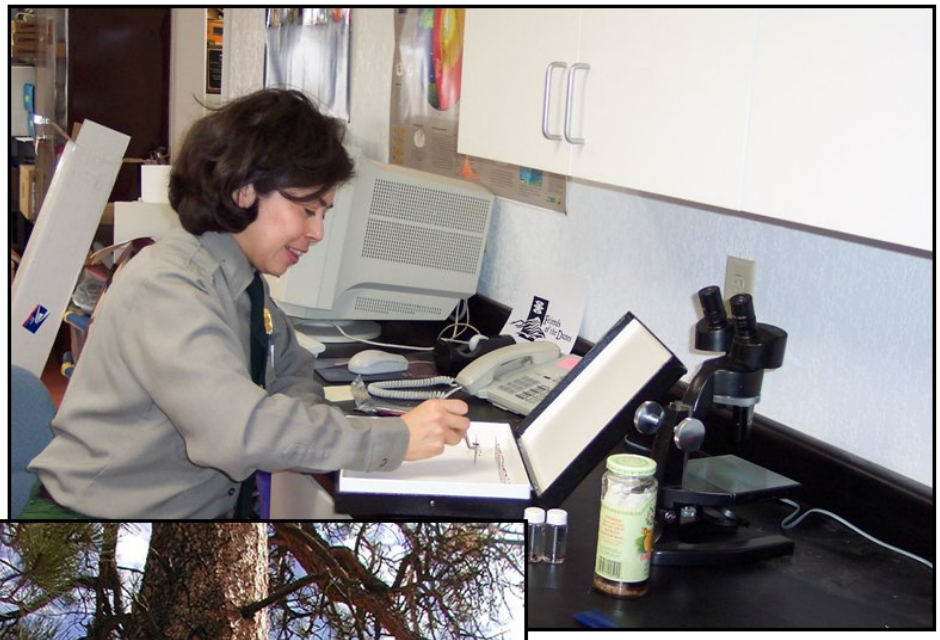


Chapter Three: Affected Environment

INTRODUCTION

This chapter describes the existing environment of Great Sand Dunes National Park and Preserve. The focus is on key park resources, visitor use and experience, socioeconomic characteristics, and park operations that would be affected by the alternatives should they be implemented. These topics were selected on the basis of federal law, regulations, executive orders, National Park Service expertise, and concerns expressed by other agencies or members of the public during project scoping. The conditions described in this chapter establish the baseline for Chapter 4: Environmental Consequences.

The first section in this chapter discusses impact topics that are analyzed in detail in this GMP. The next section describes impact topics that are not analyzed in detail and explains the rationale for this decision.

TABLE 2. IMPACT TOPICS

Impact Topics Considered in this GMP *Proposals in this plan have potential to affect these resources/topics*	**Impacts Topics Considered But Not Analyzed in Detail** *These resources/topics are important, but proposals in this plan would have only positive impacts on these resources, and/or any adverse impacts would be negligible to minor*
Archeology	Museum Collections
Historic Structures	Ethnographic Resources
Cultural Landscapes	Floodplains
Vegetation	Prime and Unique Farmlands
Ecologically Critical Areas	Air Quality
Federal Threatened and Endangered Species	Natural Soundscapes
Wildlife, Including Colorado State-Listed Species	Wild and Scenic Rivers
Soils and Geologic Resources	Energy Requirements and Conservation Potential
Wetlands	Indian Trust Resources
Water Resources	Environmental Justice
Visitor Use and Experience	
Scenic Resources and Visual Quality	
Socioeconomics	
Health and Safety	
National Park Service Operations	
Operations of Other Entities and Management Agencies	

IMPACT TOPICS CONSIDERED IN THIS GENERAL MANAGEMENT PLAN

CULTURAL RESOURCES

Historic Property Definitions

Historic properties are defined under 36 CFR Part 800. They are defined as, " any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in, the National Register of Historic Places." The National Park Service provides the following definitions for buildings, sites, structures, objects, districts, and landscapes:

- **Building:** created principally to shelter any form of human activity such as a barn, house, church, or hotel.
- **Site:** the location of a significant event; a prehistoric or historic occupation or activity; or a building or structure, whether standing or ruined, or vanished, where the location itself possesses historic, cultural, or archeological value, regardless of the value of the existing structure.
- **Structure:** a functional construction usually made for purposes other than creating human shelter such as tunnels, bridges, oil wells, or dams.
- **Object:** primarily artistic in nature or is relatively small in scale and simply constructed. Although an object may be moveable by nature or design, it is associated with a specific setting or environment, including sculptures, boundary markers, or statues.
- **District:** possesses as significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development such as a college campus, central business district, fort, or spread out ranch.
- **Landscape:** associated with events, persons, design styles, or ways of life that are significant in American history, landscape architecture, archeology, engineering, or culture.

Cultural resources associated with the Great Sand Dunes Park and Preserve include archeological sites, historic buildings and structures, ethnographic resources, and cultural landscapes. Cultural resources and values that are fundamental to the park (that is, key to maintaining the park's purpose and significance) are archeological sites associated with Folsom Early Man (9,000 years before present), culturally scarred ponderosa pines, the dunes themselves, and contemporary community connections to the park. These resources are described below. Location of archeological sites is not included in these descriptions due to vandalism concerns.

Archeological Resources

The Great Sand Dunes is rich in prehistoric resources. Over 4,500 acres have been inventoried, although this represents just a small fraction of the park. Surveyed areas in general include most of the frontcountry, Mosca, Medano, Music, and Sand Creek mountain corridors, the lower Sand Creek corridor, and various localities around springs. Archeological site distribution

tends to be high around lakes and streams, near ponderosa tree stands, in the woodlands, and along established trails and passes. Surveys have not been conducted in the majority of the Baca and Medano Ranch lands, most of the dunefield, and various wetlands located within the park. Exposure of archeological resources in the dunes and sand sheet is dynamic, as shifting dunes uncover some resources and bury others over time.

An area of approximately 10 miles by 4 miles within the sand sheet contains a dense concentration of documented and undocumented archeological resources, as well as ethnographic resources important to American Indian groups. Many undocumented sites may also exist throughout the park (Marilyn Martorano, pers. comm., 2005). Over 200 sites have been recorded and 18 have been tested. Over 70 isolated artifact finds were recorded (Martorano 2001, 2002, 2004; Martorano and Mrzlack 2003). All four stages of prehistory (Paleo-Indian, Archaic, Late Prehistoric / Ceramic, and Protohistoric stages) are represented within the park. Open campsites, stone tools, hearth features, ceramics, wickiups, and culturally peeled trees are some of the prehistoric resources found within the surveyed areas.

There are many archeological sites in the park that are eligible for or listed on the NRHP, and many more are likely to be identified in the future. Sites that may be affected by the alternatives include one site that is eligible for the NRHP and one that requires an eligibility determination. The NRHP-eligible site is in the vicinity of the visitor center and associated parking lot. The second site, which needs an eligibility determination, is located approximately 200 feet from the east side of SH 150, and is in the vicinity of the area proposed for a multiuse trail in the dunefield focus—maximize wildness alternative.

Site distribution in the sand dunes and sheet is difficult to document. As dunes migrate and sand blow-outs appear over time, sites may be repeatedly exposed and covered (Marilyn Martorano, pers. comm., 2005). Buried cultural features may be considered significant and sensitive by archeologists and American Indians. Artifacts from these sites and features have been illegally collected and vandalized (Martorano 2004). Adverse and beneficial impacts related to visitor use are possible from the proposed alternatives within this unstable area. This generalized area will also be addressed and considered for all alternatives.

Historic Structures and Districts

Although numerous buildings and structures are found throughout the park, only certain buildings qualify as historic resources because they have been listed or found eligible for listing on the NRHP (table 3). At park headquarters, two structures qualify: (1) the superintendent's residence (includes rock walls and is now used for administrative headquarters offices), and (2) the entrance station. These structures will not be discussed further in this document because no impacts to them would occur from the GMP alternatives.

Other buildings and structures, such as the visitor center and amphitheater, were built during the Mission 66 era but have lost integrity due to extensive renovations and rebuilding. (Mission 66 was a federal program to improve or replace deteriorated facilities during 1956–1966; many structures built during this era have been recognized as historically significant). The visitor center has been remodeled and

enlarged. The Mission 66 amphitheater burned down in 2000 and was rebuilt.

One unevaluated ditch segment is present between the visitor center and Pinyon Flats campground. Other unevaluated historic buildings or structures include a pipeline segment and the Garden Creek flume, the latter located immediately east of Pinyon Flats campground. Only the ditch segment will be discussed further; no impacts would occur to the remainder from the GMP alternatives.

Medano Ranch

In the southwest portion of the park, the Medano Ranch complex, which is owned and managed by The Nature Conservancy, is listed on the NRHP as a historic district. It consists of the main ranch house, various outbuildings/structures, a silo, and an extensive corral. The Medano Ranch was established in 1875, when the first homestead was erected. Early log buildings were eventually replaced or incorporated into more substantial log buildings. Contributing buildings include the main ranch house, bunkhouse, harness shed, meat house, cookhouse, privy, draft horse barn, cottonseed cake house, and corral. Noncontributing elements include two machine sheds, a storage shed, and a metal silo. The ranch complex is architecturally significant for its joining of smaller buildings to create larger ones. The main ranch house, bunkhouse, and cookhouse all represent the combination of smaller buildings into one larger building. The corral is also significant due to its complexity of design (Simmons and Simmons 2004).

TABLE 3. NPS-MANAGED HISTORIC STRUCTURES AND DISTRICTS (NRHP-ELIGIBLE) AND POTENTIAL IMPACTS

Resource No.	Name	Type	Comments
5AL301	Medano Ranch headquarters	Historic district – 9 contributing buildings/structures, 4 noncontributing buildings/structures	Listed, numerous buildings in district; impacts possible
5AL414	GRSA superintendent's residence and rock walls	Territorial Revival – building	Listed, classified structure; no impacts anticipated
5AL414	GRSA entrance station	Territorial Revival – structure	Listed, classified structure; no impacts anticipated
Unevaluated Resources			
5AL406	Water conveyance feature	Pipeline	No impacts anticipated
5AL408	Garden Creek flume	Water flume	No impacts anticipated
5AL411	Great Sand Dunes canal segment	Ditch segment	Impacts possible

Canal (ditch) Segment

This canal segment is actually more of a ditch remnant than a canal, in that it lacks formal features (Marilyn Martorano, pers. comm., 2005). It is of unknown age, but is likely associated with Euro-American ranching. It is possible that the segment was part of the 11 miles of ditches and canals located on Medano Ranch (Colorado SHPO 2005).

Cultural Landscapes

The National Park Service identifies a cultural landscape as, ". . . a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. The character of a cultural landscape is defined, both by physical materials such as roads, buildings, walls, and vegetation, and by use reflecting cultural values and traditions."

Cultural landscapes are the imprint on the natural landscape of physical human activity combined with unconscious schemes of spatial organization and patterns of living and working. This alteration and manipulation of the natural landscape provides a look at the long interaction between humans and their environment. Technology, politics, land-use management, economic, and environmental factors all influence how humans interact with the landscape and order their world. Upon closer inspection of the interplay between these factors that form a cultural landscape and between the cultural landscapes themselves, an overall understanding of the history of an area begins to emerge. This provides a broad, dynamic look at human history.

No listed or eligible cultural landscapes have been identified within the park. However, two potential cultural landscapes that could be affected by the GMP alternatives have been identified and are described in the following sections.

Medano Ranch Landscape

This potential cultural landscape centers around the Medano Ranch complex, but includes other ranches and ranching features in the area such as roads, ditches, fences, and ranch buildings from other ranches. The Medano Ranch was the largest and most important in the San Luis Valley and had enveloped the Zapata, Oliver, and Taylor ranches, as well as the Trujillo homestead and lands (Simmons and Simmons 2004). The Medano ranch buildings, structures, and objects would all be included in the landscape, in addition to features from the other ranches subsumed by the Medano Ranch. Fence lines reinforce use and management patterns on the landscape. Roads help us understand transportation systems within Medano Ranch and between the ranch and its surroundings. At one time, there were 10 miles of ditches used by the ranch for irrigation. The ditches help us to understand irrigation systems and the arrangement of agricultural field types on the landscape (Simmons and Simmons 2004). The buildings and homesteads provide insight into settlement patterns and land use.

National Park Service Administrative Landscape

This potential cultural landscape is centered around the superintendent's residence (currently park headquarters), its rock walls, and the entrance station. At one

time, the visitor center would have been part of the landscape, but it has lost its integrity through extensive renovations. It is not considered further as part of the potential cultural landscape. The superintendent's residence and entrance station are representative of a particular era and type of design, but they are only two remaining elements of what was once a more intact and larger landscape. As a result, the residence and entrance station may not be able to adequately evoke an image of the landscape as a whole.

VEGETATION

Great Sand Dunes National Park and Preserve includes a diverse cross-section of vegetation representative of the San Luis Valley and the Sangre de Cristo mountain range. From the valley floor on the western boundary of the park, to the mountain crest in the national preserve, a dramatic variety of life zones (habitats) support distinct plant communities that have been classified into broader ecological systems. Over 620 vascular plant species are known for the park and an additional 400 taxa could reasonably be expected to occur within its boundaries (Spackman et al. 2004). The park supports rare plant taxa that are discussed in the "Ecologically Critical Areas" section. For this GMP, vegetation is described in terms of broad life zones, associated ecological systems, and nonnative plant species. Plant communities at the association level are being determined by the Colorado Natural Heritage Program (CNHP) and NatureServe under the National Park Vegetation Mapping Program. This information should be available during fiscal year (FY) 2007. There are seven plant associations known within the park that are considered critically imperiled; these are discussed in detail in the "Ecologically Critical Areas" section of this chapter.

Life Zones and Ecological Systems

Great Sand Dunes, best known for impressive sand dunes, also supports other distinct life zones ranging from sabkha flats to steep alpine tundra. Intervening landscapes support short-shrubs; open piñon-juniper woodlands; montane woodlands; and forests of fir, pine, and quaking aspen, as well as extensive stands of spruce and subalpine fir. From the lowest to highest elevations are seven life zones, including sabkha, sand sheet, dunefield, piñon-juniper woodland, montane forest, subalpine vegetation, and alpine tundra.

NatureServe, a nonprofit conservation organization that provides scientific information and tools to guide conservation, has defined ecological systems to represent biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. Ecological systems represent classification units that are readily identifiable by conservation and resource managers in the field. Ecological systems that occur in the park are described under the seven life zones below (NatureServe 2005). A brief description of each life zone and its component ecological systems follows:

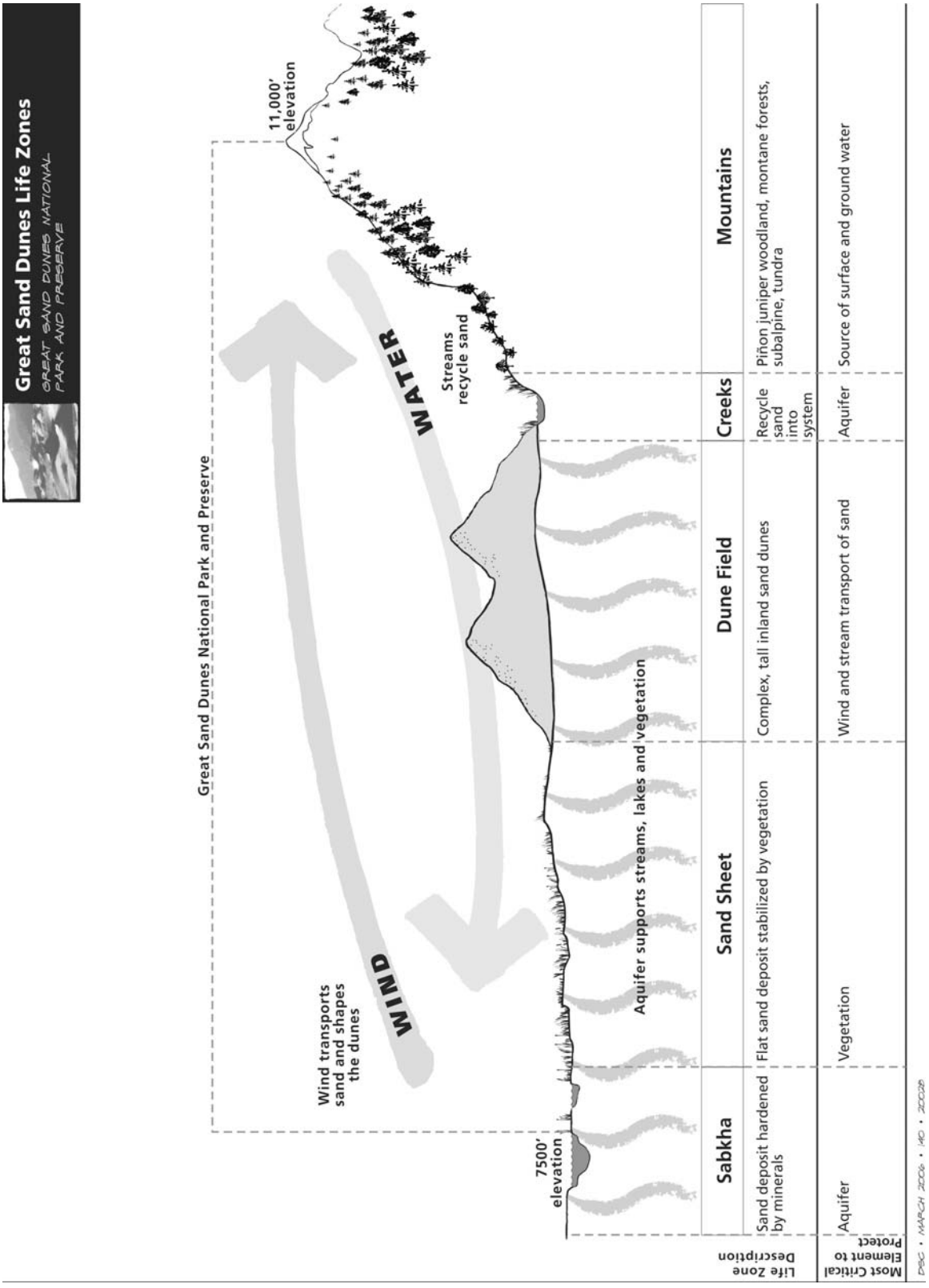


FIGURE 8. CROSS-SECTION SHOWING GREAT SAND DUNES LIFE ZONES

Sabkha Life Zone

The sabkha encompasses part of the valley floor and is characterized by an alkali-hardened sand crust. Leaching of minerals from the near-to-surface water table has resulted in high soil alkalinity tolerated only by a small number of plant species including four-wing saltbush (*Atriplex canescens*) and saltgrass (*Distichlis spicata*). The sabkha is one of the park's fundamental resources and values (see chapter 1).

Inter-Mountain Basins Playa. Composed of barren and sparsely vegetated playas (generally <10% canopy cover). Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. Characteristic species typically include greasewood or chico (*Sarcobatus vermiculatus*), and four-wing saltbush.

Inter-Mountain Basins Greasewood Flats. Occupies basins and occurs near drainages on stream terraces and flats or forms rings around more sparsely vegetated playas. Typically have saline soils, a shallow water table, and flood intermittently, but remain dry for most growing seasons. This system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by greasewood and four-wing saltbush with alkali sacaton (*Sporobolus airoides*), saltgrass, or spike-rush (*Eleocharis palustris*) in the understory.

Sand Sheet Life Zone

The sand sheet occurs on the valley floor at a slightly higher elevation than the sabkha. Soil alkalinity is reduced in this landscape where sandy soils are anchored by deep-rooted shrubs and forbs including rabbitbrush (*Chrysothamnus* spp., *Ericameria* spp.), winterfat (*Krascheninnikovia lanata*), prickly-pear cactus (*Opuntia polyacantha*), sand verbena (*Tripterocalyx micranthus*), prairie sunflower (*Helianthus petiolaris*), and yucca (*Yucca glauca*). The sand sheet is one of the park's fundamental resources and values (see chapter 1).

Inter-Mountain Basins Semi-Desert Shrub-Steppe. Typically occurs on alluvial fans and flats with moderate to deep soils. This semi-arid shrub-steppe is typically dominated by graminoids (>25% canopy cover) with an open shrub layer. Characteristic species include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), needle-and-thread (*Hesperostipa comata*), alkali sacaton, four-wing saltbush, rabbitbrush species, and winterfat.

Inter-Mountain Basins Semi-Desert Grasslands. Occurs on dry plains and mesas between 4,800 to 7,600 feet. These grasslands occupy lowland and upland areas on swales, playas, mesa tops, plateau parks, alluvial flats, and plains, but sites are typically xeric. When they occur near foothills, grasslands are on flatter land at lower elevations and are characterized by Indian ricegrass, blue grama, and needle-and-thread.

North American Arid West Emergent Marsh. Occurs in ponds, as fringes around lakes, and along slow-flowing streams and rivers. Marshes are frequently or continually inundated, with water at depths

up to 6.5 feet. Characterized by emergent and aquatic herbaceous plants including bulrush (*Scirpus* spp.), cattail (*Typha latifolia*), rush (*Juncus* spp.), pondweed (*Potamogeton* spp.), and water smartweed (*Persicaria amphibia*). This system may also include areas of relatively deep water with floating-leaved plants such as duckweed (*Lemna* spp.), water smartweed, hornwort (*Ceratophyllum* spp.), and the mostly submerged water milfoil (*Myriophyllum sibiricum*).

Dunefield Life Zone

Highly mobile sand dunes rise from the sand sheets, creating the distinctive dunefield life zone. Although mostly barren, the sand dunes support a range of plants uniquely suited for this habitat, including some rare plants described in the "Ecologically Critical Areas" section of this chapter. Common plant species found on active dunes include blowout grass (*Redfieldia flexuosa*) and scurfpea (*Psoralidium lanceolatum*). The dunefield is also one of the park's fundamental resources and values (see chapter 1).

Inter-Mountain Basins Active and Stabilized Dunes. Composed of unvegetated to moderately vegetated (<10-30% canopy cover), active and stabilized dunes and sand sheets. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand), and form patchy or open grasslands, shrublands, or steppe characterized by Indian ricegrass, four-wing saltbush, rubber rabbitbrush (*Ericameria nauseosa*), and alkali sacaton.

Piñon-Juniper Woodland Life Zone

Piñon-Juniper Woodland. Occurs as a distinct band on south- and west-facing slopes at the base of the mountains, directly above the sand sheet and sand dune formations. Regularly spaced piñon pine and juniper trees characterize this life zone with a mix of understory species including blue grama, Colorado's state grass.

Southern Rocky Mountain Piñon-Juniper Woodland. Occurs on dry mountains and on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. The woodland is characterized by an open canopy of two-needle piñon pine (*Pinus edulis*) and Rocky Mountain juniper (*Juniperus scopulorum*) with understories characterized by mountain mahogany (*Cercocarpus montanus*), currant (*Ribes* spp.), rabbitbrush, or blue grama.

Montane Forests Life Zone

At higher elevations than piñon-juniper woodlands and grasslands occupying cooler and wetter slopes are more dense woodlands and montane forests. Common trees in this zone include Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), ponderosa pine, and quaking aspen (*Populus tremuloides*). The mesic conditions support a diverse understory, particularly where there are breaks in tree canopies that allow light to penetrate. Club moss (*Selaginella* spp.), penstemon (*Penstemon* spp.), columbine (*Aquilegia* spp.), and wax currant (*Ribes cereum*) are common species.

Rocky Mountain Aspen Forest and Woodland. Found in the montane and subalpine zones where the elevation ranges from 8,300 to 10,000 feet (but occurrences can be found at lower elevations). Characteristic upland forest and woodland

species include quaking aspen without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with herbaceous ground cover characterized by snowberry (*Symphoricarpos* spp.), raspberry (*Rubus* spp.), serviceberry (*Amelanchier* spp.), and kinnikinick (*Arctostaphylos uva-ursi*). Occurrences originate and are maintained by stand-replacing disturbances such as avalanches, crown fire, insect outbreak, disease, and windthrow, or clearcutting by beaver, within the matrix of conifer forests.

Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland. Highly variable ecological system of the montane zone, occurring on all aspects at elevations ranging from 8,300 to 10,800 feet. Douglas-fir forests occupy drier sites where ponderosa pine is a common codominant. White fir stands occupy cooler sites such as upper slopes at higher elevations, canyon side slopes, ridgetops, and north- and east-facing slopes that burn somewhat infrequently. Blue spruce (*Picea pungens*) is found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifer species can be found growing in the same occurrence, and there are a number of common cold-deciduous shrub and grass species, including kinnikinick, Oregon-grape (*Mahonia repens*), mountain lover (*Paxistima myrsinites*), snowberry, and fescue (*Festuca* sp.).

Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodlands. Occur in cool ravines and on north-facing slopes at elevations ranging from 9,000 to 10,800 feet. Common canopy trees include Douglas-fir and white fir and Englemann spruce (*Picea engelmannii*), blue spruce, or ponderosa pine may be present. This system includes mixed conifer/quaking aspen stands and is characterized in the understory by Rocky Mountain maple (*Acer glabrum*), thinleaf alder (*Alnus incana*), western birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea*), fleabane (*Erigeron* spp.), strawberry (*Fragaria* spp.), and meadow rue (*Thalictrum* spp.).

Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland. Occurs on montane slopes and plateaus from 9,000 to 9,800 feet in elevation. The tree canopy is composed of a mix of deciduous and coniferous species characterized by quaking aspen, Douglas-fir, white fir, subalpine fir (*Abies lasiocarpa*), blue spruce, and limber pine (*Pinus flexilis*). As the stands age, quaking aspen is slowly reduced in cover until the conifers dominate. Commonly associated shrubs and herbs include serviceberry, chokecherry (*Prunus virginiana*), western snowberry (*Symphoricarpos occidentalis*), common juniper (*Juniperus communis*), rose (*Rosa* spp.), Oregon-grape, yarrow (*Achillea millefolium*), bedstraw (*Galium* spp.), meadow-rue, and/or false Solomon's-seal (*Maianthemum stellatum*).

Southern Rocky Mountain Ponderosa Pine Woodland. Occurs in small stands or patches at the lower tree line/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from 8,200 to 9,100 feet and stands occupy all slopes and aspects with moderately steep to very steep slopes or ridgetops the most common habitat. Stands are characterized by ponderosa pine, in addition to Douglas-fir, two-needle piñon pine, and Rocky Mountain juniper. Understories are usually shrubby, with species of rabbitbrush common. Common grasses include needle-and-thread, ricegrass (*Achnatherum* spp.), fescue (*Festuca* spp.), muhly

(*Muhlenbergia* spp.), and grama (*Bouteloua* spp.).

