utah Oral History Project" at SUU Digital Library.

Significant publications that describe the early cultures of this region include the following:

- "Deep Roots: A 10,000-Year Indigenous History of the Grand Staircase-Escalante National Monument" published by Spangler and Zweifel (2021) for the Utah BLM

- "Hisat'sinom of the High Plateaus: The Prehistory of Grand Staircase-Escalante National Monument" by Spangler et al. (2019)
- "Formative Chronology and Site Distribution on the Grand Staircase-Escalante National Monument: A Research Reference" by McFadden (2016)
- "Kaibabitsinungwu: An Archaeological Survey of the Kaiparowits Plateau" by Geib et al. (2001)
- "A preliminary assessment of archaeological resources within the Grand Staircase-Escalante National Monument" by Madsen (1997)

More publications on GSENM's archaeology can be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.15 Tribal Interests

The GSENM region is the traditional homeland of many tribal communities since time immemorial and continues to be important to those same communities today. Traditional tribal uses of the landscape include gathering food, supplies, and medicine; shelter; various crafts; ceremonies; and many more uses.

Indigenous peoples survived in this semiarid region by making the best of what the landscape offered. Ancestral Puebloans found tillable soil and enough water to grow corn, squash, and beans. By working closely with tribes today, archaeologists investigate the landscapes, features, and artifacts left by the Indigenous peoples in the past to better understand ways of life in this unique place. Present-day tribes maintain a strong connection to the land and the ancestors who inhabited this region (**Figure 2-13**). Today, undisturbed archaeological sites and artifacts are tangible connections to ancestors for present-day tribal members, and these sites and artifacts can tell archaeologists a great deal about the past occupants of this landscape.

Figure 2-13: Inter-Tribal Field Trip with the Hopi, Navajo, Paiute, Zuni, and Ute Mountain Ute Tribes in GSENM

Tribal communities with ties to the region include the Hopi Tribe, Kaibab Band of Paiute Indians, Navajo Nation, Paiute Indian Tribe of Utah (includes Shivwits Band of Paiute Indians, Indian Peaks Band of Paiute Indians, Kanosh Band of Paiute Indians, Cedar Band of Paiute Indians, and Koosharem Band of Paiute Indians), Pueblo of Acoma, Pueblo of San Felipe, Pueblo of Tesuque, San Juan Southern Paiute Tribe,

Southern Ute Indian Tribe of the Southern Ute Reservation Colorado, Ute Mountain Ute Tribe, Ute Indian Tribe of the Uintah and Ouray Reservation, and Zuni Tribe. In addition to these tribes, the BLM is coordinating with the All Pueblo Council of Governors, which includes the pueblos noted above as well as the pueblos of Cochiti, Isleta, Jemez, Laguna, Nambe, Ohkay Owingeh, Picuris, Pojoaque, San Ildefonso, Sandia, Santa Ana, Santa Clara, San Domingo, Taos, and Ysleta del Sur.

GSENM staff seek to work closely with Tribal Nations and communities on consultations for many different projects. Tribal perspectives are key to understanding past and present uses of the landscape. It is critical that the BLM take tribal perspectives into consideration for any decisions or projects that occur in GSENM. The BLM is striving to make these interactions more frequent and robust. One way this is being done will be to collaborate with Tribal Nations to develop a co-stewardship plan(s) to provide for specific co-stewardship relationships between the BLM and Tribal Nations, as stated in the RMP (BLM 2025, Section 2.2.23). The BLM hopes this will help to facilitate tribal connections and discussions, and incorporate tribal perspectives into all future aspects of GSENM.

The ERWP partners with GSENM on the ERWP's mission "[t]o restore and maintain the natural ecological conditions of the Escalante River and its watershed and involve local communities in promoting and implementing sustainable land and water use practices." As part of the ERWP's annual symposium on the Grand Staircase-Escalante region, which began in 2022, presentations on various tribal cultures, given by tribal members themselves, have been an integral part of the symposium (see agenda and video links).

Ethnographic studies of Indigenous cultures with a strong connection to the GSENM landscape include the following (in chronologic order):

- "Ethnobotany of the Hopi" by Whiting (1939)
- "Ethnobotany of the Navajo" by Elmore (1944)
- "The Ethnobotany of the Kayenta Navaho: An Analysis of the John and Louisa Wetherill Ethnobotanical Collection" by Wyman and Harris (1951)
- "Southern Paiute Ethnography" by Kelly (1964)
- "Ethnographic Assessment of Kaibab Paiute Cultural Resources In Grand Staircase-Escalante National Monument, Utah" by Stoffle et al. (2001)
- "Hopi ethnographic overview for Grand Staircase-Escalante National Monument" by Bernardini (2006)
- "An Analysis of Culturally Significant Plants, Springs and Archaeology at Grand Staircase-Escalante National Monument" by Sabata (2018)

More publications on tribal interests at GSENM may be found by searching the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.2.16 Environmental Justice and Social and Economic Values

GSENM is in rural southern Utah, in Kane and Garfield Counties, which have a combined population of 13,739 (U.S. Census Bureau 2023). The non-white portion of the population is 8.2 percent, compared to 31.8 percent nationally (Headwaters Economics 2023). Based on 2021 data, leisure and hospitality generate the most employment wages at 36 percent for the two counties (Headwaters Economics 2023).

Public lands, including GSENM, are a major reason for those employment wages through recreation and tourism. Livestock grazing continues across most of GSENM.

Indigenous communities are 4.5 percent of the population for the two counties (Headwaters Economics 2023) and have larger populations in surrounding areas, particularly in northern Arizona. There have been recent efforts to increase economic opportunities for Indigenous communities, but much more needs to be done to provide jobs, clean water, electricity, heating and cooling, health care, and healthy food options.

The BLM assessed economic values from resource management decisions as part of the Proposed RMP/ Final EIS (BLM 2024a) and analysis is provided in Chapter 3 of that Proposed RMP/ Final EIS.

Previous sociocultural and economic research at GSENM includes a 2012–13 study by Arizona State University where researchers used an appreciative inquiry approach to evaluate tourism's influence in local communities (Nyaupane and Timothy 2013). The researchers surveyed 16 GSENM gateway communities with the goal to understand the relationships among conservation, livelihood, and sustainable tourism. The results of this study have been used to inform cooperative efforts and raise public awareness of GSENM's resources and objects while promoting GSENM as a tourism destination and an area of important multiuse and economic opportunities.

More publications on GSENM's environmental justice and social and economic issues are in the recreation subsection above and in the following SUU online database: Grand Staircase-Escalante National Monument Collection.

2.3 ONGOING MONITORING

Monitoring is a key tool that researchers and land managers can use to identify changes in ecosystems—both improvements and degradation—over time. Monitoring is particularly important to assess the impacts of climate change, livestock grazing, recreation, water contamination, water diversion, groundwater pumping, and vegetation treatments. Past and ongoing monitoring are noted in the table below. Future monitoring needs and opportunities are included in **Table 3-1** in **Section 3**.

Some monitoring is conducted sporadically or on an as-needed—or opportunistic—basis. For instance, BLM archaeologists monitor archaeological sites. The majority of monitoring is conducted by the Utah Cultural Site Stewardship (UCSS) program, which recruits local volunteers to monitor archaeological sites around Utah. UCCS partners with the BLM and other land management agencies across the state. BLM archaeologists monitor more sensitive sites, such as traditional cultural properties or sacred places, and sites with high visitation, vandalism, or other impacts. The data are used internally to protect sites. To protect the location of cultural sites, the data are not intended to be shared.

Other as-needed monitoring includes monitoring of emergency stabilization and rehabilitation treatment objectives (for example, AIM, long-term trend, cover, and repeat photography); fuels treatment effectiveness monitoring; vegetation and invasive species monitoring, such as Russian olive abundance and regrowth after removal through the ERWP; rangeland and livestock grazing monitoring, such as rangeland health assessments and evaluations, utilization, actual use, precipitation data, pre-turnout inspections, and AIM data; inventory and monitoring of recreation impacts within the backcountry and dispersed areas throughout GSENM; monitoring of WSAs, including collecting data related to human-caused impacts; wilderness characteristics inventories when new information is received by the public, BLM planning, or a new project proposal; visual resources monitoring; and WSR monitoring. Paleontological sites are also monitored for three primary reasons: to evaluate

trends from human impacts, to evaluate recovery from excavation, and to see if collected sites continue to be scientifically productive.

The three components of the BLM AIM strategy are described in the table below, but they merit an overarching description as well. AIM is an approach for integrated, cross-program monitoring of renewable resources, such as vegetation, soils, water, and wildlife habitat, at multiple scales of management. High-quality information on the status, condition, and trend of natural resources is essential for making sound land management decisions that sustain the diverse uses and benefits of public lands. The AIM approach to monitoring features the following five elements: (1) a standard set of core quantitative indicators and methods, enabling easy comparison of measurements in different places and over time; (2) a defensible and statistically valid way of selecting monitoring plots that informs land management at multiple scales; (3) integration with remote sensing, providing a bird's-eye view of conditions across the landscape; (4) electronic data capture and management, streamlining information access and application to decisions; and (5) a structured implementation process built on management questions and an understanding of ecosystems.

Table 2-8, below, describes active monitoring programs with regular data collection that are available for researchers and land managers.

Table 2-8: Ongoing Monitoring within GSENM

Program	Description	Relevant Web Page or Other Source
AIM Lotic	A BLM-funded contractor conducts the monitoring. The contractor revisits existing and targeted sites for future years.	BLM National AIM Lotic Indicators Hub
AIM Riparian and Wetland	A BLM-funded contractor conducts the monitoring. The contractor revisits existing and targeted sites for future years.	BLM National AIM Riparian and Wetland Indicators Hub
AIM Terrestrial	The BLM AIM protocol is used as an inventory and monitoring tool for soils resources. A BLM-funded contractor conducts the monitoring. Sites can be resampled to assess the trend or just sampled for the resource condition.	BLM National AIM TerrADat Hub
Air Resources, Meteorological (Temperature, relative humidity, barometric pressure, solar radiation, wind speed, and wind direction)	Several weather stations are set up and collecting data in GSENM. Data are reported through the Remote Automatic Weather Station network and are available in near real-time on the MesoWest website. Maintenance is an issue, both in staff time and funding.	MesoWest
Archaeological Resources	BLM site stewards compile data on the site conditions and trends for high-profile or high-traffic sites.	For resource protection, data are not publicly available.

Program	Description	Relevant Web Page or Other Source
Fish	The UDWR conducts the monitoring of species' distribution, the threat assessment, and population status monitoring.	One example is Three Species Monitoring Summary: Roundtail Chub (*Gila robusta*), Bluehead Sucker (*Catostomus discobolus*), Flannelmouth Sucker (*Catostomus latipinnis*) (UDWR 2015).
Harmful Algal Blooms	Monitoring is completed with help and cooperation from UTDWQ for public health at high-priority recreation sites.	General information: Division of Drinking Water Harmful Algal Bloom & Cyanotoxin Response Plan
Recreation, Recreation Information Management System	The project consists of the BLM collecting visitor data at various recreation destinations within GSENM. A report of the data is submitted to the U.S. Congress on an annual basis.	—
Paleontological Resources	BLM staff and volunteers monitor sites for impacts and scientific potential. Data are stored at GSENM headquarters.	—
Recreation, Visitor Satisfaction Surveys	The project consists of measuring the quality of the visitor experiences while recreating in GSENM. BLM and contractor staff conduct the monitoring.	—
Riparian Lotic and Lentic Assessments	PFC assessments are used. Data are collected by BLM range staff, the Great Basin Institute, and other BLM interdisciplinary team members.	—
Trend of Rangeland Condition	Long-term trend data are collected by BLM range staff for actual use and utilizations. Precipitation monitoring is also used across GSENM via rain buckets, which are read monthly.	—
Water Quality	The State of Utah is responsible for monitoring water quality.	Environmental Interactive Map (select "Water Quality" and "Monitoring Locations") and Water Quality Databases and Information

Section 3. Identification and Prioritization of Management Questions and Science Needs

GSENM's science program aims to provide and facilitate scientific studies that will address land managers' questions. Scientific research is done within the constraints of the RMP and available resources (both internal and external). The science needs will be determined on an ongoing basis through coordination between GSENM staff, BLM leadership, and other BLM guidance with input from researchers and experts.

GSENM specialists and leadership have identified and prioritized a variety of science needs at GSENM, which are presented in detail in **Table 3-1**. The table specifies research questions and needs for multiple topics to encourage informed, relevant, and robust scientific investigations at GSENM. Topics and questions in **Table 3-1** align with Objectives and Management Directions in the GSENM RMP (2025), as well as from BLM and United States Department of the Interior (DOI) policy. Science needs at GSENM should include efforts that address both restoration needs as well as landscape-level issues. As science needs at GSENM evolve over time, GSENM specialists and leadership will regularly update **Table 3-1** with additional potential and needed research efforts.

The science needs and management questions identified in this section are directional; they are not fixed priorities. Mandated management (e.g., Sage-Grouse Plan, efforts to mitigate climate change, rare species listings by USFWS and others) will change science needs over time. Changes on the ground such as drought, increased visitation, altered recreation activities or changes in land uses can also lead to new or different science needs.

Researchers are encouraged to look at **Table 3-1** to identify research needs they could study and address to help inform GSENM management. Section 4 describes how researchers can apply for scientific research authorization in GSENM.