Rocky Mountain Lower Montane-Foothill Shrubland. Occurs between 9,000 to 9,500 feet elevation and are usually associated with exposed sites, rocky substrates, and dry conditions that limit tree growth. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically characterized by a variety of shrubs including service-berry (*Amelanchier* spp.), mountain mahogany, western snowberry, or yucca. Characteristic grasses include muhlys, gramas, and needle-and-thread.

Southern Rocky Mountain Montane-Subalpine Grasslands. Typically occur between 9,000 to 9,800 feet on flat to rolling plains or on lower side slopes that are dry, but may extend up to 11,000 feet on warm aspects. A stand usually consists of a mosaic of two or three plant associations characterized by oatgrass (*Danthonia* spp.) and fescue. These large-patch grasslands are intermixed with matrix stands of spruce, fir, lodgepole pine, ponderosa pine, and quaking aspen forests.

Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Occurs up to 9,200 feet in elevation, as a mosaic of multiple communities that are tree dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Stands are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. Characterized by boxelder (*Acer negundo*), narrowleaf cottonwood (*Populus angustifolia*), Douglas-fir, blue spruce, Rocky Mountain juniper, thinleaf alder, western birch, red-osier dogwood, hawthorn (*Crataegus* spp.), chokecherry, and willows, e.g., mountain, Drummond, and coyote (*Salix monticola, S. drummondiana, S. exigua*).

Wet Meadow Vegetation. Typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Important characteristic species include fleabane, bluebell (*Mertensia* spp.), lupine (*Lupinus* spp.), goldenrod (*Solidago* spp.), lovage (*Ligusticum* spp.), tufted hairgrass (Deschampsia caespitosa), Junegrass (*Koeleria micrantha*), and shrubby cinquefoil (*Dasiphora floribunda*).

Subalpine Life Zone

The subalpine life zone is located higher in elevation, above the montane forest stands and below the treeless tundra. Harsh conditions result from the cold temperatures and heavier snow accumulation that occur at high elevations. Engelmann spruce, blue spruce, subalpine fir, and quaking aspen are the common tree species.

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland. Support Engelmann spruce and subalpine fir forests that comprise the matrix forests of the subalpine zone, occur up to 11,000 feet elevation, and are usually the highest elevation forests. Sites are cold year-round and precipitation is predominantly snow, which may persist until late summer. Tree canopy characteristics are remarkably similar across its distribution, with Engelmann spruce and subalpine fir characterizing mixed stands or occurring individually as stands. Douglas-fir may persist for long periods without regeneration. Stands of mixed conifer and quaking aspen also regularly occur. Understory species common to stands on dry sites include common juniper and Oregon-grape. Disturbance includes

occasional blow-down, insect outbreaks, and stand-replacing fire.

Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland. Occurs at high elevations and is characterized by Engelmann spruce and subalpine fir. It typically occurs in locations with cold air drainage or ponding, or where snow pack lingers into late summer such as north-facing slopes and high-elevation ravines. Typical mesic understory shrubs include serviceberry and species of willows, and herbaceous plants include baneberry (*Actaea rubra*), false Solomon's-seal, flowering dogwood, fleabane, lupine, and bluejoint reedgrass (*Calamagrostis canadensis*). Disturbances include occasional blow-down, insect outbreaks, and stand-replacing fire.

Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodlands. These zones occur on dry, rocky ridges and slopes near upper tree line above the matrix spruce-fir forest. These stands are characterized by limber pine and bristlecone pine (*Pinus aristata*), Rocky Mountain juniper, and/or Douglas-fir. Understory species can include kinnikinick, common juniper, Oregon-grape, currant, reedgrass (*Calamagrostis* spp.), and fescue.

Rocky Mountain Subalpine Mesic Meadows. Restricted to sites in the subalpine zone where finely textured soils, snow deposition, or wind-swept dry conditions limit tree establishment, typically above 9,800 feet in elevation. These upland communities occur on gentle to moderate gradient slopes. These sites are not as wet as those found in the Rocky Mountain alpine-montane ecological system.

Rocky Mountain Subalpine-Montane Riparian Shrublands. Montane to subalpine riparian shrublands occurring as narrow bands lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. Generally, it is found at higher elevations, but can be found anywhere from 8,000 to 11,400 feet. Can also be found around seeps, fens, and isolated springs on hill slopes away from valley bottoms. Characteristic shrubs include thinleaf alder, birch, red-osier dogwood, and a number of willow species, e.g., Bebb, plane-leaf, Drummond, and mountain (*Salix bebbiana, S. brachycarpa, S. drummondiana, S. monticola*), among others. Generally, the vegetation surrounding these riparian systems is either conifer or quaking aspen forests.

Rocky Mountain Subalpine-Montane Riparian Woodlands. Comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations and containing the conifer and quaking aspen woodlands that line montane streams. Tolerant of periodic flooding and high water tables. Typically occur at elevations between 9,800 and 10,800 feet and are confined to specific riparian environments on floodplains or terraces of rivers and streams, in V-shaped narrow valleys, and canyons (where there is cold-air drainage). Characteristic trees include subalpine fir, Engelmann spruce, Douglas-fir, blue spruce, quaking aspen, narrowleaf cottonwood, and/or Rocky Mountain juniper.

Rocky Mountain Alpine-Montane Wet Meadows. High-elevation communities characterized by herbaceous species found on saturated sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (9,000–11,000 feet) and occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. Often occurs as a

mosaic of several plant associations characterized by graminoids and forbs, including species of sedge (*Carex* spp.), tufted hairgrass, spike-rush, rush, and marsh marigold (*Caltha leptosepala*). Often alpine dwarf-shrublands, especially those supporting willows, are immediately adjacent to the wet meadows.

Rocky Mountain Alpine Bedrock and Scree. Composed of barren and sparsely vegetated alpine substrates, typically including both bedrock outcrop and scree slopes, with nonvascular-dominated (lichen) communities. Desiccating winds, rocky and sometimes unstable substrates, and a short growing season limit plant growth. These exposed sites support sparse cover of forbs, grasses, lichens, and low shrubs.

Rocky Mountain Cliffs and Canyons. Consist of barren and sparsely vegetated landscapes (generally <10% plant cover) and are found from foothill to subalpine elevations on steep cliff faces, narrow canyons, and smaller rock outcrops. Also included are unstable scree and talus slopes that typically occur below cliff faces. There may be small patches of dense vegetation, but they typically include scattered trees and/or shrubs. Characteristic trees and shrubs include Douglas-fir, ponderosa pine, limber pine, quaking aspen, white fir, subalpine fir, two-needle piñon pine, juniper, rock-spiraea (*Holodiscus dumosus*), currant, rose, and serviceberry.

Tundra Life Zone

Tundra in the Sangre de Cristo Mountains occurs on thin soils interspersed among bare rock outcrops and rock-strewn talus slopes. Devoid of trees, this zone supports low-growing, mat-forming cushion plants and stunted shrubs. Moss campion (*Silene acaulis*) and purplefringe (*Phacelia* spp.) are common tundra cushion plants. The tundra is one of the park's fundamental resources and values (see chapter 1).

Rocky Mountain Alpine Fell-Fields. Wind-scoured, rock-strewn sites that are free of snow in the winter, such as ridgetops and exposed saddles, exposing the plants to severe environmental stress. Most fell-field plants are cushioned or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Usually found within or adjacent to alpine tundra dry meadows and are characterized by species of cushion plants and graminoids including sedge, alpine avens (*Geum* spp.), phlox (*Phlox* spp.), and moss campion.

Rocky Mountain Dry Tundra. Occurs above upper tree line on gentle to moderate slopes, flat ridges, valleys, and basins. Vegetation is controlled by snow retention, wind desiccation, permafrost, and a short growing season, and is characterized by a dense cover of low-growing, perennial graminoids and forbs. Although alpine tundra dry meadow is the matrix of the alpine zone, it typically intermingles with alpine bedrock and scree, ice field, fell-field, alpine dwarf-shrubland, and alpine/subalpine wet meadow systems. Rhizomatous, sod-forming sedges are the dominant graminoids, and prostrate- and mat-forming plants with thick rootstocks or taproots characterize the forbs, including tufted hairgrass, fescue, and alpine avens.

Nonnative Invasive Plant Species

During vascular plant inventories, the CNHP documented 47 nonnative plant species within the park (Spackman et al. 2004, Whitson et al. 2000). The most important invasive weeds, due to their difficulty to control, were determined to be

Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), leafy spurge (*Euphorbia esula*), whitetop (*Cardaria pubescens*), yellow and white sweetclovers (*Melilotus officinalis* and *M. alba*), smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*), and cheatgrass (*Bromus tectorum*). Of particular concern is leafy spurge, which is listed on the Colorado list of noxious weeds (Colorado Department of Agriculture 2003). Other perennial, nonnative species that have become established in and along wetlands include Russian-knapweed (*Acroptilon repens*), spike bentgrass and redtop (*Agrostis exarata* and *A. stolonifera*), meadow foxtail (*Alopecuris pratensis*), timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), orchardgrass (*Dactylis glomerata*), watercress (*Nasturtium officinale*), and red clover and white Dutch clover (*Trifolium pratense* and *T. repens*) (Spackman et al. 2004).

Canada thistle, leafy spurge, and whitetop are perennial species with extensive underground rhizomes that become established on moist sites and wetlands, often forming patches or stands to the exclusion of native species. They are commonly observed in the borrow areas and ditches of roads, along canals and natural drainages, around ponds, in sloughs, in irrigated hayfields, and in emergent wetlands. Smooth brome and yellow and white sweetclovers occupy mesic to dry sites and wetlands margins, usually at slightly higher elevations than the preceding species. Introduced as a pasture and erosion-control grass, smooth brome forms extensive patches and stands via underground rhizomes. Yellow and white sweetclovers, introduced primarily for erosion control on highway cut-and-fill slopes, are biennials that form a rosette the first year and flower the second, are often scattered in distribution, but can also form extensive stands. They occupy dry to mesic sites, including the margins of wetlands.

Field bindweed is a vining forb that becomes established in and persists on disturbed land, particularly roadsides, homesteads, and agricultural fields (both active and abandoned). Crested wheatgrass is a perennial bunchgrass that was introduced to enhance forage production on rangeland and also for erosion control along highways. It more commonly occurs on lands that were disturbed mechanically and re-seeded. Cheatgrass is an annual that was introduced primarily to enhance forage production for livestock. It has spread abundantly on both disturbed and undisturbed landscapes and can occur as pure stands on sites that have burned or sites that have experienced intensive use such as homesteads, corrals, agricultural fields, etc.

Methods commonly used to control these nonnative species include mechanical (mowing, disking, flooding, etc.), chemical (herbicide application), and biological (introduction of host-specific insects, etc.). These methods are also used in combination to increase their efficacy and to maximize stress on the nonnative plant populations. Control is expensive and requires perseverance because stands are not or are very rarely eliminated by using only one treatment or by treating for only one season. Control is important as part of a good neighbor policy because seeds generated in or plants spreading by rhizomes from the park can blow to or grow onto adjacent private or nonpark public lands. Of course, the reverse is also true, further establishing the need for communication and cooperation among landowners.

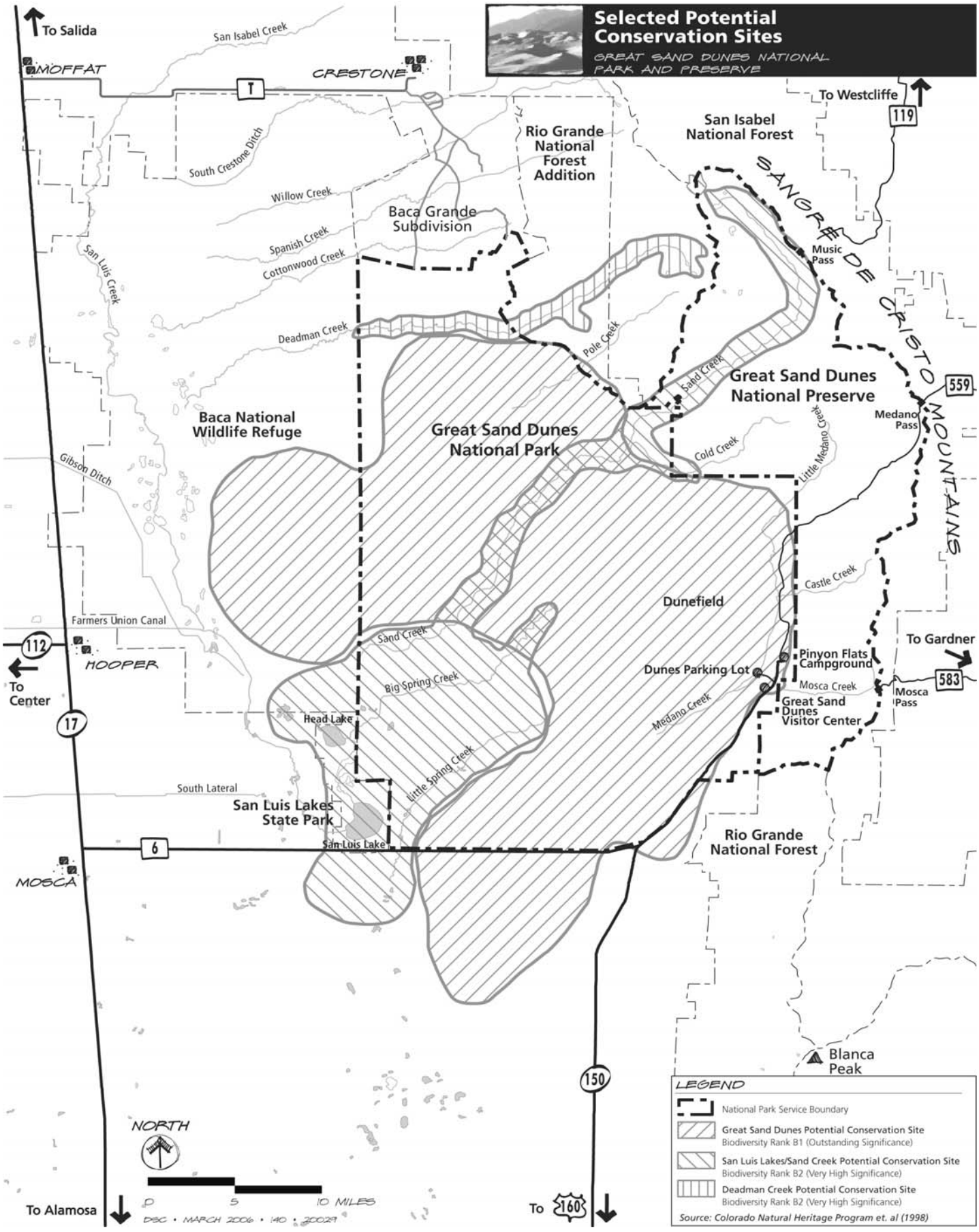
ECOLOGICALLY CRITICAL AREAS

When evaluating the intensity of environmental impacts according to NEPA, certain unique characteristics of the geographic area must be considered, including ecologically critical areas (40 CFR 1508.27). Ecologically critical areas can be defined as "special ecosystems that serve unique functions and are small in area or are unusually fragile relative to others" (Conservation Foundation 1984). To identify ecological critical areas for the purposes of this GMP, the National Park Service used a CNHP designation called "potential conservation sites." The CNHP delineates potential conservation sites to identify areas and ecological processes that are necessary to support elements of natural heritage significance in Colorado. The potential conservation sites, once identified, are given a rank (score) between 1 and 5 that reflects their overall biodiversity significance. For the purposes of this GMP, the planning team defined ecological critical areas as CNHP potential conservation sites ranked as B1 (outstanding significance) or B2 (very high significance). They are shown on the "Selected Potential Conservation Sites" map and are discussed briefly below. More detailed information about the CNHP potential conservation site program (definitions, ranks, etc.) is provided in appendix B.

Great Sand Dunes Potential Conservation Site

The Great Sand Dunes potential conservation site, estimated at 103,640 acres, encompasses the massive active sand dunes, the sand sheet with its grass and shrub communities, interdunal wetlands, and Sand and Medano creeks ("Selected Potential Conservation Sites" map). It has been assigned a biodiversity rank of B1—outstanding significance (CNHP 1998). This site contains many species that are restricted in range and endemic (native to a certain limited area) to the Great Sand Dunes system or to the San Luis Valley (CNHP 1999).

Seven rare plant associations occupy the nearly barren active dunes, the associated sand sheet, and creek banks. These include *Redfieldia flexuosa – (Psoralidium lanceolatum)* (blowout grass – (dune scurfpea)) Herbaceous Vegetation, *Achnatherum hymenoides – Psoralidium lanceolatum* (Indian ricegrass – dune scurfpea) Herbaceous Vegetation, and *Hesperostipa comata – Achnatherum hymenoides* (needle-and-thread – Indian ricegrass) Herbaceous Vegetation (CNHP 1998). The *Schoenoplectus pungens* (three-square bulrush) Herbaceous Vegetation association is an emergent wetlands that is rare in the park. Two riparian shrubland associations occupy creek bank habitat: *Alnus incana – Salix (monticola, lucida, ligulifolia)* (thinleaf alder – (mountain willow, whiplash willow, strapleaf willow)) Shrubland, and *Salix exigua* (coyote willow) Barren Shrubland (CNHP 1998). One montane riparian woodland type is also present: *Populus angustifolia / Alnus incana* (narrowleaf cottonwood / thinleaf alder) Woodland. The narrowleaf cottonwood trees growing on the banks of Medano Creek and Sand Creek are thought to represent a pure strain that has not hybridized with other stands; these are some of the oldest narrowleaf cottonwood trees known in the western U.S. and have been identified as among the fundamental resources and values of the park (see chapter 1).


Selected Potential Conservation Sites
GREAT SAND DUNES NATIONAL PARK AND PRESERVE
To Salida
MOFFAT
CRESTONE
T
San Isabel Creek
South Crestone Ditch
Willow Creek
Spanish Creek
Cottonwood Creek
San Luis Creek
Deadman Creek
Rio Grande National Forest Addition
Baca Grande Subdivision
San Isabel National Forest
To Westcliffe
119
SANGRE DE CRISTO MOUNTAINS
Music Pass
Pole Creek
Sand Creek
Great Sand Dunes National Preserve
559
Medano Pass
Little Medano Creek
Cold Creek
Baca National Wildlife Refuge
Great Sand Dunes National Park
Gibson Ditch
Castle Creek
Dunefield
Farmers Union Canal
112
HOOPER
To Center
17
Sand Creek
Big Spring Creek
Head Lake
Little Spring Creek
South Lateral
San Luis Lakes State Park
San Luis Lake
6
MOSCA
To Gardner
583
Pinyon Flats Campground
Dunes Parking Lot
Mosca Creek
Medano Creek
Great Sand Dunes Visitor Center
Mosca Pass
Rio Grande National Forest
Blanca Peak
150
NORTH
0 5 10 MILES
To Alamosa
To 160
LEGEND
National Park Service Boundary
Great Sand Dunes Potential Conservation Site
Biodiversity Rank B1 (Outstanding Significance)
San Luis Lakes/Sand Creek Potential Conservation Site
Biodiversity Rank B2 (Very High Significance)
Deadman Creek Potential Conservation Site
Biodiversity Rank B2 (Very High Significance)
Source: Colorado Natural Heritage Program et. al (1998)
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Rare plant species include *Cleome multicaulis* (slender spider-flower), associated with emergent wetlands and wetlands margins, and *Cryptantha cinerea* var. *pustulosa* (James' catseye), found on sand sheet and rocky slope habitats (CNHP 1998). The active dunes and surrounding sand sheet represent important habitat for arthropods, including six endemic insect species (Pineda 2002, CNHP 1998). As many as 2,000 insect species may be present (CNHP 1998). Endemic species include: Great Sand Dunes tiger beetle (*Cicindela theatina*), circus beetle (*Eleodes hirtipennis*), anthycid beetles (*Amblyderus triplehorni* and *A. werneri*), a noctuid moth (*Copablepheron* undescribed), and a robber fly (*Proctacanthus* n.sp.) (Pineda, 2002). A local subspecies of the rare silky pocket mouse (*Perognathus flavus sanluisi*) and the Rio Grande cutthroat (*Oncorhynchus clarki virginalis*) are also associated with this potential conservation site.

Deadman Creek Potential Conservation Site

The Deadman Creek potential conservation site, estimated at 3,500 acres, encompasses nearly the entire Deadman Creek watershed from the Sangre de Cristo Range (12,300 feet) to the floor of the San Luis Valley (7,600 feet). It has been assigned a biodiversity rank of B2—very high significance (CNHP 1998). Rare plant associations include *Populus tremuloides / Acer glabrum* (Quaking aspen / Rocky Mountain maple), *Populus angustifolia – Juniperus scopulorum / Sporobolus cryptandrus* (Narrowleaf cottonwood – Rocky Mountain juniper / Sand dropseed) Woodland, and *Populus angustifolia / Salix (monticola, drummondiana, lucida*) (Narrowleaf cottonwood / (Mountain willow, Drummond's willow, Whiplash willow)) Woodland (CNHP 1998, NatureServe 2005). Rare plant species include the canyon bog orchid (*Platanthera sparsiflora* var. *ensiflora*) and Smith whitlow-grass (*Draba smithii*) (CNHP 1998). The former occupies emergent wetlands and the latter occupies steep mountain slopes with mountain mahogany and mountain muhly (*Muhlenbergia montana*). Rare wildlife observations in the Deadman Creek corridor include a nursery for Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) in an abandoned mine adit and Rio Grande cutthroat trout (*Onchorhyncus clarki virginalis*) (CNHP 1998).

San Luis Lakes / Sand Creek Potential Conservation Site

The San Luis Lakes / Sand Creek potential conservation site, estimated at 35,000 acres, includes the Big Spring area, which has been designated a Colorado Natural Area (named Indian Spring Natural Area) by the Colorado Natural Areas Program (CNAP 2005). It includes San Luis Lakes State Park and the watershed of Sand Creek and Big Spring Creek, which flow into San Luis Lake. The site ranges in elevation from 7,500 to 12,050 feet, extending to the summit of the Sangre de Cristo range within the Sand Creek watershed. It has been assigned a biodiversity rank of B2—very high significance (CNHP 1998).

Emergent wetlands associations on the potential conservation site include *Eleocharis palustris* (creeping spikerush) Herbaceous Vegetation, *Carex simulata* (analogue sedge) Herbaceous Vegetation, *Hippuris vulgaris* (mare's-tail) Herbaceous Vegetation, and *Polygonum amphibium* (water smartweed) Permanently Flooded Herbaceous Vegetation (CNHP 1998), and brookgrass – monkeyflower (*Catabrosa aquatica – Mimulus glabratus*); for the latter there is no corresponding plant association

within NatureServe Explorer (2005). A riparian forest type occupies sand dune habitats: *Populus angustifolia* (narrowleaf cottonwood) / Sand Dune Forest. Two riparian forest and woodland types are present in the montane floodplain of Sand Creek: *Abies concolor–Picea pungens–Populus angustifolia / Acer glabrum* (white fir–blue spruce–narrowleaf cottonwood / Rocky Mountain maple) Forest and *Populus angustifolia / Salix drummondiana–Acer glabrum* (narrowleaf cottonwood / Drummond's willow–Rocky Mountain maple) Woodland. Rare plant species observed within this potential conservation site include *Cleome multicaulis* (slender spiderflower) and *Platanthera sparsiflora* var. *ensiflora* (canyon bog orchid); both occupy emergent wetlands.

A rare insect species, the San Luis sandhill skipper (*Polites sabuleti ministigma*), and two rare small mammal subspecies (the plains pocket mouse, *Perognathus flavescens relictus,* and the silky pocket mouse) have been recorded on sand sheet habitats (CNHP 1998). Pineda (2002) reported 1,034 arthropod species, mostly insects, from the Indian Spring locale. Six of these species were considered endemic. Migrant bird species, mostly aquatic birds and shorebirds, are supported by this potential conservation site. Rare bird species include the short-eared owl (*Asio flammeus*) of montane habitats, western snowy plover (*Charadrius alexandrinus nivosus*), long-billed curlew (*Numenius americanus*), black-crowned night-heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), eared grebe (*Podiceps nigricollis*), and Forster's tern (*Sterna forsteri*) (CNHP 1998).

FEDERAL THREATENED AND ENDANGERED SPECIES

The Endangered Species Act of 1973, as amended, requires that federal agencies consult with the USFWS before taking any action that could jeopardize the continued existence of any federally listed threatened or endangered plant or animal species, or critical habitat. Agencies must consider potential effects the proposed action could have on listed species and critical habitats. National Park Service policy also requires the examination of impacts on federal candidate species.

Consultation was initiated on January 5, 2005, with a letter to the USFWS. In a facsimile dated February 15, 2005, the USFWS provided an inventory list of threatened or endangered species and candidate species that are potentially present in Alamosa and Saguache counties (appendix I). There was no designated critical habitat listed in the inventory. Table 4 identifies the federally listed threatened or endangered species and candidate species potentially found in Alamosa and Saguache counties and the park. The table indicates for each species whether it was retained for or dismissed from detailed analysis in this GMP / environmental impact statement (and why).

The listed fish species identified by the USFWS as occurring in these two counties (bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker) are actually located in the Colorado River system. Based on the complete geographic separation of these species from the Rio Grande River basin and Great Sand Dunes, these species are dismissed as impact topics. In addition, on September 29, 2005, the USFWS announced its finding that the southern Rocky Mountain population of the boreal toad (*Bufo boreas*) population

did not meet the criteria for listing as a distinct population and is no longer a candidate for federal listing. Therefore, the boreal toad is dismissed as an impact topic.

Wildlife species listed as threatened, endangered, or of special concern by CDOW are also presented in table 4, and discussed below after the federally listed species. The state of Colorado does not list or protect plant species. However, the CNHP has identified several plants that occur within the park that are deserving of special attention and protection (CNHP 1998). These plants are also included in table 4 and are discussed in an ecosystem context in the "Ecologically Critical Areas" sections of this document (chapters 3 and 4).

Canada Lynx

The Canada lynx (*Lynx canadensis*), listed as threatened under the Endangered Species Act on March 24, 2000, and as endangered by the state of Colorado, is a species of the northern coniferous forest. The preferred habitat of the Canada lynx is uneven-aged stands with relatively open canopies and well-developed understories, within the elevational range between 9,000 and 14,500 feet (Quinn and Parker 1987, NDIS 2005e). While the snowshoe hare comprises 80% of the lynx diet (Brand et al. 1976), this carnivore will also take squirrels, beaver, muskrats, and even large ungulates such as deer (NDIS 2005e). Before recent reintroductions of Canada lynx to Colorado, the lynx appeared to be restricted to extremely isolated areas of the mountains of the central portion of the state (NDIS 2005e). Beginning in 1999, 166 lynx were released in southwestern Colorado, the vast majority in the Rio Grande National Forest. Released animals were tracked by satellite or VHF transmitters. Cumulative data from 1999 through January 2005 indicate three position records occurred within the park; two in the southwestern portion of the national park, and one on the extreme northern part of the preserve. The two records in the southwestern portion of the park likely represent one or two individuals dispersing from the release sites on the western side of the San Luis Valley to suitable habitat at higher elevations on the eastern side. In light of these records, continued reintroduction efforts, and the presence of potential lynx habitat in the upper reaches of the national preserve (not in the national park), the Canada lynx is retained as an impact topic and will be discussed under "Federal Threatened and Endangered Species" in chapter 4.