Table 3-1: Science Needs at GSENM

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Air Quality and Climate	Criteria pollutants	Maintain or reduce concentrations of criteria pollutants in compliance with applicable state and federal ambient air quality standards within the scope of the BLM's authority.	What are the air quality and air quality related values within GSENM?	Utilize air quality data to take management actions to improve air quality in GSENM.
Air Quality and Climate	Dust control	Minimize visibility-impairing pollutants in accordance with the reasonable progress goals and time frames established in Utah's Regional Haze State Implementation Plan and within the scope of the BLM's authority.	Where are dust-generating regions and sources within GSENM?	Utilize air quality data to take management actions to reduce identified sources of dust within GSENM.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Cultural Resources	Cultural resources	Identify, preserve, and protect cultural resources in place and in their original context.	How can our deep understanding of cultural resources in GSENM be expanded or enhanced? How can predictive models be better used and improved to identify additional cultural sites? What are the impacts on cultural resources from recreation, livestock, or other sources, and how could cultural resources be better protected? How could Indigenous knowledge holders and Indigenous perspectives be incorporated more into assessing and protecting cultural resources? How can GSENM's signage and interpretation materials be updated with language that is more respectful and inclusive of tribal communities and perspectives? What is the condition of the cultural sites within the Fiftymile Mountain ACEC?	Utilize new information, including Indigenous perspectives, to better manage and protect cultural resources. Ensure cultural resources are categorized to their appropriate uses, as described in Appendix D of the GSENM RMP. Ensure appropriate traditional use of cultural resources through consultation with Native American tribes. Support Indigenous knowledge. Utilize predictive models of cultural resources. Use Indigenous perspectives to update signage and interpretation materials. Use scientific findings to protect cultural resources in the Fiftymile Mountain ACEC.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Cultural Resources	Pioneer heritage	Provide opportunities to connect to pioneer heritage.	How can we expand our understanding of how the GSENM landscape was used in the pioneer era? What can the BLM do to better protect and highlight GSENM resources from the pioneer era?	Improve interpretive materials of historic sites to enhance the visitor experience.
Fuels, Wildfire, and Prescribed Fire	Range of natural variability	Maintain ecosystems that are at low risk of losing ecosystem components (such as ecosystems functioning within their historical range) and restore ecosystems that are at a moderate to high risk of losing ecosystem components (such as ecosystems functioning outside their historical range).	How has pinyon and juniper cover changed over time across the landscape. This could involve inventory and mapping, of pinyon-juniper woodlands and determining ages of some trees. What are the possible causes for these changes and trends? How have invasive annual grass species changed over time across the landscape? What are the possible causes for changes in vegetation that increase fire risks?	Implement prescribed fire or other vegetation treatments to preserve or restore ecosystems that were previously altered by human- and weather-related events.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Fuels, Wildfire, and Prescribed Fire	Wildland fire	Allow natural caused wildland fire to protect, maintain, and enhance resources and, when possible, allow wildland fire to function in its natural ecological role.	How do wildfire, prescribed fire, and mechanical vegetation treatment methods affect landscape vegetation diversity, vegetation resiliency, invasive species, soils, wildlife habitat, and water quality and quantity? What are the local and regional perspectives and understanding of the role of wildfire on the GSENM landscape? How might wildland fire, prescribed fire, and fuels treatments impact GSENM landscapes and the proximate communities?	Match wildfire management techniques to conditions and locations to best protect ecosystem function and resiliency, as well as to provide for human safety.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Landscape Characteristics	Dark night skies	Manage outdoor lighting fixtures to protect the quality of dark night skies.	What methods, media, and messaging would be most effective with the public and visitors to engage them in protection of GSENM's dark skies? Where would it be most appropriate to establish dark skies' key locations to direct visitors to? How does experiencing these places affect human health metrics like blood pressure, feelings of depression, etc.? What are trends in the quality of dark night skies? How are dark skies and celestial bodies important to Indigenous communities who desire to share that cultural knowledge?	Implement communication methods to engage the public in protecting GSENM's dark skies. Proactively protect dark night skies. Support Indigenous perspectives on dark skies and celestial bodies by communities who desire to share their cultural knowledge.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Landscape Characteristics	Natural soundscapes	Manage uses to protect the natural quiet associated with GSENM's soundscapes.	What methods, media, and messaging would be most effective with the public and visitors to engage them in protection of GSENM's natural quiet objects and values? Where would it be most appropriate to establish natural sounds trails to direct visitors to? How does experiencing these places affect human health metrics like blood pressure, feelings of depression, etc.? What are trends in the quality of soundscapes?	Implement communication methods to engage the public in protecting GSENM's natural quiet objects and values. Proactively protect natural soundscapes.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Landscape Characteristics	Visual resources	Manage lands according to the assigned visual resource management (VRM) class objective.	What is the public's sensitivity to change in the landscape character? Is sensitivity different in protected landscapes (NCL units) compared to nonprotected landscapes (BLM-managed lands outside NCL units)? What is the threshold at which changes in landscape character from multiple individual projects collectively hit a cumulative effect that changes the landscape character? How does experiencing these places affect human health metrics like blood pressure, feelings of depression, etc.? What are the trends in VRM classes?	Utilize thresholds for public sensitivity that align with VRM class objectives. For example, at what point is a threshold passed such that a project does not meet the management objectives associated with public sensitivity? Use an updated visual inventory.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Paleontology and Geology	Geology	Protect paleontological and geological resources from destruction or degradation.	The Kaiparowits Plateau contains one of the best age-constrained Late Cretaceous sedimentary records in North America. However, key uncertainties still exist in the formations where they are exceedingly thick or lack datable ash beds. What erosional and climatic processes and histories created the unique geomorphology (for example, slot canyons, hoodoos, and demoiselles) and rock coloration of GSENM? How do modern microbial endoliths control bedrock erosional rates and surface hardness? How did Sevier and Laramide tectonics affect the evolving Late Cretaceous landscape and geomorphology? How do Pleistocene and Holocene erosional and depositional processes compare and contrast? What is the tectonic history of larger Laramide structures like the Water Pocket Fold, East Kaibab Monocline, and the Upper Valley Anticline?	Refine the Late Cretaceous time-stratigraphic resolution in the Kaiparowits Plateau and surrounding areas through correlation, radiometric dating, paleomagnetic stratigraphy, and source area studies that result in peer-reviewed publications. Encourage specific studies on areas with high concentrations of unique geomorphological features that result in peer-reviewed publications. Encourage specific studies on areas that showcase microbial interactions with bedrock surfaces that result in peer-reviewed publications. Encourage specific studies on Laramide structures that integrate geochemical, stress/strain, and chronological data that result in peer-reviewed publications.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Paleontology and Geology	Paleontology	Protect paleontological and geological resources from destruction or degradation. Manage discretionary uses to prevent unnecessary damage to paleontological resources.	What facies and outcrops of Cenomanian, Turonian, Coniacian, and Santonian-age formations are most productive of terrestrial macrovertebrate fossils in the Kaiparowits Plateau region? What is the marine vertebrate record in the Cenomanian, Turonian, and Coniacian units (Naturita, Tropic, and Straight Cliffs Formations)? What is the broader pattern of vertebrate fossil distribution in the Chinle Formation in the Circle Cliffs and Vermilion Cliffs regions? What are the vertebrate diversity and ecology of the Morrison Formation in GSENM?	Survey the terrestrial portions of the Cenomanian, Turonian, Coniacian, and Santonian outcrops throughout the Kaiparowits Plateau, and submit novel finds to peer-reviewed publications. Inventory the marine portions of the Cenomanian, Turonian, Coniacian, and Santonian outcrops throughout the Kaiparowits Plateau, and submit novel finds to peer-reviewed publications. Inventory the Chinle Formation in the Vermilion Cliffs and Circle Cliffs regions, and submit novel finds to peer-reviewed publications. Inventory the Morrison Formation in the Escalante, Fiftymile, and Croton-Last Chance regions of GSENM, and submit novel finds to peer-reviewed publications.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Paleontology and Geology	Paleontology (cont.)	Protect paleontological and geological resources from destruction or degradation. Manage discretionary uses to prevent unnecessary damage to paleontological resources.	What are the floral diversity and ecology of the Wahweap and Kaiparowits Formations? What is the detailed osteology of the post-cranial skeletons of named GSENM dinosaurs? What is the overall vertebrate diversity of the Kaiparowits and Wahweap Formations?	Synthesize the floral diversity and ecology of the Wahweap and Kaiparowits Formations, and publish both basic alpha taxonomic diversity and novel finds in ecology and evolution. Emphasize long-description osteological studies of named GSENM dinosaurs. Since 2005, 14 species of dinosaurs have been named from GSENM. Nearly all these were named in short format papers that did not include detailed osteology of the post-cranial skeleton. Since most of these specimens represent taxa only found in the southern Laramidian Biome, their uniqueness makes complete osteological descriptions of the type specimens an important requirement for future studies. Complete inventories of the Kaiparowits and Wahweap Formation, and publish the resulting novel finds, including the 14+ unique dinosaur taxa that are already sitting in museum collections ready to be named.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Paleontology and Geology	Paleontology (cont.)	Protect paleontological and geological resources from destruction or degradation. Manage discretionary uses to prevent unnecessary damage to paleontological resources.	How does the public impact publicly interpreted fossil sites? What evidence exists in rock writing or other sources that Indigenous people were aware of paleontology such as dinosaur tracks?	Encourage long-term trend studies on sites that are widely known to the public (like the oyster beds and numerous track and petrified wood sites). Survey rock image sites to identify potential connections of fossils to prehistoric Indigenous beliefs and culture. Interview modern tribal members to catalog individual and collective beliefs on fossils, and look for connections.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Rangeland Health and Livestock Grazing	Rangeland management	Implement livestock grazing management practices to meet the BLM Utah Rangeland Health Standards in a manner that is consistent with the protection of GSENM objects.	What types of vegetation management (including species used) best support landscape restoration? What types of livestock management reduce vulnerability to invasive species' spread? What are the long-term trends in rangeland health? How can research on forage palatability, species selection, and nutritional value help guide better management of livestock to maintain healthy rangeland ecosystems? What are the impacts of range projects (for example, seedings and infrastructure) on ecosystem functions as well as livestock operations? What are the ecological differences in areas grazed by livestock and those with exclosures (without livestock)?	Utilize supplementary adaptive management tools for rangeland health and grazing management under conditions of drought. Utilize range management tools (for example, seedings and infrastructure) that have shown ecosystem benefits.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Recreation	Visitor use and experience	Manage recreation management areas in accordance with the prescriptions in Management Directions REC-20 through REC-40.	What are the visitor use data, visitation trends, and impacts caused by recreational use? Specific questions could be related to recreation's impacts on slot canyons, streams, springs and seeps, cultural sites, and other sensitive places. What are social media's effects on the outdoor recreation industry related to GSENM? What are the carrying capacities of recreation destinations in GSENM? What is the efficacy of educational, regulatory, and site management actions for minimizing recreation's impacts on GSENM? How do Indigenous people experience GSENM, and what could be done to facilitate more experiences in GSENM?	Utilize visitor use data to provide recreational opportunities in a variety of physical, social, and operational settings, from a primitive, remote landscape to a front-country landscape. These opportunities allow visitors to have desired recreational experiences and result in associated beneficial outcomes while reducing conflicts with other discretionary uses.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Soil	Biological soil crust	Protect and restore areas of biological soil crust appropriate for the soil type, climate, and landform. Emphasize research that builds understanding and improves management of soil resources and biological soil crusts.	What types of biological soil crusts are found in different settings and landforms within GSENM? How do different biocrusts influence their environment? How does installation of additional water troughs impact biocrusts within an allotment? How do biocrusts in GSENM respond to fire? How do biocrusts respond to vegetation treatments (that is, chemical and mechanical treatments)? What actions facilitate biocrust restoration after disturbance? How are changes in climate affecting biocrust species' composition and function?	Utilize research findings to prevent damage and degradation of biological soil crusts.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Soil	Biological soil crust (cont.)	Protect and restore areas of biological soil crust appropriate for the soil type, climate, and landform. Emphasize research that builds understanding and improves management of soil resources and biological soil crusts.	How can past biological soil crust models be updated to reflect current data?	Utilize updated biocrust information and research in land management decisions.
Soil	Soil stability	Protect and restore soil health, productivity, stability, and infiltration to prevent erosion from disturbance and to provide for optimal plant growth and site potential. Protect soil resources consistent with the BLM Utah Rangeland Health Standards.	What are the soil health benchmarks for the different soil types within GSENM, particularly infiltration and rates of erosion? How do soil conditions affect vegetation types and abundance? What livestock grazing practices support healthy soil function?	Utilize soil health benchmarks to adjust management to improve or protect soil resources.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Soil	Watershed health	Protect and restore overall watershed health to reduce erosion, stream sedimentation, and salinization of water, with particular emphasis on the Colorado River system.	Does spreading cattle grazing over a larger area have a benefit to soil resources in areas where cattle traditionally congregated? How do vegetation treatments (that is, chemical and mechanical treatments) affect overall soil function? What management actions reduce accelerated large-scale soil erosion? How do native and nonnative plant species, particularly noxious species, affect soil function? How does watershed condition relate to sediment flux in both ephemeral and perennial streams?	Utilize data on effective livestock management to improve or protect soil resources. Utilize soil research findings in decisions about land management.
Tribal Interests	—	Collaborate with Tribal Nations to identify science needs (including research, monitoring, and data collection) associated with Indigenous knowledge.	What are the desires and concerns of Tribal Nations regarding stewardship of GSENM?	Collaborate with Tribal Nations to foster co-stewardship relationships between the BLM and Tribal Nations as directed in the GSENM RMP.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Vegetation	Climate resiliency	Manage reference plant communities to protect and enhance or restore biological diversity.	What strategies can the BLM take now to increase resiliency in management practices? What are the possible impacts on native plant communities from recent changes in climate? How could climate change affect reference plant communities?	For BLM management actions, utilize genetic source material appropriate for the predicted future condition. Implement management of climate refugia, relic plant communities, and other vegetation that will foster resiliency to environmental change and challenges (for example, drought). Implement management for rare plants and native plant communities that fosters resiliency, resistance, and adaptation to climate change.
Vegetation	Noxious weeds and invasive plants	Restore native species to meet desired plant community objectives. Protect and restore a mosaic of native perennial and annual vegetation communities across the landscape with a diversity of species, canopy, density, and different stages of composition.	What leads to the introduction and establishment of nonnative, invasive plant species in ecosystems in GSENM? Which treatment types effectively reduce the abundance of nonnative, invasive plant species? How does management of woody invasive plants, Russian olive, and tamarisk improve or restore hydrologic function?	Implement guidance and practices, including effective prevention and education, to reduce the introduction and establishment of nonnative, invasive plants. Implement the most effective methods or combination of methods for each ecotype to reduce nonnative, invasive plant abundance with minimal negative ecological effects.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Vegetation	Riparian vegetation	Protect and restore riparian areas to PFC. Proactively manage uplands, riparian areas and waterways to protect and restore water quantity and quality.	What causes riparian areas to not properly function? How does riparian area management affect water quantity and quality? For Indigenous communities who desire to share this knowledge, what are the ethnobotanical perspectives on riparian plants of the Indigenous communities with connections to GSENM?	Implement ecologically appropriate vegetation management actions in riparian areas that improve or protect water quantity and quality and riparian health. Utilize Indigenous ethnobotanical knowledge, with the tribes' permission, in protecting and restoring riparian vegetation.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Vegetation	Special status species	Protect and recover special status species (BLM Utah sensitive and federally listed threatened, endangered, proposed, or candidate plant and animal species) habitats and populations. Actively promote recovery to the point that provisions of the Endangered Species Act (ESA) are no longer required or to avoid listing them under the ESA.	What is the status and distribution of globally and Utah state critically imperiled plant species within GSENM? Are there additional plants to consider as BLM special status species that are in need of additional management? Where are potential habitats for globally and Utah state critically imperiled plant species within GSENM? How could climate change affect special status plants? Are there potential areas of reintroduction and expansion of special status species? What are factors that may be limiting recovery and expansion of special status species (that is, lack of pollinators, altered hydrology, seed dispersing agents, etc.)?	Utilize improved monitoring plans for globally and Utah state critically imperiled plant species within GSENM. Implement improved management for globally and Utah state critically imperiled plant species within GSENM. Utilize information on suitable conditions for reintroduction or expansion of special status plant species. Utilize scientific findings to reduce ecological features that limit special status plant species populations and to foster recovery or expansion.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Vegetation	Upland vegetation	Protect and restore functional vegetation communities, including sagebrush communities; support watershed function, reduce fugitive dust; and provide quality habitat necessary to maintain sustainable wildlife populations, including sagebrush-obligate species. Proactively manage uplands, riparian areas, and waterways to protect and restore water quantity and quality.	How can the BLM manage pinyon-juniper woodlands to promote forest health and fuels mitigation? How can aging pinyon and juniper trees (counting rings of cores or slices) help the BLM assess natural pinyon-juniper woodlands versus those that have established since Anglo settlement? Which novel restoration techniques can be utilized in the ecosystems of GSENM? How do activities in the uplands affect water quantity and quality?	Utilize science-based criteria for identifying healthy and unhealthy pinyon-juniper forests. Utilize science-based guidance for identifying old trees versus younger trees based on tree form and other characteristics. Implement novel restoration techniques to restore functional vegetation communities. Implement ecologically appropriate management actions in uplands that can be implemented to improve or protect water quantity and quality. In collaboration with Tribal Nations, develop and utilize ethnobotanical perspectives, interpretations, and guidance for inclusion in future management goals and objectives of the improvement, restoration, or protection of upland vegetation. In collaboration with Tribal Nations, seek to further document and describe traditional uses or culturally important upland plants and plant communities in GSENM.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Water and Aquatic Habitat	Climate resiliency	Manage aquatic habitat and water uses to help increase climate resiliency in consideration of expected changes in water availability.	How could climate change affect water quantity and quality? How could changes to flows or water levels threaten aquatic organisms?	Utilize scientific data to decide how the availability of water for proposed uses will be determined (for example, aquifer mapping, flow monitoring, and predictive climate and drought modeling). Make decisions about aquatic habitat and water uses to help increase climate resiliency in consideration of expected changes in water availability.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Water and Aquatic Habitat	Hydrologic function and condition	Protect and restore natural hydrologic functions of watersheds to meet BLM Utah Rangeland Health Standards. Protect and restore watershed hydrologic conditions (such as minimizing sheet and rill erosion and increasing infiltration rate) in sensitive or impaired watersheds and riparian areas.	What are the characteristics of the aquifers within GSENM, including aquifer boundaries, recharge areas, flow direction, flow rate, storage volumes, and age of water? What are the processes that lead to declines in hydrologic functions and failure to meet BLM Utah Rangeland Health Standards? What actions lead to improvement in watershed hydrologic conditions in impaired watersheds? What are the ecological impacts of low-tech, process-based restoration actions (check dams, beaver dam analogs, etc.)? What parameters or metrics indicate functional or nonfunctional springs, streams, and riparian areas? What are the key hydrologic parameters in vegetation treatments that affect landscape and ecological health? What are the hydrologic effects of different types of management actions, including effects on subsurface flows?	Utilize hydrologic parameters and metrics to ensure proper maintenance of hydrologic functions and processes, and resiliency of springs, riparian areas, subsurface flows, and floodplains. Utilize hydrologic metrics when considering potential hydrologic effects on resources in the design of project-level proposals, and in monitoring the effects. Utilize hydrologic metrics when considering potential hydrologic effects on resources in the design of project-level proposals, and in monitoring the effects. Utilize key hydrologic parameters to assess the effectiveness and success of vegetation treatments and to foster healthy ecosystems. Appropriately consider hydrogeomorphic changes, streambank stability, and stream incision during project-level proposals involving hydrology, riparian areas, and floodplains.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Water and Aquatic Habitat	Water availability	Protect and restore available surface and groundwater into and out of GSENM. Prioritize the maintenance of natural flows and flood events.	What updates need to be made in the stream layer regarding flow classification (perennial, intermittent, or ephemeral) with the USGS Three-Dimensional Hydrology Program, followed by field verification? How do changes in water quantity change the functionality of springs, streams, and wetlands? What is the status of springs, streams, and wetlands? What are the Indigenous communities' connections to springs, streams, and wetlands?	Utilize data on surface and groundwater through an updated USGS Three-Dimensional Hydrology Program in management decisions. Implement strategies to improve the condition of springs, streams, and wetlands, based on indicators of proper functionality. Support and foster the connection of Indigenous communities to springs.
Water and Aquatic Habitat	Water quality	Protect and restore water quality to meet State of Utah water quality standards and the BLM Utah Rangeland Health Standards. Protect and restore surface and groundwater quality and conditions to avoid outbreaks of harmful algal blooms.	What are the hydrologic conditions within the eight watersheds identified as departed from the reference condition in the GSENM RMP? Why do certain watersheds (that is, Henrieville Wash, Last Chance Creek, and Wahweap Creek) have high TDS?	Implement management actions to move departed watersheds toward reference conditions. Implement management actions to improve watersheds with high TDS.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Wildlife	Avian species	Protect aquatic, avian, and terrestrial wildlife habitat quality and quantity, including seasonal, migratory, and connectivity habitats, to provide for biologically diverse and healthy ecosystems to meet BLM Utah Rangeland Health Standards.	What is the baseline information on species' presence and ranges, habitat use, and critical migration patterns? Do special status species (ESA listed or BLM sensitive) with the potential to occur in GSENM exist and if so, where? What management actions foster resilient habitat for avian species into the future given the predicted habitat alterations due to climate change?	Utilize scientific findings to implement management actions shown to support avian species.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Wildlife	Fish and aquatic species	Protect aquatic, avian, and terrestrial wildlife habitat quality and quantity, including seasonal, migratory, and connectivity habitats, to provide for biologically diverse and healthy ecosystems to meet BLM Utah Rangeland Health Standards.	What is the baseline information on species' presence, ranges, and habitat use, including native fish such as flannelmouth sucker, roundtail chub, and bluehead sucker? Do special status species (ESA listed or BLM sensitive) with the potential to occur within GSENM exist and if so, where? Where and how are nonnative wildlife negatively affecting native wildlife? What is the potential for the reintroduction of native Colorado River cutthroat trout in suitable habitats? What management actions foster resilient aquatic and terrestrial landscapes and protect fish and aquatic species into the future given the predicted habitat alterations due to climate change?	Utilize scientific findings to implement management actions that protect fish and aquatic habitats and species.