Summary and Determination—Federal Threatened and Endangered Species

The federally listed threatened and endangered species and federal candidate species that have the potential to occur within the park have been analyzed relative to the anticipated impacts of the four

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
Insects						
d	*Boloria improba acrocnema*	Uncompahgre fritillary	LE	—	Occurs around moist alpine slopes above 12,000 feet with extensive snow willow (*Salix nivalis*).	Not found in the park; snow willow habitat in the park differs markedly from that known to support this species; no differences among the GMP alternatives that would differentially affect this species.
Fish						
✔	*Catostomus plebeius*	Rio Grande sucker	—	E	Present in the park (introduced to Medano Creek). Occurs in areas near rapidly flowing water. Backwaters or banks adjacent to fast waters provide holding areas during the day.	—
d	*Gila cypha*	Humpback chub	E		A "big river" fish. Found in Colorado in the Yampa, Gunnison, Green, and Colorado rivers.	Historical and current occurrence limited to the Colorado River system; does not occur in the park or the Rio Grande River system. The park is not a suitable area for potential reintroduction.
d	*Gila elegans*	Bonytail chub	E	E	Found historically throughout the Colorado River drainage—in recent years bonytail have only been taken from the Green River in Utah and lakes Havasu and Mohave.	Historical and current occurrence limited to the Colorado River system; does not occur in the park or the Rio Grande River system. The park is not a suitable area for potential reintroduction.

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
✔	*Gila pandora*	Rio Grande chub	—	SC	Extirpated from the park, but under consideration for reintroduction. Found in pools of small to moderate streams near areas of current, in association with undercut banks, overhanging bank vegetation, and aquatic plants. Has been collected in small impoundments in the San Luis Valley.	—
✔	*Oncorhynchus clarki virginalis*	Rio Grande cutthroat trout	—	SC	Present in the park (introduced to Medano Creek). Found in small headwater streams; spawns in clean gravel; nursery habitat along stream margins in slower water; winter habitat includes deep pools (may be limiting in headwaters).	—
d	*Ptychocheilus lucius*	Colorado pikeminnow	E	T	Occurs in medium to large rivers.	Historical and current occurrence limited to the Colorado River system; does not occur in the park or the Rio Grande River system. The park is not a suitable area for potential reintroduction.
d	*Xyrauchen texanus*	Razorback sucker	E	E	Large river species not found in smaller tributaries and headwater streams.	Historical and current occurrence limited to the Colorado River system; does not occur in the park or the Rio Grande River system. The park is not a suitable area for potential reintroduction.

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
Amphibians						
d	*Bufo boreas pop.*	Boreal toad	C	E	Southern Rocky Mountain population. Elevational range of 7,000–12,000 ft. Found in wetlands and riparian areas in montane forest, subalpine, and alpine life zones.	Historic and current observations of this species are well north and west of the park; the park may provide suitable habitat for reintroduction if historic occurrence within the park is established; GMP alternatives would not differentially or adversely affect such efforts.
d	*Rana pipiens*	Northern leopard frog	—	SC	Elevational range of 3,500–11,000 ft. Found in wet meadows and banks and shallows of just about any type of water body.	A single individual has been found in the park in recent decades; potential for reintroduction to the park would not be affected by the GMP alternatives.
Birds						
d	*Buteo regalis*	Ferruginous hawk	—	SC	Occurs in grassland and shrubland habitats; rare in pinon-juniper woodlands. Rare occurrence in San Luis Valley.	Occurs only rarely and very locally in the San Luis Valley and has not been observed in the park; would not be differentially affected by the GMP alternatives.
d	*Centrocercus minimus*	Gunnison sage grouse	C	SC	Sagebrush shrublands and proximal grasslands; riparian areas within these habitat types.	Historic range did not include the park; not currently found in or near the park; the park would not be a suitable area for potential reintroduction.

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
d	*Charadrius alexandrinus nivosus*	Western snowy plover	—	SC	Found in open beaches, salt flats, or dry mud flats where vegetation is sparse or absent.	Not found in or near the park; a future separate study will analyze potential impacts to this species from alterations in hydrologic regime; no other impacts from GMP alternatives are anticipated.
d	*Charadrius montanus*	Mountain plover	—	SC	Occurs primarily in grazed grasslands or fallow fields.	Not found in or near the park; no impacts anticipated from implementation of GMP alternatives.
d	*Coccyzus americanus*	Yellow-billed cuckoo	C	—	Found in lowland riparian forests and urban areas with tall trees.	Not found in or near the park; no suitable habitat in the park.
d	*Empidonax traillii extimus*	Southwestern willow Flycatcher	LE	E	Nests primarily in swampy thickets, especially of willow, sometimes buttonbush, tamarisk, vines, or other plants where vegetation is 4–7 meters or more in height.	Not found in or near the park; no suitable habitat in the park.
✔	*Grus canadensis tabida*	Greater sandhill crane	—	SC	Present in the park. Migrants occur on mudflats around reservoirs, in moist meadows, and in agricultural areas. Breeding birds are found in parks with grassy hummocks and water courses, beaver ponds, and natural ponds lined with willows or aspens.	—
d	*Haliaeetus leucocephalus*	Bald eagle	T	T	Habitat includes reservoirs and rivers. In winter, they may also occur locally in semideserts and grasslands, especially near prairie dog towns.	No known nest or roost sites within the park; GMP alternatives would not affect nesting / roosting sites outside the park.

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
d	*Numenius americanus*	Long-billed curlew	—	SC	Short-grass grasslands and sometimes in wheat fields or fallow fields. Most nests are close to standing water, so that many otherwise suitable areas may be unoccupied.	One single transient individual recorded for the park and vicinity; future and separate study will analyze potential impacts to this species due to alteration in hydrologic regime; no other impacts from the GMP alternatives anticipated.
d	*Strix occidentalis lucida*	Mexican spotted owl	T	T	Occurs in unlogged, closed canopy forests in steep canyons. Nests in caves and on cliff ledges in steep-walled canyons.	Not found in or near the park; potential nesting and foraging habitat would not be affected by the GMP alternatives.
Mammals						
✔	*Lynx canadensis*	Canada lynx	T	E	Present in the park. Northern coniferous forests are preferred habitat, especially uneven-aged stands with relatively open canopies and well-developed understories.	—
d	*Mustela nigripes*	Black-footed ferret	E, XN	E	Historically occupied areas ranging from the shortgrass and midgrass prairie to semidesert shrublands.	Not found in or near the park; no prairie dog colonies (prey) in or near the park are large enough to support reintroduction.
✔	*Corynorhinus townsendii pallescens*	Townsend's big-eared bat subsp.	—	SC	Present in the park (documented along Deadman Creek). Found in caves and riparian areas.	—
d	*Thomomys talpoides agrestis*	Northern pocket gopher subsp.	—	SC	Found in many different habitat types including agricultural and pasture lands, semidesert shrublands, and grasslands at lower elevations upwards into alpine tundra. Very resilient to transient human disturbance (e.g., hikers and horseback riders).	*Thomomys talpoides* documented in park, but subspecific status unknown; regardless of subspecific status, these populations would not be affected by the GMP alternatives.

TABLE 4. SPECIAL-STATUS PLANT AND ANIMAL SPECIES

MAJOR GROUP	SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS[1]	COLORADO STATUS[2]	HABITAT COMMENTS AND OTHER NOTES	REASONS FOR DISMISSING FROM DETAILED ANALYSIS, IF DISMISSED
Plants						
✔	*Cleome multicaulis*	Slender spiderflower	G2,G3	S2,S3	Present in the park. Occurs around ponds, meadows, or old lake beds. Elevation 7500–8000 ft.	—
✔	*Cryptantha cinerea var. pustulosa*	James' catseye	G5	SNR	Present in the park. Found on the sand sheet and rocky slopes.	—
✔	*Draba smithii*	Smith's draba	G2	S2	Present in the park. Occurs on talus slopes, in crevices, and between rocks in shaded protected sites. Elevation 8000–11,000 ft.	—
✔	*Platanthera sparsiflora var. ensifolia*	Canyon bog orchid	G4	S3	Present in the park. Found in riparian habitats and wetlands (elevation unknown).	—

✔ **=** impacts to this species discussed in this environmental impact statement
d = impacts to this species dismissed from detailed analysis in this environmental impact statement

[1] C=Candidate, LE = Listed as Endangered; T=Listed as Threatened, XN=Experimental, Nonessential
[2] E=Endangered, T=Threatened, SC=Species of Concern
3 G2=Globally imperiled, G3=Globally vulnerable to extirpation or extinction, G4=Apparently Secure, G5=Secure
4 S2=State imperiled, S3=State vulnerable to extirpation or extinction, SNR=State Not Ranked

Table modified from CNHP Web site ftp://ftp.cnhp.colostate.edu/WEBDL/cnhp_tracking_list_080904.zip, and augmented with data from CNHP (1999) and Spackman et al. (2004)

GMP alternatives. The analysis indicates that the alternatives are anticipated to have no to negligible adverse impacts on the following species:

- Uncompahgre fritillary
- humpback chub
- bonytail chub
- Colorado pikeminnow
- razorback sucker
- Gunnison sage grouse
- yellow-billed cuckoo
- southwestern willow flycatcher
- bald eagle
- Mexican spotted owl
- black-footed ferret

Based on this analysis, the species listed above have been dismissed as impact topics.

The Canada lynx is the only federally listed species to which impacts may be anticipated. Therefore, the Canada lynx is discussed under "Threatened and Endangered Species" in chapter 4 of the GMP.

COLORADO STATE-LISTED WILDLIFE SPECIES

Rio Grande Sucker

The Rio Grande sucker (*Catostomus plebeius*) listed as endangered in Colorado, is found in the Upper Rio Grande basins of New Mexico and Colorado, along with some disjunct areas in Mexico (CSU 2004). It resides in riffles, runs, and pools in small- to medium-sized clear streams and eats plant and animal material scraped from rocks. Most of the populations in Colorado have been eliminated through habitat degradation and hybridization or competition with the white sucker (*Catostomus comersonii*). During 1996, a multiagency team introduced the Rio Grande sucker into Medano Creek (CDNR 1996). Medano Creek had appropriate barriers (disappears into the sand dunes) and could serve as a refuge for 200 Rio Grande suckers obtained for transplant from the Rio Tusos in New Mexico. Medano Creek parallels Medano Pass Road and is in the portion of the park already designated as wilderness. Because the action alternatives differ in the management zoning of the Medano Creek corridor, and this may result in differential impacts on the Rio Grande sucker, this species is considered as an impact topic under "Colorado State-Listed Species and Wildlife" in chapter 4.

Rio Grande Chub

The Rio Grande chub (*Gila pandora*) is a state species of special concern. This species is found in pools of small to moderate streams near areas of current. It is found in association with undercut banks, overhanging bank vegetation, and aquatic plants. This native fish is generally restricted to the Rio Grande River basin in Colorado, but has also been collected in small impoundments in the San Luis Valley (NDIS 2005g). This species historically occurred in the park and is a candidate for reintroduction. All three action alternatives would seek to return hydrologic regimes within the park to more natural conditions, resulting in the potential for more water reaching downstream users. Based on this information, the Rio Grande chub is retained for analysis in chapter 4.

Rio Grande Cutthroat Trout

The Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*), listed as a species of concern in Colorado, resides in rapidly flowing water with eddies in small

headwater streams of the Rio Grande River drainage (CNHP 1999). It was estimated by Alves (1996) that this species occupied less than 1% of its original habitat in Colorado. Medano Creek has been reclaimed by CDOW to support the Rio Grande cutthroat trout. The creek was selected because it has no outlet and could serve as a refuge for this rare trout species. Little Medano Creek also provides good habitat for the Rio Grande cutthroat trout, and even though it does not connect to Medano Creek year-round, there is a viable population present in the drainage. Because the action alternatives differ in the management zoning of the Medano and Little Medano Creek corridors, and this may result in differential impacts on the Rio Grande cutthroat trout, this species is retained for analysis under "Colorado State-Listed Species and Wildlife" in chapter 4.

Greater Sandhill Crane

The greater sandhill crane (*Grus canadensis tabida*), a state species of special concern, is an abundant fall and spring migrant in the San Luis Valley (NDIS 2005k). Migrants occur on mudflats around reservoirs, in moist meadows, and in agricultural areas. Breeding birds are found in open areas with grassy hummocks and watercourses, beaver ponds, and natural ponds lined with willows or aspens (Ellis and Haskins 1985, Renner et al. 1990). No records of breeding sandhill cranes are known for the San Luis Valley (Rawinski 2004), although this species still nests in some parts of northern Colorado (NatureServe 2005). No records of sandhill cranes utilizing the national park were provided by CNHP (1999), Rawinski (2004), or Giroir (2005). Suitable habitat in the San Luis Valley, including San Luis Lakes State Park, the various national wildlife refuges, and possibly the southwestern and currently irrigated portion of the national park, all contribute important stop-over habitat for these birds during their spring and fall migrations. The three action alternatives propose to return the hydrologic regime of the national park to a more natural state, which may have some impact on potential stop-over habitat for sandhill cranes. Therefore, this species is carried forward as an impact topic under "Colorado State-Listed Species and Wildlife" in chapter 4.

Townsend's Big-Eared Bat

Townsend's big-eared bat (*Corynorhinus townsendii*), a state species of special concern, occupies a variety of habitats across its range, including desert scrub, piñon-juniper woodlands, and deciduous and coniferous forests (Schmidt 2003). This species commonly utilizes riparian corridors within these habitats (Jones 1965, Seidman and Zabel 2001, Fellers and Pierson 2002, others). In Colorado, these bats are primarily associated with abandoned mines, saxicoline brush, sagebrush, semidesert scrub, piñon-juniper woodlands, ponderosa pine woodlands (Adams 1990, Armstrong et al. 1994) and montane forests (Adams 2003). This species is vulnerable to human disturbance at the roost, particularly at maternity roosts during the period immediately prior to parturition (giving birth). Maternity roosts often are at lower elevations to take advantage of warmer temperatures, which increase neonatal development. This species has been documented in the Deadman Creek corridor within the park (NPS 2004), and is carried forward as an impact topic under "Colorado State-Listed Species and Wildlife" in chapter 4.

Summary—Colorado State-Listed Species

Species listed by the state of Colorado as threatened, endangered, or as species of special concern that have the potential to occur within the park, have been analyzed relative to the anticipated impacts and differences of those impacts among the four alternatives. The analysis indicates that the alternatives may have the potential to affect riparian species (the Rio Grande sucker, Rio Grande chub, Rio Grande cutthroat trout, and Townsend's big-eared bat) and wetlands species (the greater sandhill crane). These taxa are evaluated, along with other members of their communities (species associated with riparian corridors and wetlands-associated species) identified below under "Wildlife," as impact topics in chapter 4. Due to the lack of anticipated impacts on the ferruginous hawk, western snowy plover, mountain plover, long-billed curlew, and northern pocket gopher, these species are dismissed from further analysis in chapter 4.

WILDLIFE

The elevational range encompassed by the Great Sand Dunes National Park and Preserve incorporates a diversity of plant communities which, in turn, provide habitat for a remarkable array of wildlife species. Recent faunal inventories of the park indicate the presence of at least 29 species of mammals (Valdez 2003), 110 species of birds (Giroir 2005), 6 species of reptiles, and 4 amphibian species (Muths and Street 2002). As such, the following description of wildlife species in the park is not all-inclusive, but provides a context for consideration of those wildlife species that may be differentially affected by the various action alternatives. Wildlife characterization of the park is presented by life zones, although many taxa, particularly larger species, move among the life zones.

Wildlife of the Sabkha Life Zone

This low-lying, salt-encrusted plain is sparsely vegetated by saltbush and saltgrass. The playa lakes and wetlands within the sabkha provide important habitat for a variety of migratory birds such as sandhill cranes (*Grus canadensis*) and American white pelicans (*Pelecanus erythrorhynchos*). A diverse complex of shorebirds, including American avocets (*Recurvirostra americana*), spotted sandpipers (*Actitis macularia*), and lesser yellowlegs (*Tringa flavipes*) occupy shorelines around playa lakes and other water bodies within the sabkha.

Wildlife of the Sand Sheet Grasslands and Shrublands Life Zone

The vast sand sheet surrounding the dunes is stabilized by a mixture of grassland and shrubland habitats. While both of these habitats are utilized by wide-ranging species such as mule deer and elk, the diverse assemblage of wildlife species that typify these habitats includes pronghorn (*Antilocapra americana*), white-tailed jackrabbits (*Lepus townsendii*), silky pocket mice (*Perognathus flavus*), and plains pocket mice (*P. flavescens*). Sage sparrows (*Amphispiza belli*) nest in sagebrush shrublands, but utilize adjacent grasslands and other types of shrublands during migration. Red-tailed hawks and American kestrels frequent this life zone.

Wildlife of the Dunefield Life Zone

While a number of wildlife species such as coyotes, mountain lions, and elk will

traverse parts of the dunefield, the only mammal to actually establish home ranges within the dunefield is Ord's kangaroo rat (*Dipodomys ordii*). A number of endemic invertebrate species are found only at the Great Sand Dunes; at least seven insect species including five beetles, a robber fly, and a moth appear to be limited to the sand dune habitat (CNHP 1999, Pineda 2002, NPS 2004). The insects that are endemic to the Great Sand Dunes include two species of ant-like flower beetles (*Amblyderus werneri* and *A. triplehorni*), Great Sand Dunes tiger beetle (*Cicindela theatina*), histerid beetle (*Hypocaccus* species undescribed), circus beetle (*Eleodes hirtipennis*), a robber fly (*Proctacanthus* species new), and an as yet undescribed noctuid moth (*Copablepharon* sp.). Additional rare species of insects observed within the dunefield life zone include the giant sand treader camel cricket (*Daihinibaenetes giganteus*) that was once thought to be endemic, but is now known from other localities, the San Luis Valley sand hills skipper (*Polites sabuleti ministigma*), and the golden-edged gem (*Schinia avemensis*).

Wildlife of the Montane Forest and Piñon-Juniper Woodlands Life Zone

These two systems occupy similar elevations (8,000 to about 9,500 feet), but occur in different positions on the landscape. Montane forest species such as Douglas-fir, aspen, and narrowleaf cottonwood, prefer wet drainages. Piñon pines and junipers occur on sunny hillsides that are drier. This diversity of habitat types provides for great species diversity within this life zone. Bobcats (*Lynx rufus*) commonly hunt these forests and woodlands for rabbits (*Sylvilagus nuttallii*), voles (*Microtus longicaudus* and *M. pennsylvanicus*), mice (*Peromyscus maniculatus* and *Neotoma cinerea*), and squirrels, including Abert's squirrel (*Sciurus aberti*) and red squirrels (*Tamiasciurus hudsonicus*). Western tanagers (*Piranga ludoviciana*), chipping sparrows (*Spizella passerina*), and green-tailed towhees (*Pipilo chlorurus*) feed among the trees, as do northern goshawks (*Accipiter gentilis*). Canyons, caves, and riparian areas in this life zone are often used by Townsend's big-eared bats (*Corynorhinus townsendii*), and a number of bat species such as long-eared and long-legged myotis (*Myotis evotis* and *M. volans*, respectively) forage among the trees in woodlands and along forest edges.

Wildlife of the Subalpine Forest Life Zone

Subalpine forests, extending from about 9,500 feet up to tree line (~11,000 feet) are characterized by hardy, stout trees such as Englemann and blue spruce, that can withstand the heavy winter snowfalls experienced in this life zone. The heavy winter snows contribute to year-round cold, damp conditions in the subalpine forest. This life zone is typically utilized by bighorn sheep (particularly on steep terrain), elk, mule deer, and black bears, beaver, and mountain lions. Warbling vireos (*Vireo gilvus*), Steller's jays (*Cyanocitta stelleri*), and gray jays (*Perisoreus canadensis*) may be observed in the subalpine life zone.

Wildlife of the Alpine Tundra Life Zone

This life zone occurs above about 11,000 feet and is characterized by a very short growing season resulting in low-growing plant life. Animals that utilize this zone include American pikas (*Ochotona princeps*), yellow-bellied marmots (*Marmota flaviventris*), and bighorn sheep.

Elk and mule deer may be seen along the forested periphery of this zone. During summer months, golden eagles (*Aquila chrysaetos*), a variety of hawks, and white-throated swifts (*Aeronautes saxatalis*) may be observed flying over, while horned larks (*Eremophila alpestris*) and white ptarmigan (*Lagopus leucurus*) may be observed nesting and foraging on the alpine tundra.

Summary—Wildlife

Wildlife that may be differentially affected by the proposed alternatives include migratory birds and ungulates (mule deer, elk, and bighorn sheep). Migratory bird species associated with wetlands habitats are collectively considered as wetlands-associated species under "Colorado State-Listed Species and Wildlife" in chapter 4 because alterations of current hydrologic regimes may impact these species. Management of elk numbers may vary under the different alternatives, having different consequences for mule deer and bighorn sheep numbers and herd health; therefore, these species are considered jointly as an impact topic in chapter 4. Finally, the action alternatives differ with regard to the presence of leashed dogs within the preserve. As these differences may have varying impacts on bighorn sheep, bighorn sheep will be considered as an impact topic in chapter 4.

SOILS AND GEOLOGIC RESOURCES

Soils

The lower elevations of the park include the sabkha, sand sheet, and dunefield life zones (see "Vegetation" section for a detailed description). These three zones lie on relatively gentle to moderately sloping topography and the overlying soils are predominantly Cotopaxi sand (2%–15% slopes), Space City loamy sand, saline (0%–3% slopes), and Dune land.

Soils were mapped by the Natural Resources Conservation Service (NRCS) for Alamosa County in 1973, and Saguache County in 1984, and were mapped in the lower elevations of the counties where there is a greater potential for agricultural use or development. The mapping performed by NRCS for these areas combined the above three soil types into two general map units that are described as follows: (1) the Dune land (NRCS 1984) or Cotopaxi-Dune land association (NRCS 1973), which encompasses approximately 40% of park soils, is comprised of deep, gently rolling to hilly, excessively drained sandy (coarse) soils; and (2) the Space City-Cotopaxi (NRCS 1984) or Hooper-Corlett (NRCS 1973) association, which occupies nearly level topography, makes up the remaining 60% of park soils, and is characterized by deep, nearly level to hummocky, well-drained to excessively drained, moderately fine- to coarse-textured soils that are strongly affected by alkali. Both of these general soil types are formed from eolian sand and sandy alluvium and are distributed across the park, with the Space City-Cotopaxi (Hooper-Corlett) association covering the western half of the park and the Dune land (Cotopaxi-Dune land) association covering the eastern half.

In the preserve (foothill, montane, subalpine, and alpine) life zones, the soils have not been mapped as extensively as in the lower elevations within the park. However, general mapping shows them to be primarily covered by Comodore very stony loam, Comodore-Rock outcrop complex, and Mount Home-Saguache cobbly sandy loam. These soil types represent shallow to deep, well-drained soil of ridges, mountain slopes, or alluvial

fans formed from igneous and metamorphic rocks.

More specific mapping of the area by NRCS identified 24 different soil types across the park and immediate vicinity. The general descriptions of these soil types are provided in table 3. There is some difference in soil taxonomy between the Alamosa and Saguache counties surveys; however, the types are combined when possible in table 5 (NRCS 1973, 1984).

Evaluation of the engineering characteristics for the listed soil types found in the vicinity of the park indicate the soils are generally poor for development of structures, including roads. The primary characteristics for this unsuitability include: susceptibility to soil blowing or erosion, caving soils, high permeability, high salinity or alkalinity, shallow soils, large stones, steep slopes, high shrink-swell ratio, shallow groundwater, flooding or wetness, and high potential for pollution of shallow groundwater.

TABLE 5. SPECIFIC SOIL TYPES PRESENT ON OR IN THE VICINITY OF THE GREAT SAND DUNES

Map Unit – Name	Description
12 – Comodore very stony loam, 25%–65% slopes	Shallow, well-drained soil of ridges and mountainside slopes that formed in colluvium from igneous and metamorphic rocks.
13 – Comodore-Rock outcrop complex, 40%–65% slopes	Shallow, well-drained soil of mountainsides that formed in thin colluvium from igneous and metamorphic rocks. The rock outcrop consists of rhyolite, closely associated volcanic material, and conglomerate materials.
14, CpB – Corlett-Hooper complex, 0%–15% slopes	Moderately well-drained, alkali soils of terraces and fans adjacent to old creek channels and in old lake basins on alluvial valley floors that formed in alkaline eolian sands, alluvium derived from basalt, and have a wind-deposited sandy surface layer.
16, CtE – Cotopaxi sand, 2%–15% slopes	Deep, somewhat excessively drained soil of dune-like hills and ridges on alluvial valley floors that formed in eolian sand.
22, Du - Duneland	Deep gently rolling to steep, excessively drained sandy soils of dunes.
30, Gn – Gunbarrel loamy sand	Deep, somewhat poorly drained, alkaline and saline soil of terraces and low fans on alluvial valley floors that formed in alluvium.
31, Gs – Gunbarrel loamy sand, saline	Deep, poorly drained soil, severely affected by salts and alkali, of terraces and low fans on alluvial valley floors that formed in alluvium.
35, Ho – Hooper loamy sand	Deep, moderately well-drained soil of floodplains and fans on alluvial valley floors that formed in alluvium derived from basalt and with a wind-deposited surface layer.
36, Hp – Hooper clay loam	Deep, moderately drained soil of floodplains and fans on alluvial valley floors that formed in alluvium derived from basalt.
42, Le – Laney loam, 0%–3% slopes	Deep, well-drained, saline and alkali-affected soil of floodplains and fans on alluvial valley floors that formed in calcareous alluvium.
45, Mc – McGinty sandy loam, 0%–3% slopes	Deep, moderately well-drained soil of fans on alluvial valley floors that formed in calcareous alluvium derived from igneous rock.
46, Mn – Medano fine sandy loam	Deep, poorly drained soil of floodplains on alluvial valley floors that formed in alluvium.
51, MtD – Mount Home-Saguache cobbly sandy loams, 4%–12% slopes	Deep, somewhat excessively drained soils of fans at the foot of the Sangre de Cristo range that formed in alluvium.