Topic	Focus	Management Objective (from RMP)	Science Questions	Science Applications
Wildlife	Terrestrial wildlife	Protect aquatic, avian, and terrestrial wildlife habitat quality and quantity, including seasonal, migratory, and connectivity habitats, to provide for biologically diverse and healthy ecosystems to meet BLM Utah Rangeland Health Standards.	What is the baseline information on species' presence, ranges, habitat use, and critical migration patterns and corridors? For instance, where are wildlife migration corridors? Do special status species (ESA listed or BLM sensitive) with the potential to occur within GSENM exist and if so, where? For instance, where are Mexican spotted owl breeding territories? Where is the potential habitat for yellow-billed cuckoo and southwestern willow flycatcher? What management actions foster resilient habitat for terrestrial species into the future given the predicted habitat alterations due to climate change?	Utilize scientific findings to implement management actions shown to foster resilient terrestrial landscapes to protect GSENM's terrestrial wildlife species into the future with the predicted habitat alterations due to climate change.

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Section 4. The Unit's Plan to Meet Science Needs

To meet the objectives of having GSENM serve as a premier outdoor laboratory and a place for understanding the natural environment, our history, our planet's past, and our place in the universe, the BLM will engage with the scientific community; collaborate with partners, including tribes; and establish an internal process for managing science, as described below. As specified in its science mission, GSENM aims to be a leader for science within the BLM and particularly the NCL. Proclamation 10286 emphasizes that GSENM is a living, outdoor science laboratory.

4.1 Community Engagement

Engaging the public in science is an important part of this Science Plan. The overarching goals of community engagement include increasing awareness and appreciation of GSENM's diverse landscapes, ecosystems, and resources (for example, biological, geological, and cultural); increasing awareness and appreciation of science conducted at GSENM and how it interfaces with the world; facilitating GSENM's use as a living laboratory by increasing opportunities to engage diverse stakeholders, researchers, and community members in basic and applied science; increasing the quality of science conducted at GSENM; and increasing the internal capacity of staff to conduct science.

Through external science education and outreach, the BLM will seek to build networks and develop an interest in, and accomplishment of, science. This includes outreach to academic researchers and their institutions, as well as the broader public, including science organizations, nonprofit organizations, and tribal entities. Ultimately, these efforts will build the BLM's understanding of resources and landscape conditions at GSENM and assist in determining the best ways to manage the lands.

Outreach to scientists can help to broaden the scope of interest in GSENM's science program and associated research, resulting in recruiting research science done in GSENM and increasing funding opportunities for science in GSENM. Further, such outreach would increase coordination between researchers, particularly those researching similar subjects, since scientists must demonstrate they have considered published literature prior to being issued a permit (see Section 5). One way that scientific outreach occurs is through the SUU digital library, which helps researchers find articles about published research completed within GSENM. Scientists can help to supplement that digital library by sharing with the BLM any published and unpublished research within and related to GSENM.

In addition, the public can share articles and reports with the BLM to add to that SUU database about GSENM. Those publications, either the citation or the full document, can be sent to the Science Coordinator (contact information is on this web page: Science & Research) who shares batches of articles with the SUU library for the GSENM database. Permission from publishers is needed to post full articles, such as pdfs, on the SUU digital library.

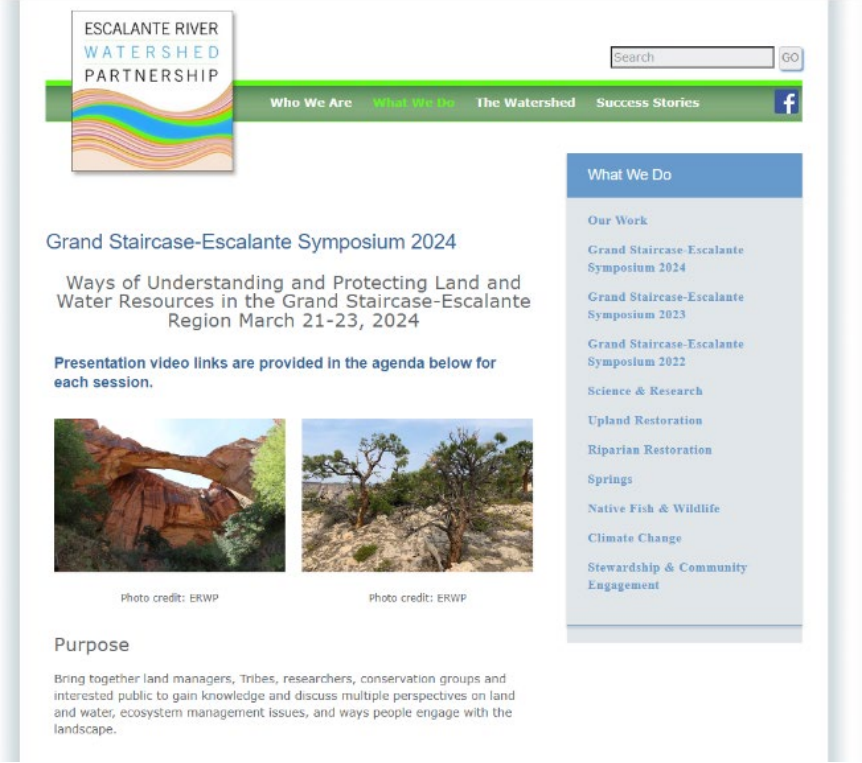
Organized symposia and scientific meetings are beneficial ways to foster scientific collaboration at GSENM. External outreach has included the decadal symposium, Learning from the Land, first held in 1997. Subsequent symposia have been held every 10 years, in 2006 and in 2016. The next symposium is

anticipated for 2026. During that symposium, the BLM will compile and share research (both external and internal to the BLM) from the previous 10 years with the public.

Additionally, the BLM supports and participates in an annual symposium about the Grand Staircase-Escalante region, which includes GSENM, Forest Service land, and National Park Service lands in the watershed area above and below GSENM. This free symposium is hosted at the Escalante Interagency Visitor Center and offered online. It is anticipated that this event will continue to be held annually (**Figure 4-1**). It includes talks on ecology, Indigenous perspectives, history, hydrology, paleontology, and more. The agendas and presentations for those annual symposia are available at the following links:

- 2022: Grand Staircase-Escalante Symposium 2022
- 2023: Grand Staircase-Escalante Symposium 2023
- 2024: Grand Staircase-Escalante Symposium 2024
- 2025: Scheduled for March 20–22, 2025

Figure 4-1: Online Website for the Grand Staircase-Escalante Symposium



Other outreach, such as for paleontology, wildlife, and botany, is also conducted through other events such as talks and presentations to schools and libraries and at the visitor centers. BLM press releases highlight research findings, such as the publication of new fossil species. The BLM also uses virtual outreach for community engagement and sharing science education, such as through GSENM's science research website (Science & Research).