TABLE 5. SPECIFIC SOIL TYPES PRESENT ON OR IN THE VICINITY OF THE GREAT SAND DUNES

Map Unit – Name	Description
53 – Ouray-Sabe dry complex, 9%–25% slopes	Deep, excessively drained soil of alluvium from sand.
67 – Seitz very stony loam, warm, 15%–65% slopes	Deep, well-drained soil of mountainsides and ridges that formed in colluvium derived from igneous rock.
71, SrB – Space City loamy sand, saline, 0%–3% slopes	Deep, well-drained soil along the margins of intermountain valleys and basins on alluvial valley floors with undulating topography that formed in eolian sand.
72, StE, Space City-Hooper complex, 0%–15% slopes	Deep, somewhat excessively drained and moderately well-drained soils of low dunes on alluvial valley floors that formed in eolian sand on low dunes and alluvium derived from basalt and have a wind-deposited surface layer.
78, UrF – Uracca very cobbly loam, 15%–35% slopes	Deep, somewhat excessively drained soil of fans covered by cobble at the foot of the Sangre de Cristo range that formed in alluvium.
Am – Alamosa loam, 0%–1% slopes	Deep, somewhat poorly drained soil on floodplains on alluvial valley floors that formed in alluvium.
CmF – Comodore extremely rocky loam, 40%–50% slopes	Shallow, well-drained soil of mountainsides that formed in colluvium and is covered by angular stones and rounded cobblestones.
CoE – Corlett sand, hilly	Deep, somewhat excessively drained, alkali soils of low dunes and ridges on the valley floor that formed in eolian sand.
CsA – Costilla loamy sand, 0%–2% slopes	Deep, somewhat excessively drained soil of alluvial floodplains that formed in alluvium.
Hs – Hooper soils, occasionally flooded, 0%–1% slopes	Deep, somewhat poorly drained soil of old lake beds that formed in alluvium.
ZnB – Zinzer loam, 1%–3% slopes	Deep, well-drained soil of floodplains on the valley floor that formed in calcareous mixed alluvium.

Source: NRCS 1973, 1984

Geologic Resources

Great Sand Dunes Geologic Processes

The Great Sand Dunes are the result of and an element in a fragile, dynamic system that both influences and sustains dune formation (dunes system map). The dune mass is a huge deposit of eolian sand nestled against the Sangre de Cristo Mountain range. An extensive vegetated sand sheet consisting mostly of flat bedded sand deposits with scattered groups of parabolic dunes, surrounds the dune mass and is stabilized by species of grasses and shrubs. “Blowouts” are concave pockets of sand that are exposed when vegetation is disturbed. They are promoted by wind erosion and are a source of sand to the dune system. The sabkha is an alkaline plain located west of and adjoining the sand sheet. It is cemented together in many places by minerals deposited by seasonal wetlands. In a comparative study of 1936 and 1990 aerial photography, the dune mass and associated sand sheet did not show any obvious shifts; rather they displayed remarkable stability over the 54-year time period (McArthur and Sanderson 1990). The national preserve protects the watershed of creeks that play a role in dunes sand recycling.

The origin of the dunes was controlled by a combination of geographic, geologic, and

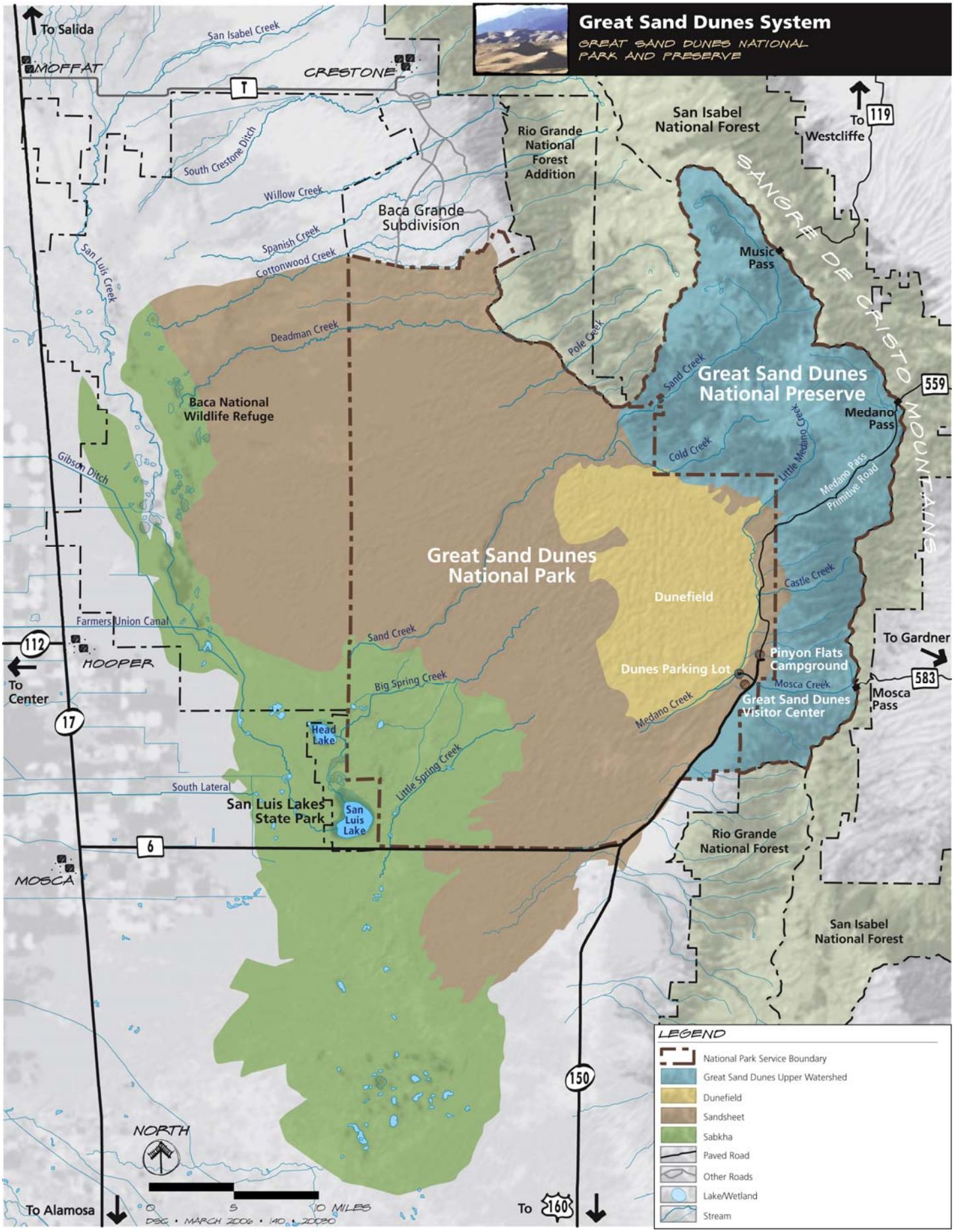
climatic factors (Taylor 1999). Most sand grains (quartz and rhyolite) that make up the dunes result from weathering of Tertiary volcanic rocks of the San Juan Mountains. A smaller amount of quartz sand originates from weathering of Precambrian granites, granodiorites, and gneisses from the Sangre de Cristo Mountains. As sand grains are transported to the valley by streams, strong winds from the southwest erode the grains from valley sediments and move them over the sand dunes. As the winds rise over the Sangre de Cristo Mountains they are funneled to the area of Medano Pass. The Great Sand Dunes and the deposition system contributing to them cover an area of approximately 497 square miles (800 square kilometers) (CNHP 1999).

Streams that drain the Sangre de Cristo Mountain range return wind-blown sand (and some feldspathic sands and gravels and carbonate fragments derived from the mountain bedrock) back to and west of the active dune system in a form of "recycling." The sand carried downstream by Medano and Sand creeks, in particular, is re-deposited on the sand dune mass by southwesterly winds. Over time, sand, wind, and water function to shape and re-shape the dunefield in a near closed loop system. At the foot of the dunes, the surging water in Medano Creek seasonally provides an interesting and delightful contrast to the near-barren sand surfaces. During the spring, pressure differentials associated with storms generate strong southwesterly winds that can blow for several days and transport millions of sand grains abrasive enough to scour the landscape, prior to depositing on the sabkha, sand sheet, dunefield, or mountains.

The sand dunes are very large, some exceeding 700 feet above the adjacent landscape. The dune mass covers approximately 30 square miles, with an average sand thickness of 136 feet (41.42 meters). The thickest dunes lie parallel to Medano Creek and are in line with San Luis Lake (Bunch 1997). Most dunes are oriented in a south to north direction in the main dune mass.

Several dune types are present and their formation is controlled by wind velocity, sand supply, and vegetation. These dune types include: reversing dunes, star dunes, transverse dunes, barchan dunes, parabolic dunes, and climbing dunes. Some very mobile dunes, known as escape dunes, are located east of Medano Creek, and form when the creek disappears during dry seasons or years (Bunch 1997). Between 1936 and 1990, escape dunes smothered a stand of ponderosa pine trees in an area now known as the Ghost Forest (Bunch 1997). Escape dunes move constantly to the northeast.

The dominant movement of the dune mass is to the northeast; however, winds frequently blow from the northeast, stabilizing the dunefield to some extent (Taylor 1999). Medano, and other creeks flowing westerly from the Sangre de Cristo Mountains erode advancing dunes on the east side of the formation, returning the sand to the southwest side where winds blow it back onto the dunes. This represents a natural sand recycling system that is relatively unique. Migration of the dunes is inhibited by the two wind directions and by the presence of wet sand grains a few inches below the dune surface. Erosion of the dune is effectively halted when wet sand is exposed. Dune mapping and the form of reversing dunes indicate that dunes within the dunefield migrate slightly.


Great Sand Dunes System
GREAT SAND DUNES NATIONAL PARK AND PRESERVE
To Salida
MOFFAT
CRESTONE
San Isabel Creek
South Crestone Ditch
Willow Creek
Spanish Creek
Cottonwood Creek
San Luis Creek
Deadman Creek
Gibson Ditch
Farmers Union Canal
HOOPER
To Center
112
17
6
MOSCA
Rio Grande National Forest Addition
Baca Grande Subdivision
Baca National Wildlife Refuge
San Isabel National Forest
To Westcliffe
119
SANGRE DE CRISTO MOUNTAINS
Music Pass
Pole Creek
Sand Creek
Great Sand Dunes National Preserve
559
Medano Pass
Cold Creek
Little Medano Creek
Medano Pass Primitive Road
Great Sand Dunes National Park
Dunefield
Castle Creek
Sand Creek
Big Spring Creek
Dunes Parking Lot
Pinyon Flats Campground
Mosca Creek
Great Sand Dunes Visitor Center
Medano Creek
To Gardner
583
Mosca Pass
Head Lake
Little Spring Creek
South Lateral
San Luis Lakes State Park
San Luis Lake
Rio Grande National Forest
San Isabel National Forest
150
To 160
To Alamosa
NORTH
0 5 10 MILES
DSC • MARCH 2006 • 140 • 20030
LEGEND
National Park Service Boundary
Great Sand Dunes Upper Watershed
Dunefield
Sandsheet
Sabkha
Paved Road
Other Roads
Lake/Wetland
Stream

Local Mineral Resources

Within the national park, subsurface mineral rights associated with the former Baca Ranch are owned by a private company. This company and others who have owned the mineral interests underlying the former ranch, have conducted extensive exploratory activities for oil and gas, including drilling two exploratory wells. National Park Service and U.S. Geological Survey (USGS) geologists generally agree that oil deposits within the geologic structure underlying the Baca Ranch present little to no prospect for developable quantities of oil or gas. No production activities for oil or gas have been requested or undertaken to date. Oil and gas exploration activities within national parks must be managed pursuant to NPS regulations designed to protect park resources and values (see 36 CFR 9B: *Non-federal Oil and Gas Rights Regulations*).

WETLANDS

Wetlands Definition and Classification

Wetlands have been defined both by academicians and agencies responsible for their management. The term "wetlands," used herein is defined to both the National Park Service and U.S. Army Corps of Engineers conventions.

The U.S. Army Corps of Engineers has jurisdiction for protecting wetlands under section 404 of the Clean Water Act. This agency defines wetlands as "*areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3[b]). Wetlands generally include swamps, marshes, bogs, and similar areas.*" Wetlands have three diagnostic characteristics: (1) over 50% of the dominant species present must be classified as obligate, facultative wetlands, or facultative wetlands, (2) the soils must be classified as hydric, and (3) the area is saturated or inundated long enough during the growing season to create anaerobic soil conditions (Environmental Laboratory 1987).

The National Park Service classifies, delineates, and maps wetlands using the USFWS Cowardin classification system (USFWS 1979). This system is based on the more inclusive definition: ". . .*lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.*" Under this classification, wetlands must have one or more of the following characteristics: (1) the land supports, at least periodically, predominantly hydrophytes (i.e., plants adapted to growing in water or in saturated soils that are oxygen deficient), (2) the substrate is comprised of predominantly undrained hydric (anaerobic) soils, and (3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year (USFWS 1979).

Both of these wetlands definition and classification systems recognize three parameters (hydrophytic vegetation, hydric soil, and wetlands hydrology), but the Cowardin system defines more habitat types as wetlands. The Cowardin system also recognizes many unvegetated sites or areas without soil (e.g., mudflats, rocky or sandy banks, beaches, stream shallows, saline lakeshores and playas) as wetlands

habitats with important wildlife habitat values.

Regional Context

In general, wetlands information presented in this section is descriptive and programmatic in nature. Based on the available National Wetlands Inventory maps for the park, it seems that wetlands mapping efforts within the expanded park to date have focused on particular areas (e.g., the southwest portion of the national park, Sand Creek, and Medano Creek). As a result, wetlands in other park areas (for example, those along Deadman Creek, Cold Creek, and Pole Creek) are not shown on the National Wetlands Inventory maps. Details concerning present extent and jurisdictional determination are not included herein and are left for more specific planning and implementation documents. Other sections of this chapter (vegetation, wildlife, ecological critical areas, water resources) provide additional information related to wetlands.

The park contains 12 primary streams that flow westward from the Sangre de Cristo Mountains and provide wetlands hydrology. They include Mosca, Medano, Castle, Sawmill, Buck, Little Medano, Cold, Sand, Pole, Deadman, Big Spring, and Little Spring creeks. Of these, the major streams are Medano and Sand creeks. They originate high in the mountains, filling numerous alpine lakes before flowing into the sand dunes and across the valley floor. Medano Creek flows around the dunefield along the eastern and southeastern borders and then into the southern portion of the sand sheet. Sand Creek flows around the dunefield on its northeastern, northwestern, and western edges and then into the northern portion of the sand sheet. Sand Creek becomes a braided, sand-bottomed creek in the vicinity of the dunefield and on the sand sheet life zones.

Since there is no surface outlet for groundwater in the northern San Luis Valley, this hydrological system is considered a closed basin. The water infiltrates quickly through the sand, adding to the already high permanent groundwater levels, which typically lie only 5 feet to 15 feet from the ground surface in the shallow aquifer under the park (Cooper 1992). The high water table of San Luis Valley creates an array of wetlands and wildlife habitats. The many types include permanent ponds and lakes, playa lakes, seasonal ponds and marshes, seeps, wet meadows on pond edges, and salt flats. Groundwater flows primarily west and southwest (Rupert and Plummer 2004) across the park. It emerges in the southwestern portion of the park as a line of springs. The water flowing from these springs creates large areas of lush, productive wetlands around Big Spring Creek and ultimately flows into San Luis Lake. In addition to these wetlands formations, wind erosion has removed sand to the elevation of the water table in places, allowing the establishment of interdune wetlands within the sand sheet life zone (CNHP 1999).

Wetlands and associated riparian habitats within the park support nearly one-third of the known plant species listed by Spackman et al. (2004). Cooper (1992) described 24 emergent wetlands associations on only the sand sheet and sabkha life zones of the park. Several rare plant species grow in wetlands habitat and most of the plant communities that are considered rare are associated with wetlands or riparian areas (see the "Ecologically Critical Areas" section).

Wetlands Functions and Values

Wetlands provide keystone habitat for a wide array of animal and plant species. Vegetation production and diversity are usually very high in and around wetlands, with many plant species adapted only to this unique environment. Wetlands destruction, filling, and draining are occurring throughout North America and pose a major threat to wildlife diversity, carrying capacity, and hydrologic regimes. Changes to and destruction of wetlands can have effects that are proportionally greater than elsewhere in an ecosystem (Graber 1996).

Wetlands in general, and those of the San Luis Valley area in particular, perform many beneficial functions (biological and physical processes) in addition to providing habitat for animals and plants (Adamus et al. 1991). These functions and values pertain to water quality, water quantity, landscape health, and human recreation:

- groundwater recharge
- groundwater discharge
- flood flow alteration
- sediment stabilization and shoreline anchoring
- sediment and toxicant retention
- production export
- aquatic diversity and abundance
- wildlife diversity and abundance
- recreation
- uniqueness or heritage value

Wetlands Distribution and Management

The largest acreages are distributed along Deadman, Medano, Sand, Big Spring, and Little Spring creeks and their tributaries. They range from sparsely vegetated playas and seasonal mudflats, to aquatic and emergent stands in shallow water and irrigated hay meadows, to streamside shrublands, woodlands, and forests, to high elevation ponds, seeps, and snow glades (see the "Vegetation" section). Introduced wetlands have become established due to irrigation of natural meadows (which has occurred for over a century) on Medano Ranch and on banks of excavated ponds, ditches, and canals, which are located mostly at lower elevations on gentle slopes and flats. A particularly high concentration of irrigated wetlands occurs in the lower reaches of Sand, Big Spring, and Little Spring creeks on Medano Ranch. In general, restoration of a natural runoff and drainage regime in these areas, which is proposed in the action alternatives, is expected to reduce the area extent of some wetlands types (e.g., wet meadow, emergent wetlands, aquatic, etc.) and expand or re-establish the extent of other types (e.g., ephemeral ponds, playas, mudflats, etc.).

Wetlands Types by Life Zone

Wetlands occur throughout the park life zones, are diverse, and can broadly be characterized in the Cowardin system as either riverine (rivers, creeks, and streams), palustrine (shallow ponds, marshes, swamps, sloughs), and lacustrine (lakes and deep ponds).

On the lowest elevations, the sabkha life zone supports limited wetlands vegetation due to high soil salinity and alkalinity. In general, aquatic, emergent, and wet meadow plant communities are intolerant of saline soils and lack of fresh water. Wetlands that have become established here are primarily palustrine emergent, consisting of grasses and other graminoids that can tolerate higher alkaline and saline conditions such as saltgrass, alkali cordgrass, and alkali sacaton. The sabkha

wetlands transition to those typically found on the sand sheet life zone in areas where the soil has been flushed by runoff.

The sand sheet and dunefield life zones contain riverine, palustrine, and lacustrine wetlands. Riverine perennial wetlands vegetation is found primarily along the margins of permanent streams (e.g., Medano, Sand, and Big Spring creeks). Palustrine emergent wetlands occur in the form of marshes and wet meadow habitat found along San Luis Creek and on the west side of the dunefield. Palustrine scrub/shrub vegetation characterized by willow species and similar hydrophilic shrubs is found along the primary drainages and margins of the larger bodies of water. Other sites in the San Luis Valley, including drained agricultural fields, barren mudflats, and un-vegetated stream and pond shores may also support wetlands.

The palustrine emergent wetlands of the sabkha and sand sheet life zones were classified into seven general wetlands plant classes and more finely into 27 wetlands and adjacent upland plant associations by Cooper (1992). The seven classes were composed of one or a few common plant species associated with the moisture gradient and include (in order from low open water to higher upland): (1) aquatics (open water), (2) hardstem bulrush (*Schoenoplectus lacustris* ssp. *acutus*), (3) spikerush, (4) three-square bulrush (*Schoenoplectus pungens*), (5) Baltic rush, (6) saltgrass, (7) cordgrass (*Spartina gracilis*), and (8) blue grama grass (upland). Depending on the presence and duration of standing water and the influx of fresh water, some of these classes may be absent or may vary locally in species composition.

The piñon-juniper woodland, montane woodland, and forest life zones contain primarily riverine and palustrine wetlands associated with streams, ponds, and wet meadows. Riverine wetlands and riparian habitat is found within and adjacent to the flowing water of the permanently flooded rock, cobble, or sand-bottomed stream channels. The vegetation is primarily a lush mix of herbaceous, shrub, and tree species. Palustrine emergent wetlands located in these life zones include beaver ponds, montane meadows, and seeps that typically support stands of sedges and grasses. The palustrine forest and woodland types have become established along streams and include quaking aspen, blue spruce, and narrowleaf cottonwood, among other tree species. Palustrine scrub/shrub wetlands occupy streambanks and saturated soils where they often mix with meadow (palustrine emergent) and riparian (palustrine forest and woodland) species. Several willow species and thinleaf alder shrubs are common shrub/scrub species.

The subalpine life zone supports similar creek bank and palustrine wetlands as those found in the montane zone. This zone also supports lacustrine wetlands associated with subalpine lakes and ponds. Palustrine emergent wetlands characterize subalpine meadows and seeps that occupy peat beds that are permanently or seasonally saturated. Subalpine vegetation is characterized by herbaceous species of grasses, sedges, rushes, and perennial herbs. Palustrine scrub/shrub wetlands in this life zone include stands of willow species and occasionally alder and birch. Palustrine forests and woodlands have become established along streams and on mesic sites that support open to thick stands of conifers, usually blue spruce or Douglas-fir, and deciduous trees, including narrowleaf cottonwood and quaking aspen. Lacustrine limnetic sites include naturally occurring glacial ponds and constructed beaver ponds. In-lake vegetation is typically limited to rooted aquatic grasses, sedges, floating vascular plants, and algae. Meadow (palustrine emergent) and riparian

(palustrine forest and palustrine scrub/ shrub) communities generally border lake margins.

Wetlands in the tundra zone are restricted to alpine streams, seeps, ponds, and snow glades. The vegetation is primarily classified as palustrine and includes low-growing species of sedges, grasses, and willows.

WATER RESOURCES

The San Luis Valley is an arid environment with average annual precipitation of 7.1 inches recorded in Alamosa, Colorado, and 8.4 inches recorded in Saguache, Colorado, over a 56-year time period (WRCC 2005). Annual snowfall averages 31.7 inches and 26.4 inches at these two locations, respectively. The Great Sand Dunes has higher precipitation, averaging 10.5 inches (NPS 1995a). Direct precipitation for the San Luis Valley represents a very minor portion of the water supply. The most important source of water to the valley is surface water inflow, which directly or indirectly provides most water used for irrigation, and recharges the aquifers. Surface water inflow largely results from variable snowmelt and runoff from the surrounding mountains and has ranged from a high of 2,783,000 acre-feet in 1941, to a low of 743,000 acre-feet in 1951. The total watershed of the San Luis Valley covers about 5 million acres . Approximately 2,800,000 acre-feet of water enter and leave the San Luis Valley annually (Emery 1997).

The northern portion of the San Luis Valley, north of the Rio Grande, encompasses approximately 2,500 square miles, includes the area of Great Sand Dunes, and is referred to as the "Closed Basin" (CSP 1996). Due to a topographic rise in the valley floor, streams that drain the northern portion of the valley and its surrounding hills and mountains (Cochetopa Hills, northern San Juan Mountains, northern Sangre de Cristo Mountains) do not flow into the Rio Grande; rather the water is retained underground within the Closed Basin.

Water Rights

The National Park Service holds several water rights for Great Sand Dunes, including rights for domestic and operational uses, instream flow, and wildlife purposes. The National Park Service has instream flow water rights (decreed June 20, 1989; priority date March 17, 1932 or June 17, 1956) for Medano, Little Medano, Horse Canyon, Castle, Sawmill Canyon, Buck, Garden, an unnamed creek, Mosca, Morris Gulch, Sand, and Cold creeks. It also inherited instream flow water rights from the USFS when lands within what is now the national preserve were transferred to the National Park Service (decreed March 30, 2000; priority date October 25, 1999): Medano, Little Medano, Horse Canyon, Castle, Sawmill Canyon, Buck, Garden, an unnamed tributary of Medano, Medano, Mosca, Morris Gulch, Sand, and Cold creeks.

The National Park Service also has federal reserved groundwater rights for domestic and operational uses, and an appropriative water right for Denton Spring for wildlife purposes.

The National Park Service filed a claim for an absolute in-place groundwater right for the Great Sand Dunes on December 30, 2004 (NPS 2004). The claim was filed pursuant to the Great Sand Dunes Act of 2000, which specifically recognized that surface and groundwater systems on and underlying the park and adjacent lands are

necessary for preserving the park's natural and cultural resource values, including pulse flow in Sand and Medano creeks. There is a history of proposals to withdraw groundwater for export from the San Luis Valley to Colorado's eastern slope. The Great Sand Dunes Act of 2000 directed the Secretary of the Interior to obtain and exercise water rights required to fulfill the purposes of the park by maintaining groundwater levels, surface water levels, and stream flow on, across, and under the park. The Great Sand Dunes Act of 2000 requires the United States to follow state procedural law in obtaining the water right and to establish the purposes and other substantive characteristics of the water right pursuant to state and federal law. The Great Sand Dunes Act of 2000 protects uses existing on November 22, 2000, and prohibits the federal reservation of water.

Two irrigation ditches in the headwaters of Medano Creek are associated with water rights senior to those of the park. The Hudson Ditch was constructed in 1886, and the Medano Ditch in 1892. Since no easement was issued for these ditches by the USFS prior to passage of the Great Sand Dunes Act of 2000, the legislative authority for issuing easements and establishing terms and conditions for such easements on these ditches now falls to the National Park Service. However, since the USFS was in the process of issuing easements for these ditches prior to the passage of the 2000 Act, the National Park Service may be required to issue an easement pursuant to the Colorado Ditch Bill (Public Law 99-545, October 27, 1986) despite the fact that this legislation would not normally pertain to an NPS area.

The Closed Basin Division, San Luis Valley Project (Closed Basin Project) is located in the topographic depression (the Closed Basin) of the Valley. The purpose of the project is to pump and deliver unconfined groundwater and available surface flows in the Closed Basin to the Rio Grande River via a 42-mile conveyance channel. The project assists Colorado in meeting its water delivery commitment to New Mexico and Texas under the Rio Grande Compact of 1939, and assists the United States in meeting its water delivery commitment to Mexico under a treaty dated May 21, 1906. The project also delivers water to the Alamosa National Wildlife Refuge under jurisdiction of the USFWS. Management responsibility for the Closed Basin Project features within the national park remains with the U.S. Bureau of Reclamation (Great Sand Dunes Act of 2000). The water level of San Luis Lake is also maintained for fishing and boating recreation using water from the Closed Basin Project (CNHP 1999). A portion of the Closed Basin Project is located within the southwest corner of the national park.

Surface Water

Surface Water Resources

Surface water is a key resource at the Great Sand Dunes, transporting sediments for redistribution to the dunefields by wind, thus shaping the landscape and affecting distribution of plants, animals, and visitor use. The surface water resources are in a nearly natural condition and consist of perennial, intermittent, and ephemeral streams. Natural playa lakes, springs, seeps, and wetlands, i.e., interdunal ponds and wet meadows, are also present within the landscape. Stream flows are often heavy following snowmelt and during flood events following storms. Spring runoff from the Sangre de Cristo Mountains, most visibly characterized by Sand and Medano creeks, is the most obvious and plentiful source of surface water and groundwater recharge in the northern San Luis Valley

(CNHP 1999); however, for the most part, the park lies in a closed basin with a high water table, alkaline soils, and little external drainage pattern (NRCS 1973).