External education and outreach to the broader public can occur in many ways, including, but not limited to, proactive science-related educational opportunities, tribal engagement, volunteer work, and citizen

science. The public can participate in the scientific process and contribute to the understanding of GSENM through websites and smartphone applications like the iNaturalist platform (see Section 2) and others listed on this web page: Engage With Us. GSENM staff also provide science presentations and nature walks at local events, such as Amazing Earthfest in Kanab.

GSENM staff hires interns, typically in the summer, to participate in the BLM's work. The internship program is currently supported through the SUU Intergovernmental Internship Cooperative.

GSENM is a key player in the ERWP, which was formed in 2009 as a collaborative effort to restore and maintain the natural ecological conditions of the Escalante River and its watershed. The ERWP is a collaborative effort to restore and maintain the natural ecological conditions of the Escalante River and its watershed beyond the boundaries of landownership and to involve local communities in sustainable land and water use practices. One of the ERWP's main projects has been the ongoing effort to reduce the population and spread of the nonnative Russian olive, which had become dominant in the region in the late 1900s and early 2000s.

GSENM staff engage with the recently formed Grand Staircase Regional Guide Association; with this association, GSENM staff reinitiated a science workshop for outfitter and guide companies in 2023. The workshop has been held sporadically in the past and is now planned as an annual event. This free workshop provides presentations by experts in natural and social sciences, including Indigenous perspectives, for the guides who can then share accurate and culturally respectful information with their clients. Presentations from the 2023 workshop are available at the following website: Grand Staircase Regional Guide Association Videos. The BLM plans to hold that workshop each year to share science information with the guides who take clients into GSENM.

The Escalante Visitor Center has telescopes and provides the public with opportunities to view night skies. Rangers provide dark-sky programming as schedules allow.

4.2 PARTNERS

The types of GSENM collaborators that the BLM partners with include scientific organizations; universities; museums; nongovernmental organizations; federal, state, and local agencies; and others. The BLM will develop and maintain a list of current partners. Examples of current partners are presented in the table below (**Table 4-1**), which is not an exhaustive list. GSENM partners with numerous organizations and groups to promote scientific research and engagement. GSENM leadership and staff encourage broad scientific participation and are always looking for new partnership opportunities with interested groups.

Table 4-1: Examples of GSENM Science Partners

Type	Partner
Federal Research Entities	Agricultural Research Service – Southwest Watershed Research Center USGS – Rocky Mountain Region
Museums	Denver Museum of Nature and Science Natural History Museum of Utah Prehistoric Museum (Price, Utah) North Carolina Museum of Natural Sciences

Type	Partner
Nonprofit Organizations	Denver Canyon Conservancy Glen Canyon Conservancy Grand Staircase-Escalante Partners Grand Staircase Regional Guide Association ERWP
State of Utah Agencies	Utah Department of Natural Resources Utah Division of Water Resources UDWR Utah State Historic Preservation Office Utah's Watershed Restoration Initiative
Tribes	Hopi Tribe Kaibab Band of Paiute Indians Navajo Nation Paiute Indian Tribe of Utah Pueblo of Acoma Pueblo of San Felipe Pueblo of Tesuque San Juan Southern Paiute Tribe Ute Mountain Ute Tribe Zuni Tribe
Universities	Brigham Young University Northern Arizona University SUU The University of Utah Utah State University Utah Tech University Utah Valley University Weber State University

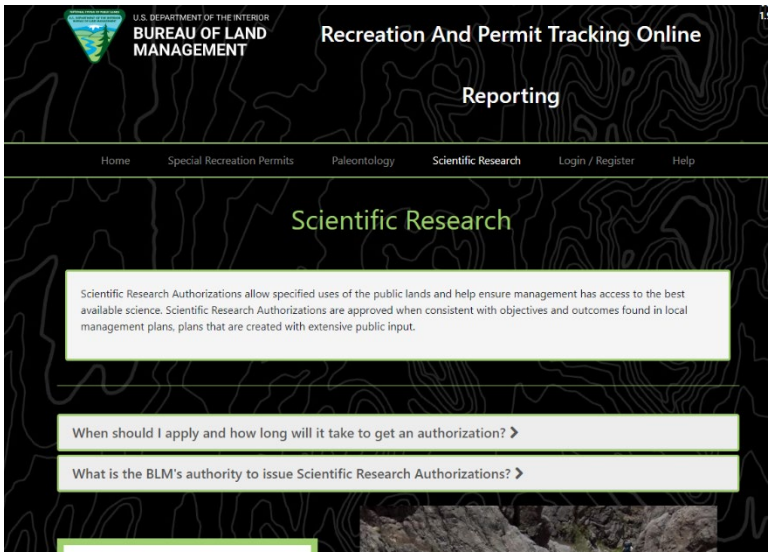
4.3 INTERNAL PROCESS FOR MANAGING SCIENCE

The GSENM Science Coordinator (sometimes called the science program administrator) is responsible for the development, coordination, and implementation of a comprehensive science program for GSENM. The Science Coordinator's roles and responsibilities are described below. Some of these activities are further described in Section 5, which explains how to apply and receive authorization to do research in GSENM.

4.3.1 Encourage Scientific Research

The Science Coordinator conducts outreach to universities, friend and partner groups, state and federal agencies, county and local governments, and Native American tribes to encourage them to develop plans and applications through the BLM's online Recreation and Permit Tracking Online Reporting (RAPTOR) system: RAPTOR (**Figure 4-2**), to conduct research in GSENM. This outreach could lead to independent research by those entities, or it could include partnerships with the BLM to conduct research on GSENM's resources, objects, and values.

Figure 4-2: The BLM's RAPTOR System



4.3.2 Seek Funding

The Science Coordinator assists in searches for funding to support both internal and externally led research in GSENM. This is focused on supporting efforts to study and protect GSENM objects. Potential funding sources would include grants and agreements from both external and government entities.

4.3.3 Review and Authorize Science Research Applications

The Science Coordinator uses the BLM's RAPTOR system to receive and lead the BLM review of science applications. This includes working with applicants to refine and improve applications, sharing applications with GSENM specialists, and issuing permits, where appropriate. Some applications may be rejected if they cannot be modified to fit within RMP direction.

4.3.4 Support Scientists in the Field

The Science Coordinator and other GSENM specialists attempt to visit researchers in the field to provide advice and support, learn about the specialists' research methods and findings, and help ensure GSENM research guidelines are followed. This engagement strengthens new and ongoing partnerships and contributes to GSENM's growing scientific record and community of practice. In-kind support that GSENM might be able to provide to researchers includes the following:

- Vehicle
- Trailer
- Geographical information system support
- Field equipment
- People to help with labor and field work
- Pack animals to transport equipment to the field
- Laboratory or office space

4.3.5 Conduct Scientific Research

In addition to coordinating ongoing scientific investigations and education at GSENM, the Science Coordinator conducts scientific research, as needed, to seek knowledge about GSENM's resources and to advise leadership and the scientific community on any particular needs.

4.3.6 Share Science with the Public

GSENM receives reports on work done by the authorized researchers, through the RAPTOR system as well as by communication with researchers. The Science Coordinator compiles and shares research conducted by government and outside entities through such means as publications, talks, and the science program website. The Science Coordinator leads the promotion and delivery of science education and public outreach programs to obtain and foster appreciation for the protection of GSENM resources, objects, and values. The Science Coordinator serves as the GSENM spokesperson for special scientific programs and events and develops proactive approaches to presenting information and obtaining public support for protection of physical, biological, and cultural resources. The Science Coordinator also develops and coordinates citizen science volunteer programs and public outreach and education events with the public on behalf of GSENM. Finally, the Science Coordinator maintains and ensures operation of the GSENM's science publication database.

Science permittees are encouraged to give talks, provide interviews, or make recordings about their research in GSENM to facilitate knowledge sharing between the scientific community and GSENM leadership.

4.3.7 Share Science with BLM Staff

The Science Coordinator compiles and shares annual science permittee reports and other unpublished documents with BLM staff to communicate about ongoing efforts across GSENM.

4.4 CONCLUSION

All efforts described above are designed to increase scientific research, understanding, and the dissemination of data and knowledge about the land, water, people, and history of this important landscape. Partnerships and ongoing research will continue to develop and grow as GSENM staff and researchers learn more about GSENM's scientific record and as they share their work, their ideas, and their results within this collaborative scientific community.