Medano Creek, fed by its numerous tributaries, flows from the Sangre de Cristo Mountains and around the dunefield along its eastern and southeastern borders and then disappears beneath the sand in the southern portion of the sand sheet where it deposits or recycles its load of sediment. Sand Creek flows from the mountains, then around the northern, northwestern, and western edges of the dunefield before entering the northern portion of the sand sheet, across which it runs to eventually flow into the San Luis Lakes southwest of the dunefield. Sand and Medano creeks become braided, sand-bottomed creeks in the vicinity of the dunefield and on the sand sheet habitats. Medano and Sand creeks are among the park's "fundamental resources and values" (see chapter 1 for the full list).

Surge or pulsating flows in Medano and Sand creeks represent the mechanism for returning vast quantities of wind-blown sand onto the valley floor. Sand Creek, although it is the largest creek in the park, does not display surge flows as consistently as Medano Creek. The water-borne transport of sand by these creeks is a key part of the eolian/hydrologic process that created and sustains the Great Sand Dunes. Sand is blown or eroded into the creek via landslides. Landslides occur as Medano Creek flows against the base of the dunes and undercuts the toe of the dune slopes. The creeks surge because the sand builds up in the creek bottom, creating a minor damming effect, and when the water reaches sufficient volume and pressure it surges downstream with the load of sand. USGS hydrologists consider the Medano Creek surge flow to be one of the best examples of this phenomenon in the world. Castle Creek also displays outstanding surge flow at times and was the site at which the explanation for the surge flow phenomenon was developed.

Water percolates from the streams and recharges the shallow aquifer or emerges as a line of springs in what is believed to be an ancient channel of the Medano Creek drainage that was buried by sand deposits (Fryberger et al. 1990). Big Spring Creek originates at Indian Spring, one of the primary examples of an emergent spring on the sand sheet, west of the dunefield, and flows southwest to San Luis Lakes. Based on a study performed by the USGS (2004), it takes over 60 years for groundwater to migrate from Medano and Sand creeks to Big Spring Creek. Because it is fed by groundwater from seeps and springs, Big Spring Creek is the only gaining system in an area where most other drainages are losing systems. Because of its constant source, Big Spring Creek is a nonflooding creek with regular flow.

In the sand sheet habitat, the wind scours sand down to the elevation of the water table, allowing the establishment of interdunal wetlands (CNHP 1999); however, the ponds associated with the interdunal wetlands have been disappearing over the last 60 years. Hammond (1997) studied aerial photographs acquired from the 1930s through 1990s and determined 69 small ponds were present along the western part of the national park in the 1930s and only five remained in the 1990s. The cause of the disappearance of the ponds has not been fully investigated. However, the existence of the ponds is directly related to the level of the shallow or unconfined aquifer of the northern San Luis Valley (USGS 2003).

Sand sheet wetlands (interdunal ponds, Big Spring Creek, and Little Spring Creek) have been identified as fundamental resources

and values for the park (see chapter 1 for the full list).

Surface Water Quality

Preliminary hydrologic research has shown that not only are surface water dynamics in the San Luis Valley complex, but that different sources vary widely in water quality (Cooper and Severn 1992). Most creeks within the park are thought to reflect near-natural water quality conditions and have been determined to maintain the highest water quality in the upper Rio Grande drainage. A USGS study (USGS 2003) found that several Great Sand Dunes perennial streams (Sand, Medano, and Mosca creeks) and ephemeral streams (Cold, Little Medano, Castle, Sawmill Canyon, and Garden creeks) are so pure that they meet the standards for the outstanding waters designation. This designation offers the highest level of water-quality protection available under the Clean Water Act and Colorado regulations, and is designed to prevent any degradation from existing conditions. The National Park Service closely monitors surface water quality within the park and preserve to ensure that high water quality is maintained. Medano Creek, with its outstanding water quality and closed system, has been identified as a fundamental resource of the park.

Potential sources of contamination to surface and groundwater at the park that are pertinent to the GMP alternatives include humans and animals (e.g., horses and dogs), and sedimentation/erosion (NPS 1995a). Oil and gas exploration activities on former Baca Ranch lands would likely not have any impacts on water quality within or near the park; such activities must be conducted according to an NPS-approved plan of operations designed to ensure protection of park resources, in accordance with 36 CFR Part 9B.

Great Sand Dunes personnel sampled 10 sites along Medano Creek for the presence of fecal coliform during 1995 (Sundermeyer 1997). Samples analyzed for June (flow of 70 cubic feet per second [cfs]) detected nearly no coliform bacteria in the water. Up to 50 organisms per 100 ml of water were detected during an August (flow of 10 cfs) analysis. During the October (flow of 2.5 cfs) sample analysis, coliform bacteria were detected at a rate of 80 organisms per 100 millimeter (ml) of water. Creeks in the park, particularly Medano Creek, continue to be monitored for total coliform and *e. coli*. Results indicate that occurrences of these bacteria are within the range of <16 and <2.2 organisms per 100 ml of water, respectively. These densities are considered in the safe range for water quality; Medano Creek is classified under the Recreational Body of Water, Division I (full body contact) by the Colorado Department of Health and Environment (CDPHE), Water Quality Division.

Groundwater

Groundwater Resources

The San Luis Valley has two major groundwater aquifers—the shallow or upper unconfined (Alamosa formation) and the deep or lower confined (Santa Fe formation) (USFWS 2003). Groundwater is regionally separated in the Alamosa and Santa Fe aquifers due to a thick layer of impermeable clay, known locally as the blue clay layer, and also lava flows. Both aquifers consist of unconsolidated clay, silt, sand, and gravel. Estimations in 1971 determined that there are over 2 billion acre-feet of groundwater stored above

6,000 feet elevation within the San Luis Valley (NPS 1997). These groundwater aquifers are considered the "fundamental resources and values" of the park (see chapter 1).

The age of the groundwater retained in the Santa Fe aquifer has been dated by the USGS (2004) at approximately 30,000 years before present; plus or minus 3,000 years. However, Magee and Mueller (1991) determined that there is mixing of the unconfined and deep aquifers along the east side of the San Luis Valley because the confining clay layer was absent in monitoring wells drilled and sampled for their study. Many flowing wells from the confined aquifer range in depths from 1,000 feet to over 2,000 feet and some flow at volumes of over 3,000 gallons-per-minute.

The Alamosa aquifer is restricted by the Closed Basin, resulting in very shallow (12 feet or less) groundwater conditions for about 50% of the San Luis Valley. The southern portion of the San Luis Valley, generally south of the Rio Grande, is well drained in terms of surface and groundwater and depth to groundwater can exceed 300 feet.

Seasonal runoff from the local mountains is the predominant recharge source for the Alamosa aquifer. Other sources include infiltration from applied irrigation water, canal leakage, and precipitation (Emery 1997). Studies performed by the USGS (2004) show there is a direct relation between the shallow aquifer and local surface water bodies, i.e., streams, creeks, and ponds. Thus, lowering of the shallow aquifer level would reduce the size and number of interdunal ponds and minimize the ability of creeks to transport or recycle upwind sand downstream to the sand sheet at the park. Historical and current groundwater pumping and water development have been employed to lower the water table to expand agriculture and build roads in the interior of the San Luis Valley.

Because the depth of the Alamosa aquifer affects the ability of local creeks to recycle sand within the park and the occurrence of the interdunal ponds and wetlands, Great Sand Dunes staff installed 19 shallow groundwater wells between 1990 and 1993 to monitor water levels at the base of the dunefield (NPS 1995a). Eleven wells were placed near Medano Creek, five near Sand Creek, two near Mosca Creek, and one in the sand sheet on the national park boundary. Recently, 10 additional wells were installed near Big Spring and Little Spring creeks. As of 2005, Great Sand Dunes staff were monitoring 27 wells in the area to better understand fluctuations in the Alamosa aquifer and their causes.

Groundwater Quality

The groundwater of the shallow (Alamosa) aquifer of the San Luis Valley is highly mineralized and gaseous, while the deep (Santa Fe) aquifer is less mineralized and often under enough pressure to maintain artesian flows at well heads (CSP 1996). Concentrations of total dissolved solids from active salvage wells placed in the Alamosa aquifer have increased and sometimes exceed water quality levels for the water to be conveyed to the Rio Grande (CSP 1996).

At San Luis Lakes State Park, salvage well 66 requires extensive treatment for removal of heavy metals, minerals, alkalinity, and dissolved solids. Additionally, iron-feeding bacteria have been found in measurable concentrations within this well (CSP 1996). Evaluation of nitrate data from Alamosa aquifer groundwater samples identified mineral fertilizers as the primary source of

nitrate in the shallow aquifer system of upper San Luis Valley (Stogner 1997). As indicated by high mineralization and nitrification of the shallow aquifer (from fertilizer use), it is evident that this aquifer's water quality is highly reliant on surface water quality in the northern San Luis Valley. That is, elements in the surface water become concentrated in the groundwater. As such, adverse impacts to surface water quality may also directly affect the quality of the Alamosa groundwater aquifer.

The term "visitor experience" refers to everything that happens to visitors while visiting the Great Sand Dunes—everything they do, learn, feel, and perceive. Insights about visitor activities and experiences come primarily from two visitor surveys. A Visitor Services Project Visitor Survey was conducted at the park June 23 – 29, 2002 (Le and Littlejohn 2003). Three hundred and sixty-four individuals responded to this survey, which is hereafter referred to as the 2002 Visitor Survey. The previous visitor survey was conducted between July and December 1997, which 284 people responded to, hereafter referred to as the 1997 Visitor Survey. These studies were conducted during short time frames and included a relatively small sample of visitors, so results may not be representative of all visitors.

The term "visitor use" refers to details about how many people visit the park, when and where they come from, how long they stay, etc. The Great Sand Dunes is presently experiencing a transition period related to the change from a smaller national monument to a larger park and preserve, opening of new lands to the public, etc. Visitor use also appears to be changing; therefore, it may be too soon to draw conclusions about new patterns of use.

VISITOR USE AND EXPERIENCE

The national parks were created to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." One of the specific purposes of Great Sand Dunes National Park and Preserve is to "provide opportunities for visitors to experience, understand, enjoy, and gain a sense of stewardship for the park's natural and cultural resources." It is therefore important to consider visitor experiences, opportunities, and visitor use when analyzing the impacts of GMP alternatives.

Visitor Experience

Fundamental Resources and Values

Several aspects of the visitor experience at the Great Sand Dunes have been identified as "fundamental opportunities" (see chapter 1 section, "Fundamental Resources and Values"). The National Park Service believes that the park should be managed to maintain these important opportunities. They are fundamental because they are tied closely to park purpose and significance—what is particularly special about the park. Fundamental visitor opportunities include the following:

- climbing and descending the high dunes, which are fairly resilient to recreational use
- experiencing surge flow, playing in Medano Creek near the foot of the dunes
- seeing the heavens (stars, planets, Milky Way, comets, etc.) at night
- viewing the dune mass with the backdrop of the high peaks, and from the mountains

- seeing wildlife in its natural setting (e.g., elk, pronghorn, deer)
- learning about the dunes system—its components and dynamic nature
- experiencing quiet and solitude in a wilderness environment
- driving in sand on the Medano Pass primitive road (high clearance four-wheel drive required)

Range of Visitor Activities

The Great Sand Dunes' spectacular scenery and unusual changing landforms attract people throughout the year. The park offers a variety of recreational activities and opportunities, particularly now that it is larger and includes the lands within the national preserve. According to the 2002 Visitor Survey, the most common visitor activities are climbing the dunes (80%), visiting the visitor center (74%), and scenic driving or photography (56%). The next most common activities include wildlife viewing (32%), dune sliding (31%), hiking (29%), picnicking (29%), and attending ranger programs (22%).

Opportunities for scenic driving are available primarily on the main park road and turnouts, plus the Medano Pass primitive road. The latter requires a four-wheel drive, high clearance vehicle due to deep sand sections (lower elevations), stream crossings, and rocky sections (upper elevations). The Medano Pass primitive road, which leaves the national preserve at the crest of the mountain range and continues on into the western portion of the San Isabel National Forest, is closed when wet, icy, or snow conditions result in resource, public safety, or maintenance concerns. Public vehicle use is not permitted on roads in park expansion lands (e.g., former Baca Ranch) until the GMP details such use.

Although most visitors do not participate in backcountry camping, back-packing, mountaineering, or horseback riding, some visitors come to the Great Sand Dunes specifically for these activities. These types of activities are popular within both the national preserve and the national park. Opportunities range from easy nature walks to strenuous multiday backpack trips. (See the "National Park Service Operations—Facilities" section of this chapter for a list of designated trails.) Horses and pack animals (e.g., burros and llamas) are allowed in most areas of the park, but there is an exclusion zone around the main dune use / visitor center area.

Camping is available at the Pinyon Flats campground and at designated sites along Medano Pass primitive road. Camping along Sand Ramp Trail is allowed only at designated backcountry campsites. Visitors can also camp in other undesignated areas in wilderness or nonwilderness portions of the park (permit required and certain conditions apply). However, there is a no-camping zone on the eastern edge of the dunefield. Camping opportunities are also available just outside the park at the Oasis, in San Luis Lakes State Park, and campgrounds in Crestone on the north side of the park and the North Crestone Creek Campground (a USFS campground located just north of Crestone).

Bicycling is restricted to the same park roads where public vehicles are allowed. Bicycles are not permitted on hiking trails or within designated wilderness areas.

The main picnic area is located adjacent to the dunes parking lot, but picnic tables are also available at several turnouts along Medano Pass primitive road.

Hunting and fishing are also popular. Hunting is allowed in the national preserve (Great Sand Dunes Act of 2000), but not in the national park. Fishing is allowed throughout the park. Both activities are conducted in accordance with applicable state and federal laws.

As of 2005, commercially guided visitor activities included guided hiking and horseback rides, photographic workshops, overnight trips with packstock, four-wheel drive tours in open air jeeps (designated route), and guided hunting (preserve only).

Dogs are allowed in all areas of the park, provided they are on a leash. This is atypical in the national park system—most national parks allow dogs only in parking lots and campgrounds. Dogs that are being used for hunting are allowed off-leash within the national preserve (see the "Health and Safety—Dogs" section for details).

Interpretation, Information, and Education

Basic information about the park, including details about visitor opportunities, facilities, programs, and safety, is available from the park's Web site, visitor center information desk, and from the interpretive newspaper. The newspaper and the park map and guide are handed out at the fee booth or visitor center. About 500 copies of the newspaper are mailed out annually in response to inquires for trip planning information.

Outdoor and indoor exhibits at the visitor center and various roadside interpretive signs provide orientation information and/or interpret natural resources/systems and cultural resources in keeping with the park's interpretive themes. The visitor center also offers visitors a central meeting place and point of orientation.

The visitor center includes an auditorium that is used for several different purposes throughout the year. During the spring and fall school trip seasons, it is used with school groups, and a series of movable, hands-on exhibits designed for that room help teachers and students connect the park with their curriculum. In summer, the park's interpretive movie is regularly shown in the auditorium.

The visitor center also provides a small space for changing exhibits, allowing for seasonal art exhibits, childrens' exhibits, or temporary displays. The Western National Parks Association maintains a year-round bookstore in the visitor center, and entrance fees are collected at the building October through April.

Scheduled interpretive programs are offered at the park most days from late May through September, and are designed to help visitors make emotional and/or intellectual connections with park resources. Interpretive programs are also offered October to April on a limited basis, or by request for groups. Programs include short talks at the visitor center, guided interpretive walks or hikes on the dunes or in the foothills, and evening ranger talks and other programs in the campground amphitheater. Sample topics include geology, hydrology, and geography, ecology and ecological systems, natural processes (wind, water, etc.), human connections with the dunes over time, the high country of the national preserve, and programs tailored for children.

Curriculum-based education programs for kindergarten through college students are available throughout the year. Hands-on discovery activities in the dunes, foothills, or wetlands are available seasonally, and in

the local classrooms in winter months. Park staff work with instructors to ensure that presentations are tailored to meet the needs of the class, as well as the park's interpretive themes. Programs are designed to increase student understanding of how their lives are connected with the natural world. The programs provide an outlet for creativity, exploration, and student-driven inquiry. Park staff are generally available for classroom programs in San Luis Valley schools from September through early April.

An online curriculum resource for primary and secondary teachers and students is also available. It includes lesson plans for elementary teachers, research-based online activities for middle schoolers, and special activities for high school students.

Free interpretive publications are available at the visitor center and from park staff; these provide orientation information and more in-depth interpretation on selected topics relative to park resources. Introductory printed information is available in German, French, Spanish, and Japanese for international travelers.

Workshops at The Nature Conservancy's Medano-Zapata Ranch are available spring through fall on a variety of topics. Bison and ranch tours are also available on selected dates.

Visitor Perceptions, Opinions, and Motivations

Respondents to the 2002 Visitor Survey were asked what they liked most about their visit to the Great Sand Dunes. The top 10 most frequently mentioned features or characteristics, in descending order, were: (1) the natural beauty of the area; (2) the dunes themselves; (3) climbing the dunes; (4) hiking; (5) uniqueness of the dunes; (6) quiet, solitude, peaceful environment; (7) walking; (8) camping; (9) playing in the sand; and (10) the helpful and friendly staff. When visitors were asked what they liked *least* about their visit, the top five were: (1) hot weather/heat; (2) smoke/haze from forest fires; (3) drought—no water in the creek; (4) not enough time to enjoy it all; and (5) long, tiring walk to dunes; all are factors that are essentially outside the control of NPS managers.

According to the 1997 Visitor Survey (conducted prior to park expansion), the most common reasons for visiting the park were photography, education, recreating on the dunes, finding solitude or quiet, watching wildlife, and hiking on developed trails.

Visitors in 2002 were also asked how particular aspects (noise, horses, dogs, night time light pollution, lack of solitude, and "other") affected their park experience. Among those elements, dogs (4%) were mentioned most often as contributing positively to visitors' experience. Lack of solitude (15%), dogs (7%), and noise (6%) were the specific aspects mentioned most as detracting from visitors' experiences.

Dogs. As the statistics above indicate, there are wide-ranging visitor perspectives regarding allowing dogs in the park. Some people appreciate (or at least don't mind) dogs being allowed in all areas of the park. There are valid concerns about the safety of dogs left in or tied to vehicles, and many dog owners simply like to take their dogs along while hiking, etc. Other people would prefer that dogs not be allowed, or that they be restricted to certain areas such as parking lots and campgrounds. Concerns about dogs include aggressive dogs, dog waste, effects on wildlife, health of dogs on the hot sand, and noise. The park

occasionally receives letters on both sides of the dog issue.

Crowding. Visitors in 2002 (an unusually low visitation year) were asked how crowded they felt during their visit to the park. In 2002, 56% indicated they did not feel at all crowded, and 35% said they felt somewhat crowded. A total of 9% of respondents said they felt crowded, very crowded, or extremely crowded. When these visitors were asked where they felt crowded, the commonly mentioned locations were the campground (mentioned 17 times), visitor center (since enlarged and remodeled—mentioned 9 times), four-wheel drive roads (4 times), dunes (3 times), and parking area (3 times). When visitors were asked what they liked least about their visit, 12 respondents (3%) said the park was too crowded or had poor visitation control—the seventh-most frequently mentioned item (of 26 items). Perceptions of crowding may be higher during years with higher visitation.

Wilderness Values, Including Solitude

As of 2005, the park contained 75,641 acres of designated wilderness. Of this, 35,955 acres were added when the park was enlarged in 2000 (Sangre de Cristo wilderness portion). According to NPS *Management Policies 2001*, recreational uses in NPS wilderness areas should be of a nature that "enables the areas to retain their primeval character and influence; protect and preserve natural conditions; leave the imprint of man's work substantially unnoticeable; provide outstanding opportunities for solitude or primitive and unconfined types of recreation; and preserve wilderness in an unimpaired condition." This means that mechanized and motorized activities are typically not allowed (see appendix G for more information). Most of the designated wilderness areas in the Great Sand Dunes provide outstanding opportunities for solitude and primitive recreation. The dark night sky and natural quiet are wilderness qualities that are highly valued by visitors to the Great Sand Dunes.

The opportunities and experiences provided by the Great Sand Dunes Wilderness and the Sangre de Cristo Wilderness are rather different due to their natural landscapes. The Great Sand Dunes Wilderness, which includes the dunefield and is located in the national park, is mostly sandy, open country. It's easy to see people, wildlife, and scenic vistas over long distances, provided the terrain allows. The portion of the Great Sand Dunes Wilderness between the dunes parking lot and the tall dune, including Lower Medano Creek, is extremely popular for free play. While opportunities for solitude here are intermittent, visitors enjoy great freedom in pursuing "primitive and unconfined recreation" as they play on the dunes. People seeking solitude during busy periods can come early or late in the day, or hike over nearby dune ridges to find it. The Sangre de Cristo Wilderness, located in the national preserve, is mostly rugged, forested, and mountainous. Below timberline, rugged topography and dense vegetation make it easier to perceive solitude—it's harder to tell when other visitors are nearby.

Park visitors in 2002 were asked to rate the importance of solitude to their visits in the designated wilderness area. Thirty percent indicated that they did not visit designated wilderness areas. Of those who did, 70% rated solitude as "very important" or "important." Eighteen percent said it was "somewhat important," and 12% said it was not important or had no opinion (2002 Visitor Survey). Of those who said recreating in the park was an important reason for their visit in 1997, more than half

were seeking little or no contact with other people (1997 Visitor Survey).

Visitor Use

Parkwide Visitation

The National Park Service defines a "visit" as the entry of any person for recreational purposes onto lands or waters administered by the National Park Service. Total annual visitation to Great Sand Dunes National Park since 1932 (the beginning of historical visitation records) steadily increased through the 1970s. Significant declines in visitation occurred in the early 1980s. Visitation rebounded in the late 1980s through the 1990s, then declined significantly again in 2002, before rebounding again in 2003 and 2004 (figure 9)

Several factors are thought to have contributed to the declines in visitation from 1997 through 2002. First, the park converted from pneumatic rubber-hose (above road) vehicle counters to more reliable electrical "loop" counters (wires embedded in the road) in 1998. Park staff estimate the rubber-hose counters inflated visitation statistics by as much as 9%. In 2000, a wildfire closed the park for a time, affecting visitation. There was also a general decline in travel and tourism since 2001 and 2002 associated with drought, regional wildfires, and lagging investments in statewide tourism campaigns.

Total visits to Great Sand Dunes in recent years include the all-time peak visitation of 312,795 in 1994, after which it declined to a low of 235,305 visits in 2002. Average visitation for the 13-year period between 1992 and 2005 is 285,540 visits (figure 10).

Visitation at Great Sand Dunes follows a seasonal pattern typical of many national parks. Visitor use peaks during the summer (July), with relatively low visitation during the winter, and moderate spring and fall use.

Medano Creek, which runs seasonally at the base of the dunes, may correlate to fluctuations in visitation. In average to wet years, Medano Creek begins as a trickle in early April, increases to a wide, shallow stream at its peak in May, and diminishes throughout the summer. By August, the creek is typically a trickle near the dunes parking area.

Despite fluctuation in total annual visitation, the patterns of visitation during the year are roughly the same. During years with low visitation, the biggest drop is evident during the summer months. Figures 11 and 12 portray cumulative visitation over the year for selected years and the 13-year average.

Visitation is relatively stable during the first and last four months of the year. However, visitation from May through August has substantial year-to-year variation (figure 12). Visitation in July is particularly volatile, with monthly visitation in 1995 nearly double that recorded in 2002, the latter a year in which drought conditions and extensive wildfires in Colorado adversely affected travel and tourism across much of the state.

If history is any indicator of future public visitation patterns to Great Sand Dunes, future management should take into account the typical visitation pattern of peak summer and low winter visitation, with moderate visitation in spring and fall. National crises such as terrorist threats and attacks, economic factors such as gasoline prices, and natural phenomena (including climatic variability, drought, and wildfire) will continue to affect future visitation.

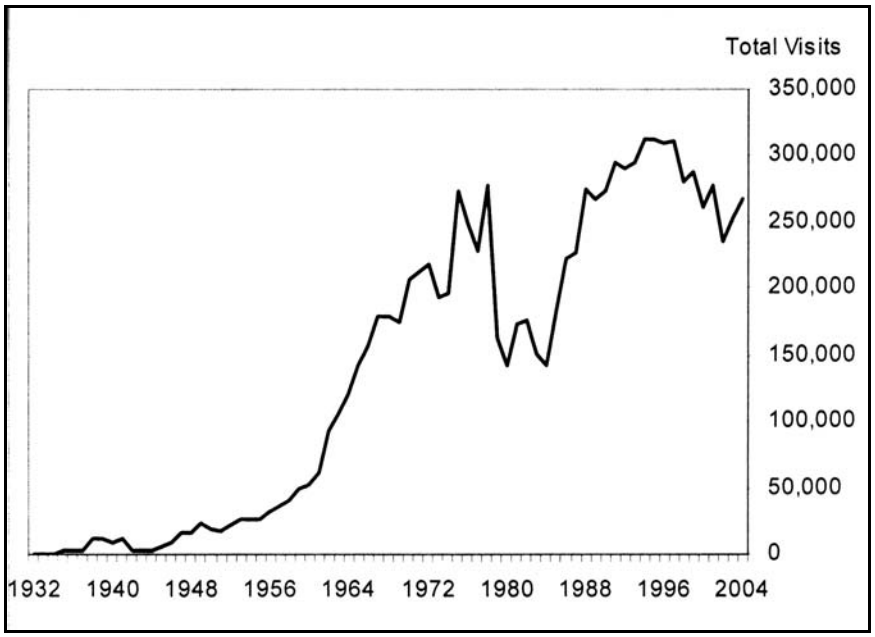


FIGURE 9. TOTAL ANNUAL VISITS TO THE GREAT SAND DUNES, 1932 TO 2004

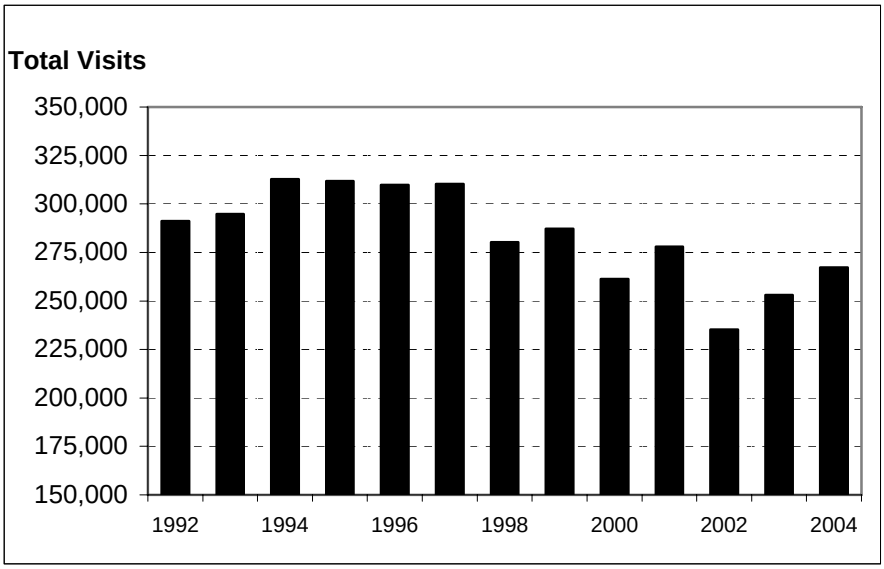


FIGURE 10. TOTAL ANNUAL VISITS TO GREAT SAND DUNES, 1992 TO 2004

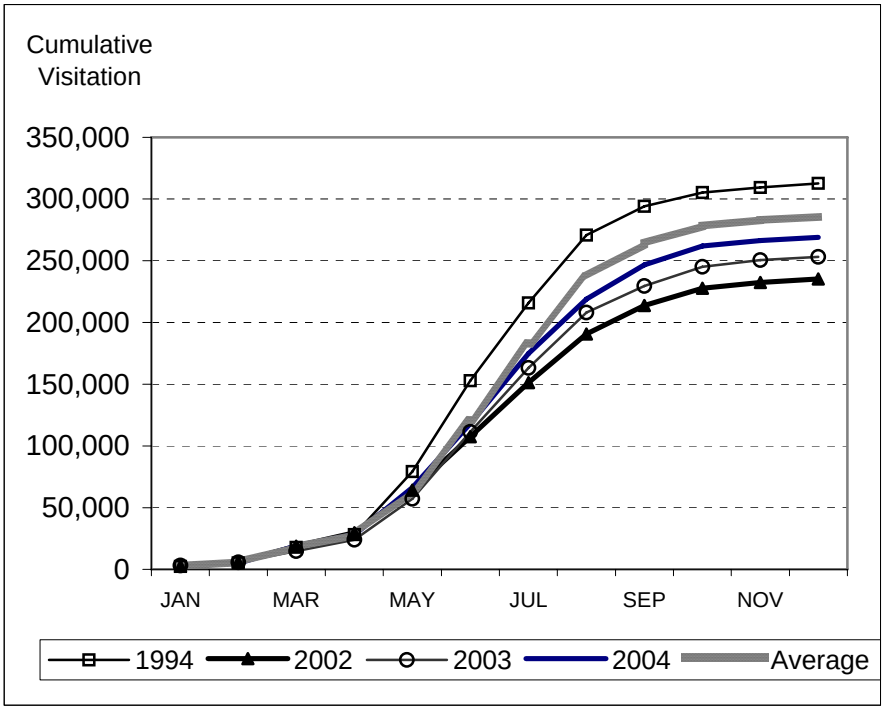


FIGURE 11. CUMULATIVE VISITATION AT GREAT SAND DUNES, SELECTED YEARS AND AVERAGE 1992 TO 2004

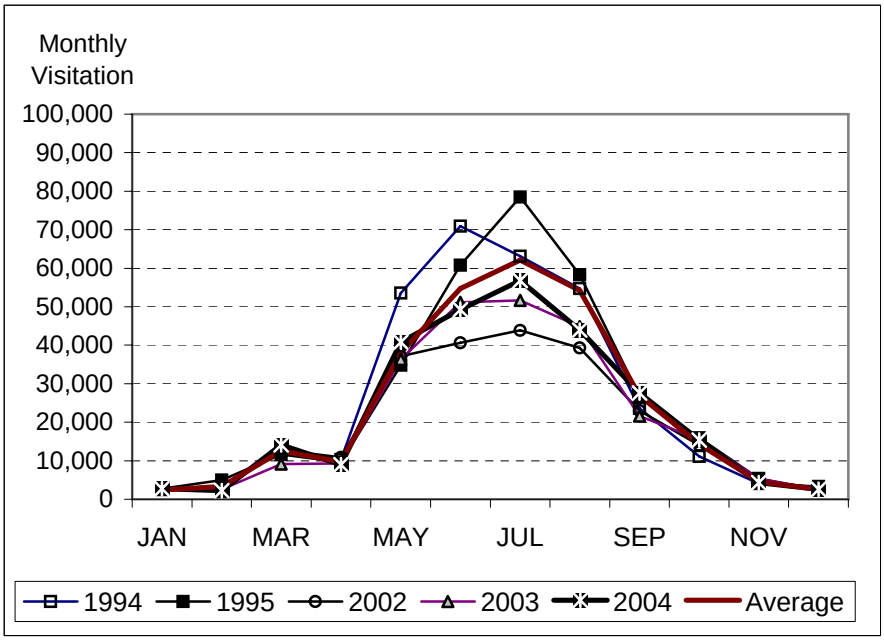


FIGURE 12. MONTHLY VISITATION AT GREAT SAND DUNES, SELECTED YEARS

Expansion of the park's boundaries and change in administrative management of the preserve resulted in an increase in recreation use. In part, the increase was a simple accounting change as use previously attributable to the national forest now occurs at the Great Sand Dunes. Another source of increase was use that either did not occur previously because the lands involved were privately owned, occurred elsewhere on private or public lands, or represents new use prompted by the establishment of the park.

Accurate tallies of the increase in use are hampered by the large geographic area affected, dispersed nature of use, and remoteness of many points of entry into the park from central administrative facilities. Estimates of such use were consequently developed by park staff, based on information obtained from the USFS, from observed backcountry use, and use at informal parking areas, and from professional judgment. These estimates suggest an increase of about 22,600 annual visitors over and above the counts recorded by the park's existing counters (table 6). The adjusted total of 291,000 visitors in 2004 provides a basis for comparing future visitation for the GMP alternatives. Annual visitation to the Great Sand Dunes is anticipated to increase over time under the no-action and all action alternatives.

TABLE 6. ESTIMATED CURRENT ANNUAL USE

2004 (recorded)	2004 (adjusted baseline)
268,400	291,000

Use of Different Park Areas

The dunefield, Medano Creek, and the developed area east of the dunes (visitor center, campground, dunes parking lot, picnic area) receive the vast majority of visitor use at the Great Sand Dunes. Of park sites accessed by hiking or horseback in 2002, the most frequently visited were the high dunes (67% of visitors surveyed), visitor center loop trail (29%), Medano Creek bed (23%), and the campground trail to the dunes (18%). Of sites accessed by automobile, the most frequently visited were the dunes parking lot (91% of visitors), visitor center (84%), and dunes picnic area (28%). Of visitors surveyed, 12% accessed Medano Pass primitive road (2002 Visitor Survey). It is important to note that this information was gathered before the former Baca Ranch lands were opened to public use in December 2004.

Unless the weather is poor or Medano Creek is not flowing, the dunes parking lot typically fills to capacity at least once daily each weekend day from Memorial Day weekend (late May) through the July 4th holiday weekend. The lot also typically fills over the Labor Day weekend in September. Thus, the lot typically fills for at least some part of the weekend six to eight weekends during the summer months. It's not unusual for the lots to remain filled for 4 to 6 hours during the middle of the day on the busiest weekends. According to park records, the dunes lot fills on days when about 500 cars enter the park.

Pinyon Flats campground typically reaches capacity on Thursday, Friday, and Saturday nights from mid-May though mid-August, plus a few days around the summer holidays. At least two parking lot turnouts located on Medano Pass primitive road (Point of No Return and Castle Creek) fill up on the holiday weekends and usually on the first two weekends in June. Castle Creek may fill more often. The primitive campsites along Medano Pass primitive road typically fill during the Memorial Day weekend. Depending on the year, they may also fill on early June weekends and during

the July 4th holiday. Medano Pass primitive road experiences enough vehicle use on busy summer weekends (especially holiday weekends) that park rangers or volunteers alternate traffic traveling in opposite directions. This reduces the need for vehicles to pass one another and helps protect roadside resources.

Length of Stay

Seventy-seven percent of 2002 visitors spent less than 24 hours at the park. Of these, 40% spent less than 2 hours, 37% spent between 2 and 4 hours, and 22% spent more than 4 hours. Of the 23% who spent 1 day or more in the park, 35% spent 1 day, 38% spent 2 days, and 27% spent 3 days or more. Most overnight visitors (86%) stayed in the Pinyon Flats campground, 7% stayed in a backcountry campsite, and another 7% said they used "other" lodging. There are no motel-type accommodations within the park, but the Oasis, a private enterprise located just outside the park on the main entrance road, includes a motel, among other amenities.

Visitor Origin and Other Details

The following statistics come from the 2002 Visitor Survey. They were gathered over one week in June 2002, and may not be typical of year-round visitation. American visitors were mostly from Colorado (38%), Texas (13%), or California (5%). Of Colorado visitors, nearly 80% came from the more urbanized and densely-populated Front Range counties that include Denver, Fort Collins, Colorado Springs, and Pueblo. Residents of the San Luis Valley accounted for about 8% of the Colorado visitors, though the share is likely higher on an annual basis. International visitors (most from Germany, Holland, or England) represented only 4% of total visitation. English was the primary language of 97% of respondents. Additional details can be found in the 2002 Visitor Survey.

SCENIC RESOURCES AND VISUAL QUALITY

Great Sand Dunes National Monument was established for "the preservation of the great sand dunes and additional features of scenic, scientific, and educational interest." The park's scenery is one reason the park is popular. The park's fundamental resources and values (see chapter 1) include viewing the dune mass with the backdrop of the high peaks and viewing wildlife in its natural setting. For viewing the dune mass with the backdrop of the high peaks, key elements include: views approaching from the west and south, views from the mountains, changing light conditions, shadows and contrasts on the dunes in early morning and evening, good air quality, and undeveloped mountain slopes.

The scenic resources of the Great Sand Dunes have a high degree of cultural significance. Many of the views into and from the park are iconic and are reflected in the works of artists. The park is a favorite subject for professional and amateur artists, photographers, and writers whose work communicates the striking scenery of the park to visitors and others.

Scenic vistas from many vantage points in and around the park are distinctive and memorable. The spectacular wind swept dunes, the high snowcapped peaks of the Sangre de Cristo range, clean air, changing skies and shadows, the rural agricultural valley, and panoramic views combine to offer a wealth of visual resources. As people move through the park's various life zones, whether on foot, horseback, or by passenger vehicle, they experience a

sequence or pattern of visual resources that provide a cumulative visual experience. This cumulative experience involves the interaction of multiple elements in relation to each other: the juxtaposition of individual features in the foreground and background, the interface of different surfaces, and the interplay of light reflecting off different colors and textures. Protecting this suite of visual resources is as important as protecting any one element.

Scenery is one of the main reasons visitors come to the park. The 2002 Visitor Survey found that 56% of visitors participated in scenic driving or photography. This was the third-highest rated activity, after climbing the dunes and visiting the visitor center. Today, although buildings and structures intrude on some scenic vistas, the surroundings are mostly natural. Human-made features do not dominate, even in the landscapes where they are visible. To date, scenic resources have not been formally studied or analyzed in the park or preserve.

The preserve stretches from the eastern boundary of the old national monument to the crest of the Sangre de Cristos, from just west of Carbonate Mountain on the south side to Milwaukee Peak on the north, then south through Music Mountain, Tijeras Peak, and Cleveland Peak. The preserve is part of the Sangre de Cristo Wilderness, and offers opportunities for backcountry hiking and camping. Views within the preserve include those of the high mountain peaks, tundra, small mountain lakes, clear blue skies, and clear, starry night skies. There are very few human-made features (e.g., Medano Pass primitive road, hiking trails, and signs) to intrude upon views, and these do not dominate the natural landscape from any perspective. The preserve also offers expansive panoramic views and glimpses of the Sangre de Cristo range, 14,000-foot-plus peaks, the eastern plains, the San Luis Valley, and the dunes, as visitors move through the landscape.

For many visitors, the ever-changing play of light and shadow on the near-barren, massive dunefield, backed by alpine peaks, provokes strong emotional responses. The dunefield can be viewed from almost anywhere in the park, including the main road and turnouts, the visitor center and loop trail, the dunes parking lot and campground, the valley floor, and from the mountains in the preserve. From the dunes, visitors see a seemingly endless dunefield from some vantage points, and the mountains and rural valley from others. The dunefield is designated wilderness and contains virtually no human-made features. Human-made structures (visitor center, roads, parking lots, campground, amphitheater, and administrative facilities) are not prominent, but they are visible on the eastern edge of the dunes, and can be a visual distraction, though for some they may provide a sense of reassurance.

The new park lands to the west of the dunes contain the grass- and shrub-covered sand sheet, salt-crusted sabkha and creeks, riparian corridors, and wetlands. These lands include features associated with ranching, including fences, two-track roads, cabins, corrals, houses, and outbuildings. Views within the new park lands include grasslands and shrublands with tree stands along some creeks, and distant views of the dunes and mountains, plus typically clear sky during day and night. Views beyond the park boundary to the west, north, and south include the rural agricultural landscape and low-density residential development. Due to the wide-open spaces, these elements do not dominate the landscape, but are merely an element in the mix.

Visual Quality and Night Sky

Great Sand Dunes National Park and Preserve is a class I air quality area. Class I areas deserve the highest level of air quality protection. The Clean Air Act of 1970, as amended, requires federal officials responsible for managing class I areas to protect the air quality-related values of these areas, including visibility, and to consult with permitting authorities regarding possible adverse impacts from new or modified emitting facilities. The Wilderness Act of 1964 also provides direction for management of air quality; it gives the National Park Service responsibility to manage designated wilderness to preserve and protect its unspoiled character, which can be affected by human-caused air pollution.

Great Sand Dunes National Park and Preserve has consistently attained state and federal ambient air quality standards (Fire Management Plan Environmental Assessment 2005). However, visual quality is often affected by particulates in the air. On most days, visibility is 60 to 80 miles for 180 degrees (NPS Fire Management Environmental Assessment 2005). Air quality was monitored at the then national monument from 1988 to 1995, and a 1997 report summarizing this monitoring program concluded that visibility is best in winter and worst in spring (Binkley 1997). Sulfates, soot, and coarse particulate material contribute most to decreased visibility. Smoke from natural and prescribed fires, woodburning stoves, and campfires is one problem. Effects of agricultural operations (burning stubble, harrowing, planting, etc.) are another. Windy weather increases airborne particulates and decreases visibility, especially in the windier spring months. In 2005, 16 industrial facilities, including refineries, cement plants, a steel mill, a pharmaceutical manufacturer, and 10 power plants were tentatively identified by the Colorado State Department of Public Health and Environment as sources of haze clouding the region's national parks, including the Great Sand Dunes. Automobiles, wildfires, and dust from feedlots also contribute to the mix of haze-forming pollutants in the region (Denver Post 2005).

Another component of visual quality is ambient light and its effect on the night sky. In accordance with NPS *Management Policies 2001*, the National Park Service strives to preserve natural ambient lightscapes, which are natural resources and values that exist in the absence of human-caused light. Commercial, residential, and agricultural development in the San Luis Valley can introduce light into otherwise naturally dark areas. Within the park, the administrative areas, campgrounds, Medano Ranch, and the visitor center are sources of artificial light. These areas are directly visible from vantage and viewing points within the park and preserve. The National Park Service minimizes extraneous light sources and protects the dark night sky by using shielded lighting, downward directed lighting, and strategically located light sources. The Baca Grande community, located to the north of the national park, has guidelines designed to minimize extraneous light. These include use of motion-activated lights, and shielded or hooded exterior lighting that is limited to entry walks, porches, and exterior patios (Baca Grande 2002). Due to such efforts and the largely rural and undeveloped landscape surrounding the park, there are outstanding opportunities to see the stars, moon, and planets on clear nights. Attempts to measure night darkness at the park have been unsuccessful thus far .

SOCIOECONOMICS

The influence area for economic and social considerations associated with the Great Sand Dune GMP encompasses Alamosa and Saguache counties in south-central Colorado. The region is predominately rural. The largest community in the region, the city of Alamosa, is located about 25 miles southwest of the park, with several smaller communities in the surrounding area.

Population

Alamosa and Saguache counties experienced modest population growth during the 1980s and 1990s. After 1990, population growth slowed in Alamosa County. Population growth in Saguache County was substantially higher, with a net increase of 2,410 residents, or 52% compared to 1990 (table 7). The latter growth was concentrated around the community of Center, about 25 miles west of the park, and in the Baca Grande subdivision. Statewide population growth was 40% during the same period, exceeding 4.6 million in 2004.

In Alamosa County, the city of Alamosa population was estimated at 8,545 in 2004. Another 126 residents resided in Hooper, and the remaining 6,417 residents (42%) lived in unincorporated Alamosa County. The majority of Saguache County residents (3,676 est.) lived in unincorporated areas, including the Baca Grande subdivision. Center and Saguache are the county's two largest communities, with 2,500 and 620 residents, respectively, in 2004. Other communities in the region include Bonanza City, Crestone, and Moffat (U.S. Census Bureau 2005(b)).

Population trends in the two counties are driven by different influences. In Alamosa County, new births are offset in large part by out-migration. Growth in Saguache County has occurred primarily from lifestyle migration into the Baca Grande and Crestone communities, and the settlement in Center of agricultural households employed across the San Luis Valley.

Economic Overview

Total full- and part-time employment in Alamosa County was 10,521 in 2003, compared to 7,191 in 1990; a gain of 3,330 jobs or 46%. Employment in Saguache increased to 2,750 jobs in 2003 from 2,131 jobs in 1990; a gain of 619 jobs or 29%. Employment data for 2003 highlight structural differences in the economies of the two counties (table 8).

The federal government has a substantial presence and plays an important role in the regional economy. Federal agencies, including the National Park Service, USFWS, USFS, U.S. Postal Service, NRCS (agriculture), and others reported a total of 237 civilian employees in the two counties in 2004, about 1.8% of all jobs. The economic significance of the number of jobs is amplified by their above-average earnings and associated operating, maintenance, and capital expenditures in the local economies.

TABLE 7. POPULATION GROWTH TRENDS, 1990 TO 2004

	1990	2000	2004	Change 1990–2004	% Change 1990–2004
Alamosa	13,617	17,966	15,088	1,471	11%
Saguache	4,619	5,917	7,029	2,410	52%
Colorado	3,294,473	4,301,261	4,601,403	1,306,930	40%

Source: U.S. Census Bureau, 2002 and 2005(a)

TABLE 8. EMPLOYMENT BY MAJOR CATEGORY, 2003 (PERCENT OF TOTAL)

County	Farming	Industrial *	Trade & Services **	Government ***
Alamosa	8%	15%	56%	21%
Saguache (est.)	20%	26%	31%	23%
* Industrial includes forestry, mining, utilities, construction, manufacturing, transportation and warehousing, management of companies, and administration and waste services.				
** Trade and services includes wholesale and retail trade, information services, finance and insurance, real estate, professional and technical services, education and health care, arts and recreation, accommodation and food services, and other services.				
*** Includes federal, state, and local government				

Source: U.S. Bureau of Economic Analysis, 2005

Agriculture plays a major role in the Saguache County economy, both in terms of direct farm employment, and indirectly through support for agricultural services, transportation, trade, and related private and government services. Agriculture is also important in Alamosa County; however, trade and services are more dominant, reflecting the city of Alamosa's role as a regional trade and service center.

In 2002, 570 individual farms and ranches, encompassing more than 681,000 acres, were operating in the two counties (table 9). Of those, 318 were in Alamosa County, collectively covering nearly 44% of the county's total land area. Agricultural operations in Saguache County involved about 24% of the county's total acreage. In 2002, sales of local crops and livestock generated more than $176 million in the two-county region. Potatoes, barley and wheat grains, and forage for livestock feed were the predominant crops in terms of the acres harvested.

Among the local ranch operations is the 103,000-acre Medano-Zapata Ranch owned by The Nature Conservancy. Comprised of two historic ranches, the Medano-Zapata now operates as a working cattle and bison ranch, environmental education center, and landscape-scale conservation area. Eleven full- or part-time positions are associated with Medano-Zapata. Annual economic contributions of the Medano-Zapata Ranch include approximately $500,000 in sales of livestock and hay, which support ranch operations, a comparably sized operating

TABLE 9. OVERVIEW OF AGRICULTURAL OPERATIONS IN THE REGION, 2002

County	Number of Farms	Total Farm Employment	Acres in Farms	Average Size (Acres)	Market Value of Sales (Millions)
Alamosa	318	752	204,640	644	$ 94.5
Saguache	252	542	477,003	1,893	$ 81.9

Sources: USDA, 2004 and Bureau of Economic Analysis 2005

budget for The Nature Conservancy's environmental education and conservation programs, and expenditures in the local community by guests and visitors to the Medano-Zapata Ranch (Robertson 2005).

Recreation and tourism also have a substantial role in the regional economy. In addition to the park, other recreation and tourism attractions in the San Luis Valley include:

- portions of the Rio Grande National Forest
- the Cumbres and Toltec Scenic Railway (a steam-powered excursion railroad)
- Monte Vista, Alamosa, and Baca national wildlife refuges
- San Luis Lakes State Park and multiple-state wildlife management areas
- Los Caminos Antiguos Scenic Byway
- Fort Garland Historic Fort and Museum
- multiple spiritual, new age, and retreat centers in Crestone and the Baca Grande subdivision
- Shrine of the Stations of the Cross in San Luis
- numerous local museums and historical sites
- annual sandhill crane migration and festival

In addition, U.S. highways 160, 17, and 285 carry many tourists through the region to Mesa Verde National Park, Santa Fe, Taos, and a myriad of other cultural, recreational, and historical destinations. Visitors and travelers support numerous jobs in the region's retail trade, accommodations and dining, and entertainment and other affiliated industries.

Commercial Services Provided for Great Sand Dunes National Park and Preserve

As of 2005, one concessioner operated within the park to provide firewood and incidental camper supplies such as sunscreen, insect spray, ice, and vended soft drinks. Ten incidental business permit holders provided services for horseback riding and pack trips, guided hunting, guided hiking, photography workshops, and four-wheel drive tours (NPS records 2005).

Income, Poverty, and Unemployment

Total personal income in Alamosa County was $350.1 million in 2003, nearly three times the $120.4 million in Saguache County.[2] More than 11% of all earnings paid to workers in Alamosa County was to workers commuting from outside the county. Saguache County benefited from a net inflow of $16.8 million. Net earnings flows from Alamosa County and into Saguache County have increased in recent years. Despite recent gains, per capita income in the area lags behind other areas in Colorado (table 10). Per capita incomes of $23,216 in Alamosa (2003) and $18,063 in Saguache, ranked 50th and 62nd in the state, respectively.

Over time, local unemployment rates have been persistently above the statewide averages (table 11). The seasonality of many jobs in agriculture, tourism, and trade, and service firms catering to students at Adams State College contribute to that pattern, as well as to the lower than average per capita incomes.

Demographic Characteristics

Alamosa County's population tends to be younger than that of either Saguache County or the state of Colorado. Alamosa County has a higher share of residents between 15 and 34 (table 12). Saguache County, in contrast, has a higher share of residents 55 years and older, many of whom are retired or semi-retired.

Both counties have relatively large minority populations. More than one of four residents in Alamosa and Saguache counties are nonwhite, compared to about one of six statewide. Hispanics and Latinos comprised over 40% of the local population in 2000, and American Indians accounted for 3.7%. Apache, Navajo, Ute, and Latin American were the most commonly reported tribal affiliations. No established American Indian reservations are located in Alamosa or Saguache counties.

Over 72% of all residents in Alamosa County in 2000 had lived in the county in 1995, 28% having moved from elsewhere, primarily elsewhere in Colorado. More than 31% of Saguache County residents had moved there since 1995.

Housing

At the time of the 2000 census, Alamosa and Saguache counties recorded vacancy rates above the statewide average of 8.3%. In Alamosa County, overall vacancy rates were 10.2%, with 621 units vacant. More than 25% of all units were reported vacant in Saguache County (table 13). However, while more than half of the vacant units in Alamosa County were for rent or sale, 46% of the vacant units (361 units) in Saguache County were reported as being for seasonal, recreational, or occasional use. The latter includes about 75 units located in Crestone, the Baca Grande subdivision, and nearby areas.

[2] Personal income includes work-related earnings, social security and other income maintenance payments, unemployment benefits, retirement, and income derived from investments. Total personal income is an indicator of the relative size of an economy, while changes in income over time may reflect changes in economic welfare, but also changes in the levels of economic activity, population, and inflation. Per capita, median, and other income measures provides a basis for comparing economic welfare between areas.

TABLE 10. PER CAPITA PERSONAL INCOME, 2000 TO 2003

	2000	2001	2002	2003	% Change 2000–2003	Statewide Rank (of 64)
Alamosa County	$ 20,568	$ 21,588	$ 22,984	$ 23,216	13%	50
Saguache County	$ 15,260	$ 17,081	$ 18,337	$ 18,063	18%	62
Colorado	$ 33,370	$ 34,491	$ 34,228	$ 34,561	4%	NA

Source: U.S. Bureau of Economic Analysis, 2005

TABLE 11. UNEMPLOYMENT RATES, 2000 TO 2005

	Annual Average					2005 (June)
	2000	2001	2002	2003	2004	
Alamosa County	3.5%	5.8%	6.3%	6.7%	6.2%	5.9%
Saguache County	5.3%	8.6%	7.4%	5.6%	7.0%	7.6%
Colorado	2.6%	3.9%	5.9%	6.0%	5.5%	5.2%

Sources: Colorado Department of Labor and Employment, 2005 and U.S. Bureau of Labor Statistics, 2005

TABLE 12. SELECTED DEMOGRAPHIC CHARACTERISTICS, 2000

	Median Age (Years)	Persons 15 to 34 years	Persons 55 years and older	Race: White	Hispanic or Latino
Alamosa County	30.6	32.7%	17.1%	74.6%	41.4%
Saguache County	36.9	23.8%	21.1%	74.1%	45.3%
Colorado	34.3	19.6%	17.6%	85.2%	17.1%

TABLE 13. SELECTED HOUSING CHARACTERISTICS

	Census 2000				New Units Built, 2000 to 2004
	Total Units	Percent Occupied	Total Vacant Units	Units for Seasonal, Recreational or Occasional Use	
Alamosa County	6,088	89.8%	621	75	+ 270
Saguache County	3,087	74.5%	787	361	+ 454

Source: U.S. Census Bureau 2002 and 2005c

Recent population growth and migration are reflected in recent levels of new residential construction. An estimated 270 new housing units (a 4% increase over the total housing stock in 2000) have been built in Alamosa County. During the same period, 454 new homes were reported in Saguache County (nearly a 15% increase in 5 years). Many of these units are located in the Baca Grande subdivision, with the pace of new development reportedly spurred by the designation of Great Sand Dunes National Park and Preserve.