Section 5. Science Direction and Protocols

5.1 Research Authorization Process

All scientific research done by external entities (not the BLM) in GSENM must first go through an application process. The research authorization process opens communication between researchers and GSENM staff to provide feedback on BLM and RMP requirements, potential conflicts, previous and concurrent related research, logistical information (road conditions, wildlife concerns, high-use areas to avoid, etc.), and the potential for collaboration. The authorization also facilitates the sharing of results with GSENM and identification of useful information for land management and public outreach.

As researchers develop a proposal, they are welcome, but not required, to contact GSENM staff (such as the Science Coordinator) who can provide information that could help the researchers design a technically complete proposal. Contact information for the Science Coordinator and other GSENM staff can be found (as of August 2024) on the lower right of the following web page: Science & Research. That interaction can also occur after the application is submitted.

5.2 RAPTOR

The RAPTOR system is a new BLM online program to manage many permits, including the following:

- Special recreation permits
- Paleontological resource use permits
- Scientific research permits

The BLM began using the RAPTOR system in 2024 to manage all scientific research applications for GSENM and the Kanab Field Office. The RAPTOR system is gradually being adopted by BLM units; many do not yet (as of August 2024) use the RAPTOR system.

Proposals for scientific research at GSENM should be submitted via the online RAPTOR system. The submitted applications automatically go to the GSENM Science Coordinator, who reviews proposals for completeness and applicability to GSENM. Next, the application is shared with BLM resource specialists who evaluate the proposal in relation to the constraints of the RMP and BLM regulations, including potential impacts on resources and other user groups. The BLM Authorized Officer (Assistant Monument Manager or Monument Manager), in consultation with the Science Coordinator and staff specialists, adds stipulations or requirements, if needed, which are documented in a permit generated and sent via the RAPTOR system.

The RAPTOR application process guides the applicant in providing the information needed for BLM staff to determine the suitability of a proposal, including the following:

- Applicant information and qualifications
- Location of proposed work (maps or geographical information system layers, or both, are important)
- Description of the scope, need for, and methodology of proposed work
- What, if anything, would be left on-site (such as t-posts)

- Dates of proposed work
- Plans for collection of specimens such as soil, rock, plants, or seeds
- Where specimens (if collected) would be deposited

It is important that researchers know that vehicles must stay on approved travel routes and that cross-country vehicular travel is not allowed. In some cases, researchers might be granted authorized use of administrative routes, which are only intended for BLM and other authorized users.

Applicants should try to submit their application at least a month or two in advance of the planned activity to allow for the appropriate level of review. GSENM staff will seek to respond to the applicant in time for the applicant's proposed research to begin. An applicant could ask for an expedited review, in unusual circumstances. Otherwise, application reviews and authorization (if granted) will take about 1 to 2 months. If meaningful effects are anticipated, National Environmental Policy Act of 1969 (NEPA) and/or other environmental compliance processes may be warranted.

5.3 OTHER PERMITTING

Paleontological research permits, while obviously scientific research, are under the auspices of the Paleontological Resources Preservation Act of 2009, which designates the State Director or the State Director's designated authority (usually the BLM regional paleontologist that covers Utah) as the signatory for permits. Therefore, paleontological resource use permits have a separate authorization process in the RAPTOR system, called "Paleontology Resource Use Authorizations" (see RAPTOR - Paleontology). Paleontological permits are required for any qualified individuals (including BLM staff) to conduct reconnaissance surveys, surface collection, and excavation and collection of paleontological resources on BLM-managed lands.

Archaeological permits are issued partly under the authority of Section 302(b) of the Federal Land Policy and Management Act of 1976 and 43 Code of Federal Regulations 2920 and under the authority of the Archaeological Resources Protection Act of 1979. A permit for archaeological investigations is a land use authorization request that the State Director or the State Director's designee issues to appropriately qualified applicants, provided that the proposed work would further knowledge in the public interest, would not conflict with other legitimate or protected uses of BLM-managed lands and resources, and would not be inconsistent with any approved management plan, objective, or established policy applicable to the public lands concerned. Archaeological permits are not issued to other federal agencies.

Officially proposed cultural resource work may be authorized by a written agreement. Approval is subject to the same review process and considerations specified in BLM Manual Section 8150. The BLM Utah State Office issues permits for archaeological investigations. For more information, contact the State Archaeologist, BLM Utah State Office; 440 W 200 S Suite 500, Salt Lake City, Utah 84101, or by email at blm_ut_cr_permits@blm.gov, or visit BLM - Utah Archaeology.

For some research, additional permits may be required, such as for the following:

- Fish or other wildlife sampling; contact UDWR
- Rare plants or animals; contact the USFWS

5.4 REPORTING

All scientific investigations require annual and final reports. Reminders to complete annual reports will automatically be sent from the RAPTOR system at the end of each year. A final report must also be prepared and include an executive summary, the research background, methodology, results, and a discussion illustrating the research's relevance to GSENM management. Any publications generated with this research should be shared with the GSENM Science Coordinator. Researchers are also asked to present their findings to the public in some form, such as a talk at a local library, a podcast interview, or a symposium presentation.

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Section 6. Organization and Communication of Complete Science

Completed scientific research at GSENM will be tracked and cataloged to support ongoing management decisions and to ensure scientific information is available to the public. This will be done with the following two systems:

- **Public Reports and Publications**—A bibliography of publicly available reports and publications about GSENM is being maintained on the Grand Staircase-Escalante National Monument Collection website through the Gerald R. Sherratt Library at SUU. This digital library provides references and, in some cases. links and hard copies to publications on scientific, historical, and management topics related to GSENM. There are currently over 600 documents listed in this digital library.
- **Internal Reports**—Internal reports, including unpublished or sensitive information about GSENM, will be stored in a BLM GSENM science database. This internal database will allow managers and specialists to search and access useful information on GSENM science to inform both management decisions and scientific activity at GSENM.

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Section 7. Integrating Science into Management

As the overarching management plan, the RMP guides all scientific management within GSENM. In turn, past and future scientific research will be used to guide management decisions and answer management questions for activities in GSENM. Direct dialogue between scientists and managers will be encouraged and fostered through this plan and the work of the GSENM Science Coordinator and other staff at GSENM.

All proposed research activities in GSENM are reviewed by an interdisciplinary team of specialists and managers who determine whether the activity fits within the constraints of the RMP and other BLM guidelines. Authorized research provides valuable information to GSENM staff.

Integrating scientific findings into management decisions is an ongoing effort, and the BLM expects to continue to learn more over time. As the BLM learns from past management and scientific research, GSENM staff will identify future scientific research needs, and the cycle of management decisions, evaluation of effectiveness (both successes and failure), and adaptive management will continue.

Specific mechanisms that will be used to integrate scientific research into management decision-making are listed below. These will be implemented by the Science Coordinator or the appropriate BLM specialists.

- At monthly GSENM staff meetings, provide brief (about 10 minutes or less) updates on:
    - Proposed scientific research, including opportunities for specialists to get in the field with researchers
    - Completed scientific research (results, publications, etc.)
- For unpublished scientific research results, including annual reports researchers provide to the BLM, create written summaries (a paragraph or so) and post them on the following GSENM web page: internal GSENM science web page.
- For publicly available research, post links to documents or summaries, or both, on the public-facing GSENM Science & Research web page.
- As needed or requested by GSENM managers, write white papers (internal document of a page or two) on important or pressing issues and research findings that could help managers in decision-making.
- Schedule science presentations by experts who have conducted research in GSENM (or other places) on issues important to managers. Schedule these in the evening, as have happened in 2024, as well as during the day (such as brown-bag lunchtime science talks) at the GSENM visitor centers to facilitate attendance by BLM staff and tourists/visitors. Advertise these presentations well to the public.
- Give presentations that summarize recent GSENM research at local or regional venues, including the Grand Staircase-Escalante regional symposium (annual), special recreation permit science workshop (annual), the science symposium (every 10 years), and possibly others.

- When appropriate, review and summarize the applicable research (especially newer findings) for use in NEPA discussions and documents to provide the best available science to specialists and managers. This is not a new suggestion; it is just emphasizing what should be part of NEPA already.

The following are ideas that might be incorporated in the future, if there are sufficient time and resources:

- Interview scientists who have conducted research in GSENM and post the interviews on the public-facing GSENM Science & Research web page, or encourage existing podcasts to conduct such interviews.
- Evaluate biological science collections (such as bee specimens and other insects and plants at Brigham Young University laboratories) to facilitate understanding of past and present conditions and/or to motivate future research.
- Include research from the Kanab Field Office (adjacent to GSENM) in a section of the GSENM public web page.
- With all projects, include an effectiveness monitoring component. This would involve identifying measures of success before the project and evaluating how well the project produced the desired results, or any other significant changes.