As of 2005, housing at the park included 13 dwelling units used on a full-time or seasonal basis, including seven individual units, three of which are shared housing for seasonal employees, one duplex (two units), a triplex apartment building, and one trailer. In addition, two trailer pads are available for seasonal use by employees with their own recreational vehicle (RV) or trailer. An older trailer that does not comply with NPS standards for occupancy is also on the park inventory, but plans are in place to remove it.

Traffic and Emergency Services

The primary highway access to the main entry to the park is via SH 150 from the south and Alamosa County Road 6N from the west. The former connects to SH 160, the major east-west highway across southern Colorado, and the latter connects to SH 17, a key north-south regional highway in the San Luis Valley. Several USFS gravel and dirt roads provide motorized access to the eastern boundary of the preserve.

North of the park, Saguache County Road T is a paved road that extends east from SH 17 and terminates at two destinations—Crestone and the Baca Grande subdivision. Thus, traffic on County Road T is related primarily to these destinations. The Crestone destination includes the town of Crestone (population 73 in 2000) and three USFS trailheads with a total of 30 to 35 vehicle spaces and a 13-site campground associated with one of the trailheads. The Baca Grande destination includes a small Colorado College satellite facility, a restaurant, and several other small businesses, over 600 residences, more than a dozen spiritual retreat centers, and two informal points of pedestrian access to the national park from the terminus of public (Saguache County) roads. One of these county roads terminates within a few hundred yards of the national park boundary; the other terminates at the boundary, where public vehicle access ends. Both local and nonlocal visitors use these access points; some visitors park their vehicles at or near the terminus of the county roads, which can be inconvenient to those living nearby. Park visitors using horses are not allowed access at these points. Some people also park illegally within the Baca Grande subdivision to access adjacent USFS lands.

County Road T has experienced an estimated increase of 10 to 20 trips per day due to national park-related traffic. As discussed above, some of that traffic continues onto county roads within the Baca Grande subdivision. Traffic data are not available to accurately assess the relative magnitude of such traffic for County Road T and roads within the subdivision. However, traffic increases are expected on county roads in the near future due to residential growth in the Baca Grande subdivision (the number of residences could more than triple during the next 15 to 20 years) and an increase in spiritual retreat visits (from more retreat centers and more events per center). Therefore, the contribution of national park / preserve-related traffic is likely to remain small in comparison to traffic

generated by residents of the Crestone / Baca Grande community; their guests, construction contractors, and recreation visitors to the national forest; and guests and staff of the spiritual organizations, monasteries, and retreat centers in the community.

Traffic on the major state highways in the region, shown in table 14, is heaviest in and around the city of Alamosa, declining rapidly with distance from the city. For example, the annual average daily traffic (AADT) of 5,600 vehicles on SH 17 in Alamosa in 2004 had decreased to 2,800 AADT just north of County Road 6N and to 1,600 AADT north of Moffat. Similarly, traffic volume on SH 160, east of Alamosa, had declined by nearly 60% between the junctions with SH 17 and SH 150. Traffic volume on SH 150, which park staff believe carries more park-related traffic than does County Road 6N, was 670 AADT.

Average annual daily traffic associated with the park is estimated at 400 to 450 vehicles. That estimate is based on vehicle counts at the main entrance and allowances for staff, vendors, and other traffic that enter the park boundary, but turn around before the main entrance. That traffic volume represents about 6.5% of the combined traffic of SH 160 and SH 17 near their respective intersections with SH 150 and County Road 6N.

Another issue related to highway traffic is that of highway accidents and public safety, specifically demands on local law enforcement and emergency medical first responders. In Alamosa County, the county sheriff responds from its Alamosa headquarters to accidents and incidents on county roads, with a staff of seven patrol officers / first responders. The department reports that incidents are rare in the vicinity of the national park and preserve. Troop 5B of the Colorado State Patrol Troop, headquartered in Alamosa, handles incidents on state highways (150 and 17) and dispatches, as necessary, the Mosca-Hooper Fire Department to provide extrication assistance. Emergency medical service, including ambulance transport, is dispatched from the San Luis Valley Regional Medical Center.

TABLE 14. TRAFFIC CHARACTERISTICS NEAR THE GREAT SAND DUNES, 2004

Route/Location	Annual Average Daily Traffic (AADT)	Cars & other Light Duty Vehicles	Trucks
SH 17, north of junction with SH 160 in Alamosa	5,600	5,370	230
SH 17, south of County Road 2S	3,300	3,030	270
SH 17, north of County Road 6N	2,800	2,590	210
SH 17, north of Moffat and County Road U60	1,600	1,470	130
SH 150, north of SH 160	670	610	60
SH 160, at junction with SH 17 in Alamosa	9,900	8,990	910
SH 160, west of Alamosa at El Rancho Lane	4,100	3,460	640
SH 160, at junction with SH 150	4,100	3,470	630

Source: Colorado Department of Transportation 2005

The Mosca-Hooper Volunteer Fire Department (24 volunteers) provides primary structural fire protection for the park. The park is a signatory to the "Annual Fire Operating Plan" for the six-county area of the San Luis Valley. This plan provides for mutual aid, whereby the closest available forces respond as needed to wildland fires within the planning area. The Mosca-Hooper Volunteer Fire Department, Baca-Grande Volunteer Fire Department (a 27-member department supported financially by the Baca Grande Property Owner's Association), and Kundalini Fire Management (a 20-member department that also serves the Baca Grande subdivision and surrounding area) all respond to fires within the park boundary. Likewise, park staff provide initial attack assistance for wildland fires occurring outside the park boundary in neighboring jurisdictions.

Under agreements between the federal government and neighboring counties, national park rangers may respond to other emergency situations outside park boundaries. The need for such response, which would generally arise when an incident occurs near the park and when on-duty sheriff's deputies and state patrol officers are responding to other events, arises very infrequently.

In Saguache County, Troop 5B of the Colorado State Highway Patrol responds from its Alamosa headquarters to emergency calls on state highways and dispatches the Baca Grande Volunteer Fire Department and Baca/Crestone Ambulance Service (16 volunteers, 1 paid). The latter provides emergency medical service to an area of approximately 600 square miles. The county sheriff responds to other incidents (Pamela Gribb, pers. comm., 2005).

Land Use and Ownership

The predominant land uses in the study area include agriculture, forested areas, natural areas supporting wildlife, rural residential, residential, commercial, and industrial lands. The latter are concentrated in and near Alamosa, other communities in the area, and along the major highway corridors through the region.

Land use adjacent to the park is a combination of forested lands (Rio Grande National Forest), range and farmland (including lands associated with Medano Ranch and the newly established USFWS Baca National Wildlife Refuge), the Oasis commercial development immediately adjacent to the park near the main entrance, and rural residential development. The latter includes the Baca Grande subdivision and Crestone to the north, and the Zapata subdivision to the south. The San Luis Lakes State Park and portions of the Bureau of Reclamation's Closed Basin Project are situated southwest of the park.

The majority of Alamosa and Saguache counties have been zoned as agricultural, with residential uses allowed "by right." Other uses in unincorporated areas require approvals from the respective zoning administrators and commissions. Separate zoning and land-use regulations govern development in Alamosa, Center, and Saguache.

Privately owned lands comprise over two-thirds of Alamosa County, a higher share than characterizes Colorado as a whole. Another 19% of the land is in federal management and about 12% is owned and managed by the state (table 15). Federal land management agencies include the BLM, USFWS, USFS, National Park Service, and Bureau of Reclamation.

Federal lands account for approximately 69% of the lands in Saguache County, a much higher share than in either the state as a whole or Alamosa County. Another 4% of the land in the county is managed by the state and 27% privately owned. The latter includes a small amount of land managed by local public entities such as municipalities or school districts.

An important dimension of the extensive federal land ownership are payments-in-lieu-of-taxes, or PILT. PILT is a federal program administered by the BLM distributes annual payments to local governments that contain qualified federal lands within their jurisdictional boundaries. The payments are intended to help offset the diminished property taxes receipts due to nontaxable federal lands within their boundaries.

A county's eligibility for PILT is based primarily on the acres of federal lands in the USFS and national park systems, and lands administered by Bureau of Land Management. A total of 79,182 entitlement acres were located in Alamosa County in FY 2005, with 1,393,880 acres in Saguache County (table 16). Of those lands, the National Park Service manages 13,081 acres in Alamosa County and 117,670 acres in Saguache County. These NPS acreages reflect federal land acquisition and administrative management changes associated with the park and preserve as of October 1, 2004.

Actual PILT payments are affected by congressional appropriation levels. Fiscal year 2005 PILT payments to counties were $107,594 to Alamosa County and $456,617 to Saguache County. In recent years, congressional appropriations have funded about 68% of the total PILT entitlements.

TABLE 15. LAND OWNERSHIP

County	Total Land Area (Acres)	Ownership (Percent)		
		Federal	State	Private and Local Gov't
Alamosa	462,854	19%	12%	69%
Saguache	2,027,724	69%	4%	27%
Colorado	66,614,084	37%	5%	58%

Source: Colorado Department of Local Affairs 2001, and Department of the Interior 2005

TABLE 16. FEDERAL PAYMENT IN LIEU OF TAXES, FISCAL YEAR 2005

County	Total Land Area (Acres)	PILT Entitlement (Acres)	Entitlement Share of Total	Total PILT Receipts
Alamosa	462,854	79,182	17.1%	$ 107,594
Saguache	2,027,724	1,393,880	68.7%	$ 456,617

Sources: Colorado Department of Local Affairs 2001, and Department of the Interior 2005

Saguache and Alamosa counties also received payments under the Refuge Revenue Sharing program. Similar in principle to PILT, this program involves only lands administered by the USFWS. In 2004, payments were $2,000 to Saguache County and $10,699 to Alamosa County. The payment to Saguache County reflects lands acquired by the USFWS through September 2004 (Fowler 2005).

Economic Contributions of Great Sand Dunes Park and Preserve

The location and operations of the park function as an important cog in the regional economy. Spending by visitors to the park, as well as NPS personnel and operating and maintenance expenditures, support local business establishments and generate tax revenues to help support local government.

Visitor Spending

Total recreation visits of 268,824 were recorded at the Great Sand Dunes Park and Preserve in 2004. Of that total, 43,100 visits involved overnight stays in the park; the remainder were day visits. Based on the 2002 Visitor Survey for the park, 64% of the latter were by nonresidents, of which over 90% spent at least one night in the region[3]. Using procedures developed by the National Park Service to estimate the economic impacts of its operations, these figures result in an estimated total of 135,995 party-days.[4]

Based on the estimated profile of users to the park, average spending per party-day in the region is estimated at $90.60, yielding total estimated annual visitor spending associated with the park of $13.13 million (table 17). Most of the total, $9.02 million (69%), is by visitors staying overnight in area motels, bed and breakfasts, and other lodging accommodations. Nonlocal day users account for the second-largest share of spending, $2.79 million or 19%.

An estimated $9.18 million of the total visitor spending is captured in Saguache, Alamosa, or other nearby counties located within a reasonable distance to accommodate overnight visitors prior to or following their visit. The remaining $3.96 million leaves the region to cover the cost of goods sold. Locally captured receipts include those by motels, RV parks, and other accommodations, as well as restaurants, cafes, retail merchants, and other recreation and entertainment establishments. Locally captured visitor spending includes nearly $300,000 in annual purchases of books, maps, and other items sold by the Western National Parks Association at the gift shop in the visitor center. A portion of that total is returned to the park as a contribution via an agreement between the National Park Service and Western National Parks Association.

Total spending by visitors also includes entry and camping fees at the park. In FY 2004, such receipts included nearly $353,000 in entry fees and $150,000 in camping fees. A portion of the fees collected by the park accrues directly to the park for use in meeting the backlog of capital facility and maintenance needs.

[3] The visitor survey defined the region as locations within a 1-hour drive of the Great Sand Dunes. That radius encompasses Alamosa, Saguache, Crestone/Baca Grande and other communities within the San Luis Valley.

[4] A "party-day" is a standardized measure of visitor use that accounts for varying sizes of travel groups, lengths of visit, day versus overnight visits, and multiple entries into a park. Party-days are used to develop economic impact estimates using expenditure data that are typically collected and reported for a group of visitors, i.e., a party, on an average "per day" or "per trip" basis. The expenditure day typically includes camping or overnight lodging expenditures. Since not all visitors stay overnight, converting recreation visits to party-days provides a basis for estimating overall expenditures using average expenditures.

TABLE 17. ANNUAL SPENDING IN SAN LUIS VALLEY BY VISITORS TO THE GREAT SAND DUNES

Category	User Segment			
	Local Day User	Nonlocal Day User	Motels, B&Bs, etc.	Camping
Spending per Party-Day	$ 38.11	$ 45.08	$ 165.94	$ 65.69
Party-Days	21,075	32,613	54,372	27,934
Total Spending	$ 803,000	$ 1,470,000	$ 9,022,000	$1,835,000
Total Spending – All Users	$13,131,000			

Sources: MGM2 and Sammons/Dutton LLC

Overall, visitor spending associated with the park supports an estimated 334 jobs across the region, generating $4.1 million in annual personal income. This is in addition to jobs and income associated with park operations and staff, which are discussed in the next section.

Park Operations

The annual budget for NPS operations at the Great Sand Dunes National Park and Preserve represents an economic infusion into the regional economy. Spending of wage and salary income by NPS employees stimulates induced effects in the region, and spending by the National Park Service on utilities, supplies, and services support additional sales, jobs, and income. The effects of National Park Service operations are an addition to the effect of visitor spending associated with the park.

The annual base operating budget at the park for FY 2002 through FY 2004 averaged about $1.45 million. An increase in the base budget went into affect in FY 2005, coinciding with the expansion of the park.

In 2004, the park was funded for 22 full- and part-time, year-round employees, plus 21 seasonal employees (six FTEs). The NPS payroll for personnel was $1.45 million in salaries and benefits, or more than 86% of the total operating budget in fiscal 2004. The National Park Service spent another $191,000 for utilities, services and travel, supplies, and small equipment items.

National Park Service spending in the local economy in FY 2004 is estimated to have supported 37 jobs in the San Luis Valley, including 28 FTE jobs at the park and an equivalent of nine additional jobs supported by the park's direct local spending and that of NPS employees. National Park Service operations generated an estimated $1.66 million of personal income in 2004, including the direct payroll of staff.

Overall, spending by the park and park staff generates an estimated $1.45 million in expenditures for housing, utilities, transportation, and other goods and services.

Combined Effects of Great Sand Dunes Visitor Spending an Park Operations

The combined effects of Great Sand Dunes visitor spending and park operations include 371 full- and part-time jobs (2.8% of all local jobs), $15.58 million in spending, and $5.76 million in personal income. Local spending supports local

businesses and generates various fees and tax revenues that help support local government.

Attitudes and Lifestyle Issues Associated with the Park

Although there is no single, established, defined community associated with the Great Sand Dunes, there is a virtual community comprised of the staff, visitors, neighbors and adjacent landowners, park volunteers, American Indians, and many other interested individuals and entities. The latter include local, nonlocal, and even international residents, private enterprises, public-interest groups, governmental agencies, and other institutions and organizations. The broader community also encompasses the property owners and residents of the nearby Zapata subdivision, employees and members of The Nature Conservancy, and the property owners, residents, institutions, and spiritual retreats in Crestone and the Baca Grande subdivision to the north. Many members of the broader community were active in efforts to see the park established and consider themselves to have a vested interest in the park.

Within that broad community exists a wide spectrum of views, perspectives, and attitudes regarding the park itself and associated resources and opportunities. For some, the park is viewed primarily as an outdoor recreational resource, for others a unique and globally significant environment warranting conservation. Even among outdoor enthusiasts, attitudes regarding the park vary among those who seek solitude and backcountry experiences commonly associated with wilderness, those who desire motorized access to large portions of the existing nonwilderness, and those who view the park and the surrounding environs as significant in a metaphysical or holistic sense, contributing to their spiritual, emotional, or psychic well-being.

Members of this virtual community, be they individuals, groups, or institutions, ascribe to multiple views toward the park, how it presently affects them, and how it could affect them if the park were managed differently in the future. Moreover, many may see both benefits and adverse effects on their personal and community lifestyle, depending on how the park is managed. For example, some residents of the Crestone/Baca Grande community and elsewhere see economic development potentials associated with future recreation use, while also being concerned about the potential traffic impacts of such use. In fact, among local residents, the subject of public access to the northwest part of the park is perhaps the single most critical issue associated with future management of the park, and resolution of that issue may shape their sentiments toward the park over the long term.

HEALTH AND SAFETY

Approximately 260,000 people visited the Great Sand Dunes during 2004 for recreational purposes, primarily during the summer (NPS 2005a). Because of the expanded land base and redesignation as a national park, visitation is expected to increase in the spring, fall, and winter seasons. Total annual recreation visits are projected to reach approximately 375,000 in 2025.

The health and safety of park visitors, staff, and neighbors are of great importance to the National Park Service. Areas of concern related to health and safety identified during the scoping and planning process for this GMP include: dogs, fire, traffic

safety within the park, and personal accidents/injuries.

Dogs

Leashed dogs are allowed throughout the national park and preserve. Leashed dogs have been allowed in the park (formerly the monument) for years. Dogs that are being used for hunting are permitted off-leash in the preserve only[5]. Dogs were also allowed in this area (preserve) prior to 2000, when it was managed by the USFS.

Health and safety concerns related to dogs include visitor injury, intimidation, and annoyance; dog waste in surface waters; and safety/health of dogs themselves (from traversing hot sand or temperature extremes while confined to visitor vehicles). Between 2000 and 2004, no dog bites were reported in the park. No information is available about bites that may have occurred, but were not serious enough to require medical treatment. In the 2002 Visitor Survey question about park safety, only one respondent of 364 mentioned off-leash dogs as a safety concern (NPS 2002). However, the park sometimes receives complaints about aggressive dogs. Because no personal injury incidents have been reported, this health and safety issue is not analyzed in detail in this document. Other topics connected with dogs (e.g., water quality, visitor experience, and wildlife effects) are discussed, however, in separate sections of this document.

[5] Unleashed dogs, up to eight in a pack, may be used to chase and tree mountain lions in the preserve. As of 2005, the mountain lion hunting season lasted from November 17 – March 31. The preserve is located in Management Unit 82, for which six mountain lion licenses were available in 2005. It is also legal to use unleashed dogs in the preserve to pursue, bring to bay, retrieve, flush, point (but not kill) small game, waterfowl, game birds, or furbearers. Some small game seasons are open year-round.

Fire

Between 1983 and 1997, there was an annual average of 1.3 recorded wildland fires in the park (NPS et al. 2005). One human-caused wildfire began in the Zapata subdivision south of the park in 2000 and burned into the park, destroying a seasonal residence, the amphitheater, plus various signs, barriers, etc. This fire burned approximately 3,000 acres of mostly grassland and shrubland habitat, with some piñon-juniper and aspen woodlands, plus a riparian area (NPS et al. 2005).

A number of towns, subdivisions, and individual residences are located near the park and could be affected by fires that start in the park. These communities include Crestone/Baca Grande, Moffat, Hooper, Mosca, and Zapata. Park visitors, NPS staff, and Nature Conservancy staff based at Medano Ranch could also be affected, as could Baca National Wildlife Refuge employees. Capacities at various park camping areas include the Pinyon Flats campground (650 people), designated backcountry campsites (42 people), and primitive campsites along Medano Pass Road (400 people). The Nature Conservancy also has guests occasionally at Medano Ranch; most visit between March and October (NPS et. al 2005).

The *Greater Sand Dunes Interagency Fire Management Plan Environmental Assessment / Assessment of Effect* (April 2005), analyzed environmental effects of this cooperative fire management plan. Those discussions are not repeated in this GMP. New fire risks associated with the GMP alternatives are those caused by humans using new areas of the park. In particular, the proposed campground in the northern portion of the park (three public nodes alternative) could pose fire risks. Also, if Medano Ranch buildings are

left unmaintained (dunefield focus—maximize wildness alternative), they could pose a potential structural/wildland fire (accidental or arson) hazard.

Traffic Safety Within the Park

Visitors are directly affected by the experiences they have when they arrive at the park and make their way to its principal features, primarily by automobile. Scenic driving is a common recreational activity in the park (NPS 2002). The main park road provides access to the park headquarters, visitor center, Montville trailhead, dunes access road, amphitheater, Medano Pass primitive road, and Pinyon Flats campground. In addition, numerous turnouts along the main park road provide panoramic views of the dunes and the surrounding mountain ranges (NPS n.d.).

Twenty-three motor vehicle accidents were reported in the park from 2000–2004 (see tables below) (NPS 2005b). Of this number, 11 were reported along the main road, accounting for nearly half of all accidents of this type in the park. The highest number of motor vehicle accidents (10) occurred in 2004, and half of those occurred along the main road. With the exception of the year 2002, traffic accidents increased in frequency during 2000–2004. It is not clear whether this trend will continue, but it is likely to if more roads are available and if visitation increases. Eighteen of the 23 accidents occurred during the busiest visitor season (May to September), and the most traveled roads—i.e., the main road and Medano Pass Road—experience the largest number of accidents. These patterns are likely to continue.

TABLE 18. GREAT SAND DUNES ACCIDENTS BY LOCATION 2000–2004

	Number	% of Total
Main Road (entrance)	11	48
Medano Road	4	17
Medano Pass	3	13
Dunes Lot	2	9
Campground	2	9
Visitor Center	1	4
Total:	**23**	**100 %**

TABLE 19. GREAT SAND DUNES ACCIDENTS BY YEAR

	Number	% of Total
2000	2	8
2001	5	22
2002	1	4
2003	5	55
2004	10	44
Total:	**23**	**100 %**

When the dunes parking lot fills, visitors park along the shoulders of the dunes lot access road and portions of the main park road. Visitors then walk on the road to reach dunes access points. Although this phenomenon has not resulted in accidents to date, this is a safety concern as visitation is expected to increase. Actions proposed in the GMP alternatives that could (1) introduce accidents in new areas, or (2) increase the number of vehicles in existing areas, and which have the potential to affect the incidence of vehicle, vehicle-pedestrian, vehicle-bicycle, or bicycle-pedestrian accidents include:

- public vehicle access to Medano Ranch headquarters

- public vehicle access to the north part of the park (former Baca Ranch)
- increased parking capacity at the dunes parking lot
- multiuse path or bike lanes from the park entrance to the visitor center
- hiking/biking path from Pinyon Flats campground to the dunes lot

Impacts of these actions as they relate to traffic safety are discussed in the environmental consequences chapter.

Personal Accidents/Injuries

Of the nearly 1 million visitors who visited the park and preserve during the period 2000–2004, 95 experienced accidents or other health-related incidents. This equals roughly one visitor in every 10,500 (NPS 2005b).

Emergency medical service (EMS) and search and rescue (SAR) records from 2000–2004 provide information about visitor safety at the park. During this period, 95 EMS and SAR incidents occurred (NPS 2005b). Of these, six (6%) occurred outside the dunefield area and 89 (94%) occurred in and around the dunefield, including the visitor center and campground. Of the incidents outside the dunefield area, one required both a SAR component and an EMS component. There were 28 SAR incidents and 61 EMS incidents in and around the dunefield. In 18 of 31 SAR incidents, the subjects were found uninjured. The most numerous causes of EMS responses were illness and trauma from falls (NPS 2005b).

New areas open to visitor use or actions in the GMP alternatives that could change the incidence of visitor accidents include:

- visitor use in the north part of park (former Baca Ranch)
- eventual visitor use in the south part of the park (Medano Ranch)
- new hiking trails in the preserve
- allowing historic structures to decline
- encounters with bison

The Medano Ranch and former Baca Ranch areas are open landscapes composed of sand, shrubland, grassland, and riparian corridors. Visitor safety risks in this area include dehydration, heat stroke, lightning, exposure, sudden and unexpected weather changes (frostbite/hypothermia), altitude, and disorientation. In the north part of the park (former Baca Ranch) limited EMS access in the event of an accident is a concern. In the Medano Ranch area, buildings that are allowed to gradually deteriorate by nature's forces and encounters with bison are of interest. To date, there have been no bison/staff or bison/visitor incidents at Medano or Zapata ranches (Robertson 2005).

The mountainous preserve is composed of aspen forests, mixed montane conifer forests, alpine dry tundra and moist meadow, piñon-juniper woodland, and spruce-fir woodland. This mix of terrain and habitat draws many hikers and campers. New hiking trails could affect the incidence of visitor accidents. Technically challenging terrain, altitude, lightning, dehydration, heat stroke, exposure, frostbite/hypothermia, altitude, disorientation, and restricted EMS access in the event of an accident are of concern.

Various historic buildings, which may or may not be maintained, are located in areas where visitors may be present. Buildings that are left to deteriorate by nature's forces could pose safety risks. Although the National Park Service plans to assess buildings to see if they pose a human safety risk, rapid degradation or a shortage of park staff to monitor the condition of buildings could contribute to unsafe conditions. Unsafe conditions could include hantavirus from rodent habitation, or structural failings such as rotting roofs, floors, or frame. Often historic habitation sites have hidden pipes, barbed wire, and other sharp metal objects that pose injury risks. Such buildings could also shelter potentially dangerous wildlife such as rattlesnakes.

NATIONAL PARK SERVICE OPERATIONS

Operations and Management

Great Sand Dunes National Park and Preserve is administered by a superintendent and several division chiefs. Management of the park is organized into several functional divisions. As of 2005, there were 28 FTEs. The GMP alternatives could necessitate minor staff increases. When the expanded park is fully staffed, there would be from 33 to 38 FTEs, depending on the alternative. The added staff would address park operational, maintenance, and visitor service needs for an increasing number of visitors, a larger geographic area, and an expanded inventory of access points, trails, equipment, and facilities. Implicit therein would be a need for future increases in the park's annual operating budget. However, overall budgets for the National Park Service are established by congressional appropriation, with budgets for individual units established by allocating the overall budget among the competing needs within the agency. Future budget constraints could limit or delay increases in the Great Sand Dunes budget, while inflationary effects erode current budgets. These factors would limit future staffing and implementation of GMP elements.

The park also benefits from cooperative arrangements for managing land resources and providing services (and in some cases, sharing of resources). Nonetheless, these arrangements require staff time and other resources to implement. Numerous federal, state, local, and private organizations and agencies work cooperatively with Great Sand Dunes staff.

Administration

The administration division provides coordination and is responsible for park budget, fiscal, and real property management activities. Administration also has responsibility for human resources, information management, and park housing administration. As of 2005, there were 2.2 FTEs in this division.

Friends of the Dunes is a nonprofit citizen's support group for the Great Sand Dunes. The organization provides volunteer and financial aid for Great Sand Dunes projects, assists with visitor education efforts, and promotes recreational opportunities at the dunes. Western National Parks Association is a nonprofit cooperating association of the National Park Service that supports interpretive activities at the park through development of publications, book and merchandise sales at the visitor center, etc.

Interpretation and Visitor Services

Interpretation includes education services for diverse audiences, interpretation of identified park themes, staffing the visitor center, and providing information and orientation for park visitors through personal and nonpersonal services (e.g., park Web site, publications, exhibits, and Volunteer-In-The-Parks program). The main base of operations for interpretive staff is the visitor center building. Depending on the GMP alternative, new interpretive staff could be needed at Medano Ranch. As of 2005, there were four FTEs in interpretation.

Visitor services include fee collection and campground management. Fee collection includes revenue management, greeting visitors, visitor safety, and dissemination of resource protection messages. As of 2005, there were 5.5 FTEs in visitor services.

Resource and Visitor Protection

The resource and visitor protection division is responsible for visitor and employee safety, resource protection, emergency response, park and facility patrols, security, emergency medical services, search and rescue, structural and wildland fire, law enforcement, air operations, resource protection education, dispatch, and concession operations in the park. This division also provides emergency and law enforcement response and aid to local, county, and state agencies through cooperative agreements. Addition of the preserve and areas like the former Baca Ranch and Medano Ranch substantially enlarged the boundaries of the old national monument. As a result, the park now includes additional natural and cultural resources that require protection and patrols. More area and more visitors means more need for medical services, law enforcement, dispatch, patrols, resource protection education, fire protection, and search and rescue. As of 2005, there were seven FTEs in this division.

Facility Maintenance

Maintenance is responsible for the operation and maintenance of all park facilities and equipment including: utilities (water, wastewater, power, and solid waste), structures and grounds, frontcountry and backcountry visitor use areas, trail systems, picnic areas, roads, park signs, and vehicles. New facilities, structures, roads, trails, and use areas will require additional maintenance. As of 2005, there were 7.9 FTEs in this division.

Resource Management / Museum Collections Management

The resource management division is responsible for management of natural and cultural resources. It oversees the research program; consults with outside resource experts, agencies, and associated tribes; plans for future research and management needs; monitors and protects resources; ensures that management has pertinent scientific information on which to base decisions; and provides information for staff and visitor education. As of 2005, there were 6.5 FTEs in this division.

Resource management and museum collections share museum collections management and library management responsibilities. The park's museum collection includes natural objects (floral and faunal specimens), cultural objects and materials, and archives and photographs.

Facilities

The park includes structures within the original national monument, and structures within the park expansion area (Alpine Camp and structures associated with Medano Ranch, which is currently owned by The Nature Conservancy, but could be transferred to the National Park Service during the life of this GMP). There are also other historic structures in the former monument (e.g., Shockey's cabin, Herard Homestead, etc.), but the GMP would not alter management of these structures.

The National Park Service monitors deferred maintenance in the national park system through the use of an asset tracking system known as the Facility Management Software System. Deferred maintenance is work that should have been done at specific times but was not, primarily due to budget constraints. The National Park Service is striving to reduce the deferred maintenance backlog by prioritizing projects and funding them through various funding sources, including the Fee Demonstration Program.

Park Buildings

National Park Service buildings and structures associated with the original monument include the visitor center, Pinyon Flats campground, amphitheater, comfort stations at the dunes parking lot, park headquarters and entrance station along the main park road, maintenance buildings, horse shelter and corrals, resource laboratory, and park housing area. Table 20 provides sizes for individual structures.

TABLE 20. NATIONAL PARK SERVICE BUILDINGS AND STRUCTURES

Structure	Sq. Feet	Structure	Sq. Feet
Visitor Center	13,800	Comfort Stations (5)	474
Amphitheater	600	Mission 66 Comfort Station	400
Amphitheater Bridge	—	Dome Comfort Station	616
Entrance Station	667	Water Tank	—
Superintendent's Residence (headquarters)	1,926	Residential Trailer	980
Resources Lab and Offices	2,560	Residential Trailer	840
Shop	3,716	Residence (3)	1,787
Maintenance Storage Bldg.	2,400	Residence (3)	1,512 ea.
Fire/Search and Rescue Cache	2,220	Residence (apartments)	1,625 ea.
Fee Booth	63	Residence (duplex)	2,661
Horse Barn	1,292	Trailer Pads (2)	—
Wood Shed	203	Well Houses (4)	120 ea.

Two new additional housing units would be built in the existing employee housing area under the no-action alternative. No other changes are proposed to any of these areas or structures, so they will not be discussed further in this document.

Alpine Camp. Alpine Camp is proposed for use in all alternatives as a backcountry patrol cabin. This site includes a simple one-room "cabin," a frame privy, a small one-room tack building, and a corral. Alpine Camp is not discussed further because no changes are proposed for this area.

Medano Ranch. Medano Ranch includes the headquarters complex, which consists of a main ranch house on the north, and other buildings located along the edges of the open ranch yard. These buildings roughly form a square. Support facilities for ranch workers are located at the east part of the square, while animal facilities are located on the west and south. A large corral area lies south of the buildings. Several smaller log buildings that are no longer needed for ranching operations are now gone. About half of the original Medano Ranch structures still stand.

Buildings and structures are listed in table 21 (NPS 2004):

Roads and Trails

Roads and trails provide access to many of the park's natural wonders. Roads provide access to facilities such as the visitor center, picnic areas, and campgrounds. Trails provide access to more remote locations within the park such as lakes, scenic overlooks, mountain passes, and the dunes.

Roads. The main park road is a 4.5-mile, two-lane paved road connecting the main park entrance on the south boundary to the Pinyon Flats campground and amphitheater, which lie at the road's northern terminus. Piñon Circle is a two-lane paved road running from east to west that provides access to administrative facilities (maintenance area, resource management lab, fire cache facility, and employee residences). The dunes access road is a two-lane paved road running from east to west, connecting the main park road to the dunes parking lot and the Mosca Creek picnic loop. Medano Pass primitive road is an unimproved four-wheel-drive road that runs northeast from near the Pinyon Flats campground through the park and preserve. Cow Camp Road is an improved gravel road in the northwestern portion of the park (NPS n.d.).

At the park headquarters, visitor and employee parking (11 spaces, one wheelchair accessible) is provided north and south of the building. At the visitor center, 54 parking spaces are provided for passenger vehicles, including two wheelchair-accessible spaces and two spaces for RVs and buses. Sixteen spaces are designated for employee parking. The dunes parking lots (north and south) have a combined capacity of 93 passenger vehicle spaces and 11 oversize spaces (for RVs, trailers, etc.). The Montville trailhead parking area provides 25 passenger vehicle spaces (including one wheelchair accessible), for the Montville nature trail, the Wellington Ditch trail, and the Mosca Pass trail. The Pinyon Flats amphitheater parking area provides 22 passenger vehicle spaces, including one wheelchair-accessible space and four RV/bus parking spaces. An RV dump station is located in the center of this parking area, which is also used for loading and unloading visitors' horses from trailers (NPS 2005b).

TABLE 21. MEDANO RANCH BUILDINGS AND STRUCTURES

Structure	Description
Main Ranch House	Log ranch house consisting of three small one-story cabins joined together with a log addition to the east (pre-1912 with post-1947 additions)
Bunkhouse/Kitchen	A rectangular building measuring 28 ft 8 in x 21 ft
Cook's House	A small one-story, rectangular log building measuring 29 ft 4 in x 13 ft
Harness Shed	A simple one-story rectangular (26 ft 6 in x 12 ft 4 in) frame building
Draft Horse Barn	A one-story square log building measuring 28 ft x 28 ft
Meat House	Pre-1920 log building measuring 13 ft 6 in
Outhouse	Pre-1941 frame building measuring 6 ft 4 in x 6 ft 4 in
Cottonseed Cake House	Pre-1930 (possibly 1880s) frame building measuring 40 ft x 19 ft
Corral	Pre-1912 irregular corral measuring approximately 550 ft (east-west) by 300 ft. (north-south) with wide central alley (15 ft wide) running east-west
Machine Shed	Post-1947, long rectangular structure measuring 81 ft 5 in x 20 ft 7 in
Metal Silo	Post-1947, cylindrical metal silo of unknown dimensions
Shed	Post-1947 log building measuring 48 ft 1 in x 20 ft 4 in
Machine Shed	Post-1947, long, narrow log building measuring 84 ft 4 in x 25 ft

Roads at Medano Ranch include the main ranch road, which extends north from County Road 6N to ranch headquarters, and then west to Dollar Lake and Hooper. Two four-wheel-drive roads run to Big and Little Springs and numerous smaller two-tracks follow fence lines (Robertson 2005).

Trails. The Montville Nature Trail is a short loop trail located 0.2 mile east of the visitor center. It showcases flora, fauna, and natural park processes. Mosca Pass Trail heads east from the visitor center into the Sangre De Cristo Mountains to Mosca Pass, where it exits the preserve and becomes a road. From this same trailhead, the Wellington Ditch Trail extends north to the Pinyon Flats amphitheater and campground. From that point, the trail becomes the Sand Ramp Trail and heads north skirting the mountain apron, crosses Medano Creek and then heads west to Sand Creek. North of Sand Ramp Trail, the Sand Creek Trail extends to the northeast along Sand Creek to the Sand Creek Lakes. Music Pass Trail connects to Sand Creek Trail east of Sand Creek Lakes. The Dunes Overlook Trail is located off the Sand Ramp Trail, north of Pinyon Flats campground. The Medano Lake Trail extends west from a parking area along Medano Pass primitive road, just southwest of the pass summit. There are also several connector trails such as the one between Pinyon Flats campground and the dunefield.

The three public nodes—new dunes experiences and the NPS preferred alternative propose additional trails in the northern portion of the park to provide access to the mountain front.

Campgrounds

Pinyon Flats campground is the only developed campground in the park.

Located north of the visitor center, the campground is open year-round and has 88 campsites available on a first-come, first-served basis. Fire grates, picnic tables, flush toilets, and drinking water are available. The campground is located in piñon-juniper forest and has striking views of the dunes and Sangre de Cristo Mountains. None of the GMP alternatives propose changes to the Pinyon Flats campground. Designated backcountry campsites in the park can accommodate up to 42 people, and primitive campsites along Medano Pass primitive road can accommodate up to 400 people.

The Great Sand Dunes Oasis, which is open seasonally, is located at the entrance to the park. Various facilities are available here, including a store, campground (70 spaces), lodge, RV spaces with hookups, small cabins, showers, and a dump station.

San Luis Lakes State Park, located in the low dunes just outside the southwest corner of the Great Sand Dunes, includes the 51-site Mosca campground (open seasonally). It features a panoramic view of the lake, the surrounding mountains, and the dunes. All sites have electrical hookups, sheltered tables, fire grates, and drinking water. It also includes a dump station and laundry facility, plus a bathhouse with modern restrooms and hot showers. Campsites can accommodate motor homes, trailers, or tents.

The Crestone/Baca Grande community, located immediately north of the park, also has camping facilities. The private Camper Village near Crestone has approximately 10 campsites for RVs (saguache.com 2005). The North Crestone Campground is a USFS campground located 1.2 miles north of Crestone. It has 13 campsites with tables and fire grates. It includes hand pumps for water and vault-style outhouses (USFS 2005b). The UFO Watchtower private campground, located on Highway 17, has a number of primitive sites with no facilities available (ufowatchtower 2005). Commercial campgrounds are also available in Alamosa and Blanca, Colorado.

OTHER ENTITIES AND MANAGEMENT AGENCIES' OPERATIONS

During the development of the GMP, concerns arose relative to the impacts of the various GMP alternatives on the operations of other public land and resource management agencies (particularly CDOW, USFS, and USFWS) as well as other organizations (e.g., The Nature Conservancy and Lexam). These concerns related to public vehicle access to and through the northern portion of the park, and designation of wilderness (with possible attendant consequences for monitoring, management, and other activities). The bases for these concerns are described below, and the concerns are addressed as an impact topic under "Other Entities and Management Agencies' Operations" in chapter 4.

Public Access Across the Northern Park Boundary

Public access across the northern boundary of the national park is currently limited to pedestrian access. Due to surrounding land ownership and road patterns, topography, and designated wilderness, there is presently no way to access the northern portion of the national park by vehicle, although visitors can get to the northern boundary via the Baca Grande subdivision. The USFS would like to consider the possibility of public vehicle access to its new lands bordering the park so that the agency can consider activities and facilities in that area during their management planning. The new USFS lands are located east of the Baca Grande subdivision and are

referred to as "Zone B" in the Great Sand Dunes Act of 2000. Liberty Road, which forms much of the border between the new National Park Service and USFS lands in the area just southeast of Baca Grande, actually passes through (instead of running just outside the boundary of) the park for approximately 0.7 mile. The main concerns of the USFS are (1) public vehicle access to USFS lands for general recreation, and (2) public vehicle access to USFS lands to facilitate elk hunting and elk herd population control. The latter of these concerns—facilitation of elk hunting and elk herd population control—has also been expressed by CDOW relative to public vehicle access through the northern portion of the park. The USFS is also concerned about access to and possible future uses of private in-holdings at Liberty, Short Creek, and Pole Creek.

There are two potential future routes for public vehicle entry into the northern portion the national park: (1) via Saguache County public roads through the Baca Grande subdivision, or (2) via road(s) through the Baca National Wildlife Refuge. This potentiality necessitates that the USFS and USFWS also consider these routes in their planning processes. Because public vehicle access via either of these routes is outside the control and jurisdiction of the National Park Service, this GMP does not resolve the question of which option, if either, might ultimately be used. It instead leaves flexibility for either option, should future conditions allow.

Vehicle access across the northern boundary of the park may appeal to some segments of the public, particularly those for whom hiking or horseback riding long distances is difficult or impossible. Public comments during the National Park Service GMP planning process also indicated a general desire to retain the wild character of ecologically sensitive areas such as the various riparian corridors and canyons in the northern part of the park.

Current estimates for the number of hunters who may want to access the mountain front via Liberty Road (or some other vehicle access route in the northern part of the park) ranges from 20 to 30 hunters for each of the three 5-day hunting seasons, which translates to 60 to 90 hunters annually (CDOW 2005). The number of trips into and out of the area may actually exceed this number if some of the hunters drive in to scout areas before the season(s) begin.

Designation of Additional Wilderness

Designation of additional wilderness within the park is recommended in two of the GMP alternatives (NPS preferred alternative and the dunefield focus—maximize wildness alternative). The Wilderness Act of 1964 (Public Law 88-577) provided for the establishment of the National Wilderness Preservation System. The Wilderness Act states, "In order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." Although there is great similarity between the National Park Service Organic Act and the Wilderness Act, Congress applied the Wilderness Act to the National Park Service to strengthen its protective capabilities. National Park Service *Management Policies 2001*, section 6 states, "The National Park Service will evaluate all lands it administers for their suitability for inclusion within the National Wilderness

Preservation System. For those lands that possess wilderness characteristics, no action that would diminish their wilderness suitability will be taken until after Congress and the president have taken final action. The superintendent of each park containing wilderness will develop and maintain a wilderness management plan to guide the preservation, management, and use of the park's wilderness area, and ensure that wilderness is unimpaired for future use and enjoyment as wilderness." Therefore, all wilderness categories, including suitable, study, proposed, recommended, and designated shall be treated as wilderness (Interagency FMP 2005).

The Colorado Division of Wildlife has expressed concern about the potential consequences of wilderness designation on CDOW efforts to control elk numbers. Declines in bighorn sheep and mule deer populations along the Sangre de Cristo range have been attributed, at least preliminarily, to the burgeoning elk population in and near that mountain range. Growing elk numbers are also thought to be responsible for habitat degradation in portions of the Sangre de Cristo Wilderness. It has been suggested that elk are using the national park as a refuge, since no hunting is allowed on NPS lands outside of the preserve. The CDOW concern is that if additional portions of the park are designated as wilderness, methods for controlling the increasing elk herd, particularly those requiring use of motorized vehicles (e.g., "hazing" or herding elk to areas where hunting is permissible) will be unavailable. The result could be that the elk population would grow unchecked, resulting in damage to natural habitats and neighboring agricultural areas, further declines in other native ungulate species, and increased risk of a disease outbreak in the elk herd itself.

Wilderness designation does not necessarily preclude the use of ATVs or other vehicles or equipment to carry out needed control actions. The "minimum requirement" concept and "minimum tool" and "primitive tool" procedures, as specified in the Wilderness Act (1964), NPS *Management Policies* (NPS 2001), *National Park Service Reference Manual 41*, and *Minimum Requirement Decision Guide* (ACNWTC 2004), could be applied for elk management activities within designated and recommended wilderness areas. The need for active elk management, and the selection of strategies and tactics, would have to be clearly demonstrated and justified by the cooperative elk/bison study currently being conducted by the National Park Service and others. If that study does demonstrate such a need, elk management actions within designated or recommended wilderness areas would be conducted using minimum impact tactics. Strategies and tactics would be selected commensurate with elk behavior and values to be protected, as well as to minimize long-term environmental impacts. Theodore Roosevelt National Park, most of which is designated wilderness, has made such an evaluation and determined it to be acceptable to use helicopters to round up elk, bison, and horses.

The Colorado Division of Water Resources has expressed concern about the potential impacts of wilderness designation on access to monitoring wells within new wilderness. The minimum requirements process discussed above would also apply to water-monitoring activities.

IMPACT TOPICS CONSIDERED BUT NOT ANALYZED IN DETAIL

MUSEUM COLLECTION

Great Sand Dunes National Park and Preserve's museum collection consists of prehistoric and historic objects, natural history specimens, artifacts, and archival and manuscript material. The curation facility at the Great Sand Dunes National Park and Preserve, which is located in the NPS visitor center, provides adequate climate-controlled, secure storage for museum collections. There is adequate storage space for the foreseeable future in this facility. The GMP alternatives do propose any changes to how museum collection items are curated or stored, so this topic was dismissed from detailed analysis.

ETHNOGRAPHIC RESOURCES

Ethnographic resources are traditional sites, structures, objects, landscapes, and natural resources that communities define as significant to their way of life. *Seinanyédi, An Ethnographic Overview of Great Sand Dunes National Park and Preserve*, by David R.M. White, Ph.D., was written for the National Park Service in 2005. This overview identified communities who traditionally have an association with resources in the San Luis Valley and with Great Sand Dunes Park and Preserve.

Over 30 American Indian tribes, Spaniards, Mexicans, Mestizo, Hispanics, African Americans, Asian Americans, Pacific Islanders, and European Americans have affiliations with the San Luis Valley and the park. Connections with ethnographic resources were determined in consultation with the Ute, Navajo, Jicarilla Apache, Keresan Pueblos, Tewa Pueblos, Tiwa Pueblos, and Towa Pueblo of Jemez (White 2005).

Ethnographic resources within and near the park are particularly important to Jicarilla Apache, Navajo, Puebloan, and Ute people. They often visit and collect resources as part of their cultural heritage. Collected resources may include piñon nuts, various edible and medicinal plants, and sand for sacred sand paintings. Landscape features that pertain to emergence narratives are considered culturally significant. These features include water resources, Mt. Blanca, and areas not disclosed to the public (White 2005).

Ethnographic resources will not be affected by the GMP alternatives. American Indian groups and individuals will continue to be able to collect resources and go to significant areas of the park that they have traditionally visited. This topic was therefore dismissed from detailed analysis. However, a large area within the dunefield considered important by the tribes is addressed in the "Archeology" sections.

FLOODPLAINS

Executive Order 11988 (*Floodplain Management*) requires federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with occupancy and modifications of flood-plains, and to avoid direct and indirect support of floodplain development whenever there is a practicable alternative. Section 4.6.4 of NPS *Management Policies* states that the National Park Service will manage for the preservation of floodplain values and minimize potentially hazardous conditions associated with flooding. National Park Service Director's Order 77-

2 and the accompanying *Procedural Manual* (2003) provide guidance and procedures for implementing floodplain protection and management actions in units of the national park system.

There are a number of alluvial fans along the western foothills of the Sangre de Cristo Mountains. The main park roadway crosses numerous ephemeral stream drainages and one perennial stream (Mosca Creek). The ephemeral streams tend to develop during flood events that occur periodically on the alluvial fans. Mosca Creek is relatively small (average peak flow of less than 5 cfs) and has a small floodplain of no more than 30 feet across. Surface runoff is carried by corrugated culverts under the roadway and it occasionally runs across the roadway from east to west (NPS 2005c).

The dunes parking lot is situated in the bottomlands adjacent to Medano Creek. Medano Creek is intermittent in this area, generally flowing in the spring and into late summer. When flowing, it is a braided stream that spreads out and moves back and forth across the relatively flat, sandy landscape. Thus, this area lacks a well-defined floodplain such as those associated with more typical, rectangular stream channels. Since this area lacks well-defined floodplains, the statistical parameters used for flood stage, flood frequency, and stream stage cannot be applied here. However, impacts to floodplains associated with providing bike lanes on the main park road (NPS preferred alternative), hiking/biking paths (NPS preferred alternative, dunefield focus—maximize wildness alternative), or new day-use parking lots (dunefield focus—maximize wildness alternative) in the frontcountry zone would be anticipated to be long term, adverse, localized, and negligible. No human risk from floodplains would be associated with these facilities.

A floodplains statement of findings is not required for this project. NPS *Procedural Manual 77-2: Floodplain Management*, B–"Excepted Actions" indicates that exceptions include "picnic facilities, scenic overlooks, foot trails, and small associated daytime parking facilities in non-high-hazard areas provided that the impacts of these facilities on floodplain values are minimized."

PRIME AND UNIQUE FARMLANDS

In 1980, the Council on Environmental Quality directed that federal agencies must assess the effects of their actions on farmland soils classified by the NRCS as prime or unique. Prime farmland is defined as soil that produced general crops such as common foods, forage, fiber, and oil seed; unique farmland produces specialty crops such as fruits, vegetables, and nuts.

The NRCS has identified several hundred acres of soils north and northeast of the San Luis Lakes State Wildlife Area as "unique farmland," as "prime farmland if irrigated," or as "prime farmland if irrigated and reclaimed of excess salts and sodium." These prime and unique farmland areas, located on Medano Ranch, are owned or leased by The Nature Conservancy. Some are irrigated and used as forage areas for bison on Medano Ranch. None of the GMP alternatives would affect the soil qualities that make these soils prime or unique. Irrigation might be discontinued under certain alternatives if/when The Nature Conservancy transfers management responsibility to the National Park Service, but the qualities that make these soils suited for forage production or other agricultural uses would be maintained, or could be restored at some point in the future if irrigation were restored. Because no prime or unique farmland soils would be destroyed or converted to uses that

would impair their special qualities, this topic was dismissed from detailed analysis.

AIR QUALITY

The Clean Air Act of 1955, as amended (42 USC 7401 *et seq.*) was established to promote the public health and welfare by protecting and enhancing the nation's air quality. The act established specific programs that provide special protection for air resources and air quality-related values associated with NPS units. Section 118 of the Clean Air Act requires parks to meet all state, federal, and local air pollution standards. NPS *Management Policies 2001* addresses the need to analyze potential impacts to air quality during park planning. Great Sand Dunes National Park is classified as a class I air quality area (Clean Air Act, as amended).

Sources of air pollution within the planning area include automobiles, space and water heating equipment, fuel storage tanks, camp fires, wildfires, wood burning stoves, and agriculture. Despite these sources, air quality within the planning area has historically been excellent. In 2001, estimates of emissions at the park were tabulated for many of these sources (NPS Fire Management EA, 2005). These estimates indicate that Great Sand Dunes National Park and Preserve has attained state and federal ambient air quality standards (Interagency FMP 2005).

The Clean Air Act also states that the federal land manager has an affirmative responsibility to protect park air quality-related values from adverse air pollution impacts.

Today, only PM_{10} (particulate matter) is monitored at the park, and visibility is currently the only air quality resource value known to be affected by pollution (Fred Bunch, pers. comm., 2005). Effects of the GMP alternatives on visibility (primarily from dust kicked up from vehicles) are addressed in the "Scenic Resources" and "Visual Quality" sections of this document. Other impacts on regional or local air quality from the GMP alternatives would be negligible. Air pollution from sources outside the park would continue to be addressed through Clean Air Act authorities and through cooperative efforts between the National Park Service and other entities. Air quality was therefore dismissed from detailed analysis.

NATURAL SOUNDSCAPE

In accordance with NPS *Management Policies 2001* and Director's Order – 47: *Sound Preservation and Noise Management*, an important component of the National Park Service mission is preservation of natural soundscapes associated with national park units. Natural soundscapes exist in the absence of human-caused sound. The natural ambient soundscape is the aggregate of all natural sounds that occur in an area, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive and can be transmitted though air, water, or solid materials. The frequency, magnitude, and duration of human-caused sound considered acceptable varies among NPS units as well as potentially throughout each park unit, being generally greater in developed areas and less in undeveloped areas.

Noise sources in and around the Great Sand Dunes include visitors and employees, vehicles, motorized and mechanical equipment, aircraft passing overhead, and noise generated from surrounding residential and agricultural areas. A study conducted at the then monument from July 1993 until October

1994 concluded that the background sound level averaged less than 45 decibels 99% of the time, less than 40 decibels (the sound of a library) 90% of the time, and less than 35 decibels 50% of the time (NPS 1995 Ambient Sound Monitoring).

New trails, trailheads, public and administrative use areas, and a primitive campground are proposed in various GMP alternatives and could introduce low levels of sound (especially from human voices and passenger vehicles) into new areas of the park, but this would also have a negligible to minor adverse impact on visitors and employees. During construction, human-caused sounds would increase due to construction-related activities, vehicle traffic, and construction crews. Any sounds generated from construction would be temporary, lasting only as long as the construction activity continues, and would have a negligible to minor adverse impact on visitors and employees. The topic of natural soundscapes was therefore dismissed from detailed analysis.

WILD AND SCENIC RIVERS

Ten streams within the national park and preserve have been evaluated and found eligible and suitable for inclusion in the wild and scenic rivers system (appendix H). The GMP alternatives would not adversely affect the qualities that make these streams eligible and suitable for designation. This impact topic was therefore dismissed from detailed analysis.

ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

The implementing regulations of NEPA require that energy requirements, natural or depletable resource requirements, and conservation potential be analyzed. Any differences between the alternatives in terms of these factors would be localized and negligible. This impact topic was dismissed from detailed analysis.

INDIAN TRUST RESOURCES

Secretarial Order 3175 requires that any anticipated impacts to Indian trust resources from a proposed project or action by Department of the Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes. There are no Indian trust lands, assets, resources, or treaty rights associated with Great Sand Dunes National Park and Preserve. This impact topic was therefore dismissed from detailed analysis.

ENVIRONMENTAL JUSTICE

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of federal programs and policies on minority and low-income populations and communities. Executive Order 13045 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of federal programs and policies on children. None of the actions proposed in the GMP alternatives would have a disproportionate and adverse impact on minority populations, low-income populations or communities, or on children. Therefore, this topic was dismissed from detailed analysis.