Section 8. Science Plan Review and Approval

This Science Plan will be a guide for conducting research within GSENM under the larger framework of the GSENM RMP. As a living document, this Science Plan will be updated on an as-needed basis. The most current version will be made available on the GSENM Science & Research website.

MARC COLES-RITCHIE

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Marc Coles-Ritchie
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Appendix A

Hyperlink Internet Addresses

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Appendix A. Hyperlink Internet Addresses

This appendix lists the full URL (web address) for each hyperlink presented in the Science Plan document. The addresses are organized by document section and presented in the order in which they appear in the text.

SECTION 1. INTRODUCTION AND THE SCIENTIFIC MISSION OF GSENM

National Conservation Lands: https://www.blm.gov/programs/national-conservation-lands

Utah National Conservation Lands: https://www.blm.gov/programs/national-conservation-lands/utah

SECTION 2. SCIENTIFIC BACKGROUND OF GSENM

Proclamation 6920:
https://www.blm.gov/sites/blm.gov/files/Utah_GSENM_Presidential%20Proclamation.pdf

Proclamation 10286: https://www.federalregister.gov/documents/2021/10/15/2021-22673/grand-staircase-escalante-national-monument

Assessment, Inventory, and Monitoring: https://www.blm.gov/aim

Grand Staircase-Escalante National Monument Collection: https://www.suu.edu/library/special-collections/grand-staircase.html

Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings 1997: https://spcoll.li.suu.edu/eadfiles/pO1mcH8BnM5_0W5sN8vR/sympos97.pdf

Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings 2006: https://spcoll.li.suu.edu/eadfiles/pO1mcH8BnM5_0W5sN8vR/sympos06.pdf

Learning from the Land: Grand Staircase-Escalante National Monument Science Summary 2006–2016: https://spcoll.li.suu.edu/eadfiles/pO1mcH8BnM5_0W5sN8vR/sympos20.pdf

Escalante River Watershed Partnership: https://escalanteriverwatershedpartnership.org/

MesoWest: https://mesowest.utah.edu/cgi-bin/droman/mesomap.cgi?state=UT&rawsflag=3

PurpleAir: https://map.purpleair.com/1/mAQI/a10/p604800/cC0#8.24/37.01/-112.688

Salt Lake County—Current Conditions: air.utah.gov

Geology of the Circle Cliffs Area, Garfield and Kane Counties, Utah:
https://spcoll.li.suu.edu/eadfiles/pO1mcH8BnM5_0W5sN8vR/davidson.pdf

Web Soil Survey: https://websoilsurvey.nrcs.usda.gov/app/

BLM National Assessment, Inventory, and Monitoring TerrADat Hub: https://gbp-blm-egis.hub.arcgis.com/datasets/BLM-EGIS::blm-natl-aim-terradat-hub/about

Soil carbon storage responses to expanding pinyon-juniper populations in southern Utah: https://esajournals.onlinelibrary.wiley.com/doi/10.1890/08-0784.1

Prioritizing conservation effort through the use of biological soil crusts as ecosystem function indicators in an arid region: https://www.fs.usda.gov/biology/resources/pubs/soils/2008_bowker-prioritizing_cons_effort_soil_crusts.pdf

Revisiting classic water erosion models in drylands: The strong impact of biological soil crusts: https://www.sciencedirect.com/science/article/abs/pii/S0038071708001636

EDDMapS: http://www.eddmaps.org/

Science in Your Watershed: https://water.usgs.gov/wsc/map_index.html

Presentation: https://www.youtube.com/watch?v=5fqJYZAm21U&list=PLZO4ezUY_n4rvvC4L42gYWr8TILTIwmPv&index=1

Springs Stewardship Institute: https://springstewardshipinstitute.org/

Paria River Near Kanab, Utah: https://waterdata.usgs.gov/monitoring-location/09381800/#parameterCode=00065&period=P7D&showMedian=false

Escalante River Near Escalante, Utah: https://waterdata.usgs.gov/monitoring-location/09337500/#parameterCode=00065&period=P7D&showMedian=false

Pine Creek Near Escalante, Utah: https://waterdata.usgs.gov/monitoring-location/09337000/#parameterCode=00065&period=P7D&showMedian=false

BLM National Assessment, Inventory, and Monitoring Lotic Indicators Hub: https://gbp-blm-egis.hub.arcgis.com/datasets/BLM-EGIS::blm-natl-aim-lotic-indicators-hub/about

BLM National Assessment, Inventory, and Monitoring Riparian and Wetland Indicators Hub: https://gbp-blm-egis.hub.arcgis.com/datasets/BLM-EGIS::blm-natl-aim-riparian-and-wetland-indicators-hub/about

Excavations at the Arroyo Site, 42KA3976: A Pueblo II/III Virgin Anasazi Farmstead: https://spcoll.li.suu.edu/item/ve1ncH8BnM5_0W5sE8tz

Southern Utah University Digital Library: https://contentdm.li.suu.edu/digital/collection/GSENM/search

Agenda and video links: https://escalanteriverwatershedpartnership.org/what-we-do/grand-staircase-escalante-symposium/

Division of Drinking Water Harmful Algal Bloom and Cyanotoxin Response Plan: https://deq.utah.gov/drinking-water/division-drinking-water-harmful-algal-bloom-cyanotoxin-response-plan

Environmental Interactive Map: https://enviro.deq.utah.gov/

Water Quality Databases and Information: https://deq.utah.gov/water-quality/databases-and-information

SECTION 4. THE UNIT'S PLAN TO MEET SCIENCE NEEDS

Engage With Us: https://www.blm.gov/working-us

Grand Staircase-Escalante Symposium 2022: https://escalanteriverwatershedpartnership.org/what-we-do/grand-staircase-escalante-symposium/

Grand Staircase-Escalante Symposium 2023: https://escalanteriverwatershedpartnership.org/what-we-do/grand-staircase-escalante-symposium-2023/

Grand Staircase-Escalante Symposium 2024: https://escalanteriverwatershedpartnership.org/what-we-do/grand-staircase-escalante-symposium-2024/

iNaturalist: https://www.inaturalist.org/

Intergovernmental Internship Cooperative: https://www.suu.edu/iic/

Grand Staircase Regional Guide Association: https://www.gsrga.org

Grand Staircase Regional Guide Association Videos: https://www.youtube.com/@GSRGuideAssociation/videos

Recreation and Permit Tracking Online Reporting: https://permits.blm.gov/raptor/home-gensc

SECTION 5. SCIENCE DIRECTION AND PROTOCOLS

Science and Research: https://www.blm.gov/programs/national-conservation-lands/utah/grand-staircase-escalante-national-monument/science-research

Recreation and Permit Tracking Online Reporting: https://permits.blm.gov/raptor/home-gensc

Recreation and Permit Tracking Online Reporting – Paleontology: https://permits.blm.gov/raptor/home-paleo

BLM - Utah Archaeology: https://www.blm.gov/programs/cultural-heritage-and-paleontology/archaeology/what-we-manage/utah

SECTION 6. ORGANIZATION AND COMMUNICATION OF COMPLETE SCIENCE

Grand Staircase-Escalante National Monument Collection: https://spcoll.li.suu.edu/collections/pO1mcH8BnM5_0W5sN8vR/items

SECTION 7. INTEGRATING SCIENCE INTO MANAGEMENT

Internal Grand Staircase-Escalante National Monument science web page:

https://doimspp.sharepoint.com/sites/blm-GSENM-Science/_layouts/15/AccessDenied.aspx?Source=https%3A%2F%2Fdoimspp%2Esharepoint%2Ecom%2Fsites%2Fblm%2DGSENM%2DScience%2FSitePages%2FLearningTeamHome%2Easpx&correlation=b8145fa1%2Dc0ce%2D6000%2Dcc55%2D25d01629253f&Type=item&name=88a6c62d%2D68b4%2D434a%2D9731%2D39cb40563f9a&listItemId=2&listItemUniqueId=3dcdb4fd%2D4618%2D4344%2D8b6e%2Db5bb203b1e8d

Grand Staircase-Escalante National Monument Science and Research:

https://www.blm.gov/programs/national-conservation-lands/utah/grand-staircase-escalante-national-monument/science-research

SECTION 8. SCIENCE PLAN REVIEW AND APPROVAL

Grand Staircase-Escalante National Monument Science and Research:

https://www.blm.gov/programs/national-conservation-lands/utah/grand-staircase-escalante-national-monument/science-research